CONFERENCE PROCEEDINGS

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EDITORIAL

Welcome to the proceedings of the 2010 conference of the Design Research Society hosted by Université de Montréal, Canada.

The international biennial conference of the DRS is held during even numbered years in various countries around the world. The most recent conferences have been held in London, Melbourne, Lisbon, Sheffield, and now Montréal. We are most grateful to the hosts of this year's conference for the hard work they have put in since the early discussions some two years ago.

By close agreement, DRS biennial conferences alternate with the biennial conferences of the International Association of Societies of Design Research which are held in odd numbered years, thus consistently ensuring that a world class general design research conference is held somewhere in the world each year as a service to the international design research community.

Organisation of the DRS biennial conferences is taken very seriously. Host institutions and their organising teams are often new to the special demands of DRS conferences, though the collective experience of the Society is provided to organisers as published guidelines, and members of the Society assist organisers as advisors, reviewers and sometimes convenors of focused strands of presentations.

One firm principle of these DRS conferences which has been honed over several events, is to ensure the highest standards of selection of papers that will be presented at the event and subsequently published in the proceedings. This principle is important for two reasons. Firstly, delegates tell us that they prefer to attend conferences where only the strongest research is presented that is appropriate to the audience, is communicated clearly, and demonstrates research that has reached a stage where there are findings worthy of transmission. Secondly, as the oldest learned society of its kind, the DRS believes that the interests of the community of scholars - including early career researchers and doctoral research students - are best served by adequate screening of submissions to include only work that is demonstrably robust research worthy of publication.

Review of proposals is overseen by a small internationally based Review Committee comprising several skilled reviewers, which is appointed by the DRS. This committee is chaired by a member of the DRS Council and operates independently of the host organisers. In this way, the focus is rightly on academic judgement of the research.

All reviews are double blind - that is where the reviewer and the author are unknown to each other. We rely heavily upon independent reviewers who have either been invited due to their previous good record of conducting reviews, or who have volunteered and been vetted for the purpose. Reviews were conducted by 209 reviewers plus the committees. Each full paper was read by at least two independent reviewers as well as at least one member of the Review Committee.

The quality of peer review is of course only as good as the judgements that reviewers make. Reviewers may have varying levels of expertise. Some are expert in certain closely focused topics, others may have a more encompassing view of research beyond their deeper expertise. We are fortunate to count among our reviewers for this conference some of the most prominent scholars globally. Where possible, we have matched reviewers' expertise closely to the topic of the paper. Reviewers are also expected to provide feedback to authors for improvement of their paper, or to justify their decisions.

DRS considers that maintaining a high standard of acceptance to its conferences both sets a benchmark for peer review of research papers, and attempts to provide a solid body of work to which future scholars, including research students, may refer.

DRS conferences attract many more proposals than organisers can accommodate. In our experience about one third of initial proposals make it through to the final publication. In other words, about two thirds of applications are rejected either at the proposal stage or after submitting a full paper. In rounded figures, the total of initial proposals for this conference numbered 600, from which 380 authors were asked to submit full papers for a second round of reviews. 250 full papers were received. Following final judgements, 150 papers were selected for presentation at the conference and for subsequent publication in the proceedings, thus giving an exceptional ratio from initial submission to presented paper of about 4:1. In this sense, DRS conferences are nearer to a good journal review process than many other conferences in our field.

The working language of DRS conferences is English. On this occasion, being located in a French speaking country, we optionally invited papers in French. These were reviewed by a Francophone team, and the results calibrated with the main review. The papers are published in the proceedings in their original language, though French presentations at the conference have the benefit of simultaneous translation into English.

The programme of presentations is rich and extensive, with discussions ranging across various practices which cover the recurring topics of our field of design research. Parallel sessions provide strands that run throughout the conference programme. Here we find many strands that seem common to these kinds of events such as: methods for design and research; reflective practice; interaction; user centred and participatory designing; and many others. Also, newer strands are appearing representing perhaps current or emerging concerns such as: design and society; creativity; sustainable design; and growing work across or between disciplines. In addition there are specially convened strands that address issues arising from DRS special interest groups, for example well-being, pedagogy, and experiential knowledge.

I would like to take this opportunity to thank our host organisers, the large body of reviewers based around the world, my colleagues on the Review Committee, and advisors who have been instrumental in bringing together a collection of papers clearly demonstrating the health of research in our community at this time.

We hope that you enjoy the conference, and that these proceedings provide valuable reading for you, your colleagues, and your students.

David Durling
(Chair, Review Committee)

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The Role of Interaction Design in Information and Communication Technologies Embedded Product Development Activity

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Abstract

This paper describes the role of interaction design in information and communication technologies (ICT) embedded product design and development activity. Besides presenting the relationship between industrial design and interaction design in the same activity, it also re-defines this relationship in terms of roles in ICT embedded product development activity.

This research has been accomplished by having an extensive interdisciplinary literature review, a series of interviews and also a case study based on a specific product's development process. The series of interviews have been conducted face to face in USA with professionals from 5 different industrial design and interaction design based consulting firms such as IDEO, Cooper Interaction, Smart Design, Swim Interaction Design Studio and LUNAR Design. The next step of the field research has been a case study based on gathering information of a spesific product through secondary sources and then conducting in-depth interviews with designers, who have worked in that product's development process, from different professions.

Major conclusions of the research include as follows: Being a younger discipline relative to industrial design, the role of interaction design in ICT embedded product development activity has the similarities to that of industrial design in the same activity. The most extensive collaboration between industrial design and interaction design is seen at *Planning* and *Concept Design* phases in ICT embedded product development activity. As the products become more complex in terms of interactions, interaction designers will gradually need to manage the design teams. There will be a need for a new sub-field of interaction design which is supposed to emerge as interaction design management. Comparing with industrial design, interaction design is foreseen to have a wider activity area in *Planning, Concept Development* and *System Level Design* phases of ICT embedded product development activity. As interactions with products become more and more immaterial, be a new actor from service design is supposed to have a role in ICT embedded product development activity.

Keywords

interaction design; industrial design; information and communication technologies; role of the designer; product development activity.

Penetration of information and communication technologies (ICT) in daily life has been causing changes in products. When the intensive use of ICT in different sectors is taken into consideration, it becomes inevitable to say that this subject is even transforming design processes.

Industrial design, as a professional practice, has been influenced by different dynamics such as the development of information and communication technologies, changes in products, changes in the way users interact with products, emergence of different disciplines in product design and development activity, changes in the focus points of product design and development activity throughout its short history.

In a context where products become more complex and where the competition in ICT embedded product development activity increases day by day, interaction design discipline comes into question. Alike Industrial Revolution has led up to the emergence of industrial design, the development of digital technology, especially of ICT and its use has caused the emergence of interaction design.

Throughout 20th century, while the interaction between users and products has been material, along with beginning of the design of ICT embedded products, materiality has been giving its place to immateriality in terms of interaction. This change has led to the emergence of new roles and professions in product development activities (Margolin, 1998; Buchanan, 2001; Forlizzi and Batterbee, 2004; Zimmerman, et al., 2004). One of these roles, accepted to design of the dialogue between users and products by a general definition, is interaction design (Smith, 2004; Moggridge 2006; Cooper, et al., 2007; Kolko, 2007). The profession which provides users interact with a product or system in a short span of time, continuity of interaction, decrease the period of first experience and provide less complexity but more satisfaction is considered to be interaction design (Smith, 2004; Zanini, 2004; Moggridge, 2006).

The Role of the Designer in Product Development Activity

Even though there are not specific periodical distinctions, it has been determined that there have been changes ranging from the definition of design to its role in product development activities. Especially in terms of industrial design, it is determined products and product development processes have concentrated on different focuses (Sparke et al, 1997; Vertelney and Booker, 1990; Cagan and Vogel, 2002; Heskett, 1980; 2002; Er, 2007).

Both designing and production activities have been under the responsibility of craftsmen who had the roles of designers before the Industrial Revolution (Heskett, 1980; Vertelney and Booker, 1990; Rothstein, 1999; Dreyfuss, 2003; Cagan and Vogel, 2002).

With Industrial Revolution taking out design and production from one person's responsibility, products have no more been designed and mass produced for only one but wide range of users (Heskett, 1980; 2002; Buchanan, 2001; Cagan and Vogel, 2002). In this period, the role industrial designer had been limited to design of the skin, or in other terms form (Loewy, 1979; Heskett, 1980; Dreyfuss, 2003).

Beginning to take place in early phases of product development processes caused designers participate also in user research studies (Kelly and Peters, 2001; Press and Cooper, 2003; Brown, 2005). Previously working with user and market data which marketing professionals put forward, designers have begun to collaborate with social science professionals such as human factors specialists and with people from other professions; then they needed to have information on cognitive and psychological factors in order to understand user needs and preferences. It is possible to assume that this situation accords with the factors such as understanding users, designing products or services for as many as users that underlie interaction design. Looking from the perspective of different dynamics, it is possible to say that not only ICT, but also the changes in social and economical structures will contribute to the critical roles of both industrial design and interaction design in product development activities.

Interaction Design

Interaction, which naturally exists from the presence of human beings, is taken into consideration as a profession in product development activities in this study. As Cooper et al (2007) and Smith (2004) states, interaction design is a new discipline that utilizes methods and techniques from existing disciplines.

It is determined that the development of ICT, especially the Internet, decrease in hardware dimensions, changes in products, user numbers and profiles, user-product interactions, changes in software and service development activities and the graphic user interfaces have appeared in the emergence of interaction design.

It is possible to assume that interaction design attempts to makes the interaction that is becoming more complex and more immaterial be understandable, useful, usable and desirable for users. While industrial design concentrates on the form and function of a product traditionally, interaction design concentrates both on how users interact with ICT embedded products, softwares and services and on how information can be exchanged.

Alike industrial designers design products for different uses with the contribution of mechanical technology, interaction designers define and design the dialogue between users and products, services and systems (Smith, 2004; Kolko, 2007). This similarity between industrial design and interaction design indicates that both of these professions interwine each other in terms of role sharing in product development activities. On the other hand, this similarity can be seen as an indication for potential changes in role sharing in product development activities.

Methodology

In this study an extensive literature review, including various disciplines, a series of interviews and a case study has been held.

“The role of interaction design in ICT embedded product development activity” being as the basic research interest of this study is a very new and limited field in terms of product development activity in Turkey. Therefore interviews have been conducted face to face in USA with key professionals from leading industrial design and interaction design based consultancies, that have pioneer work in the mentioned area internationally, such as IDEO, Cooper Interaction, Smart Design, Swim Interaction Design Studio and LUNAR Design. The interviewers were Bill Moggridge (IDEO), David Cronin (Cooper Interaction), Gitta Salomon (SWIM Interaction Design Studio), John Edson (LUNAR Design), Sheila Foley (Smart Design, SF Office). In this phase of field research, the definitions and design and development processes of those mentioned consultancies were examined.

The second phase of the field research has been planned as a case study based on a representative product’s literature review and interviews with professionals from different disciplines on its design and development process. After product selection criterion was prepared, it has been corresponded with firms such as Apple, Nokia and LUNAR Design. At the end of this correspondence, the case study was held on a product called Pasco Spark which has been recently designed by LUNAR Design and planned to be shipped in August 2008. Interviews of this case study were held with specialists from different professions who have worked in Pasco Spark’s design and development process through the Internet.

Findings of Interviews

Interaction designers of interviewers accept industrial designers as professionals who design product’s form and its mechanical interaction with users and who has knowledge on production and materials. On the other hand, industrial designers see interaction designers as professionals who design product’s digital interaction with users. Behavior has been stated to be the common point in both of these definitions.

Although interaction design has been considered to take part from the first step of product development activity as a common aspect of interviewers, it has been determined that there are different approaches in the related sector.

During the interviews except from IDEO, it is determined that there are significant phases in which interaction design and industrial design collaborate in the rest of the interviewer firms design and development process. When the design and development processes of the firms have been examined, interaction design based consultancies stated that some of industrial design based consultancies contacted with them to work together after having fundamental design decisions, even after defining the product's form. Interviewers emphasized that this situation has negative effects on final product's success and innovation (Cronin, 2005; Moggridge, 2005; Salomon, 2005).

When industrial design and interaction design processes in ICT embedded product development activities are considered, it is possible to assume that the fuzzy front end of product development is the process where the most collaboration and corporation between interaction designers and industrial designers takes place. It is examined that when design concept has been being generated, roles of industrial designers and interaction designers on creating the form of the product and the location, form, color and material of physical controls which users interact with, has been indefinite.

Although there has been a common viewpoint that traditional product design and development process has been supposed to continue, it has been stated that there would be changes in ICT embedded product development activities. On the other hand, it is determined as a common approach that there would be changes in terms of new material uses and production technologies.

Case Study Findings

Pasco Spark which was designed by LUNAR Design has been the product of the case study. It is a product used for education that enables students aged between 12-16 years old explore the world and make discoveries in basic sciences both inside and outside the classroom. The interviews of the case study were held with project manager, interaction designers, industrial design lead and user researchers who worked throughout Pasco Spark's design and development process in LUNAR Design.

As well as having a role as interaction designers, the interaction designers also had roles as project manager and user researchers in Pasco Spark's development process (Author, 2009). It is determined that the reason one of the interaction designers took part as the project manager besides being an interaction designer has been because of the complexity in Pasco Spark's functionality and content. LUNAR's design and development process consists of 3 main phases including sub-phases: vision, magic (the design phase) and reality (Anderson, 2008; Lebas, 2008). Although the sub-phases seem to be similar, it is determined that there are differences in terms of the content proposed and the techniques used by industrial design and interaction design (Author, 2009). During the vision phase while the design and development team concentrate on user research studies, it is observed that interaction designers focus on researching user mental models and processes. On the contrary, it is determined that industrial designers research ergonomic considerations of users and competing products in the market. When the time spent on user research is considered, it is examined that industrial designers pass over to other phases in a shorter time than interaction designers. Thus it is determined that industrial designers have already created general qualities and form alternatives about product when interaction designers just begin creating concepts.

In Pasco Spark's development activity, the phase during which collaboration and corporation between industrial design and interaction design take place is determined to be concept generation. During this phase there is information needed to be exchanged between industrial designers and interaction designers; that is to say, there are sub-phases in which both designers are dependant to each other (Author, 2009): interaction designers need to get information about the screen dimensions in which the content and interaction is supposed to be embedded from industrial designers. Thus the dimensions of the product affect the dimension and resolution of the screen and those are the factors which affect the quality and quantity of information and the interface that are supposed be embedded in the product. But at this point, it is foreseen that not only industrial designers but also interaction designers might propose the mentioned dimension information. Although this information is directly dealed with the product's form and is supposed to be within the role of industrial designers, it can be accepted as type of information in terms of product's content and its dialogue with users at the same time. On the other hand, the prototypes concerning the use of both the digital content and physical content are supposed to be compatible with each other and constitute an entirety. Because of these reasons industrial designers and interaction designers are needed to work dependant to each other.

Conclusions

This study attempts to define the role of interaction design in ICT embedded product development activity, to re-define its relationship with industrial design within the same process. According to these mentioned aims, the results of this research are explained below.

Development of Interaction Design

Being a younger discipline relevant to industrial design, the role of interaction design in ICT embedded product development activity has similarities with the changes industrial design's role in product development process (Author, 2009). Alike industrial designers being included into the development team after basic design decisions have been determined, interaction designers have had the similar experience. Also, alike industrial designers have been accepted to be who only design the form, interaction designers have been seen professionals who only design the graphical user interfaces. This belief and approach is still been observed in the sector. Although there are exceptional approaches are determined in literature review and interviews which constitutes the first phase of field research, it appears that interaction design has been involved in the development process after Planning and Concept Generation phases. On the other hand, it is determined that interaction designers both work as user researchers and project managers in the case study. Although the second phase of the field research has been conducted as a single case study, the above mentioned development shows that interaction design will gradually continue to have a wider role in ICT embedded product development activities.

Additionally, ICT embedded products are becoming more and more multifunctional and the behavior of such products are provided by dynamic interfaces instead of static ones. In this situation, it can be accepted that the products are becoming "boxes" that shelter the hardware and functions in terms of physical considerations. This determination also shows that interaction design has begun to have a wider role than industrial design has in ICT embedded product development activities.

The contents and functions of products becoming more and more dynamic causes the interaction shift from material qualities towards immaterial qualities. The said interaction moving toward immateriality is supposed to cause the emergence of another new actor on service design in ICT embedded product development activities.

The Relationship Between Industrial Design and Interaction Design in ICT Embedded Product Development Activity

It is essential for interaction design and industrial design to be in corporation and collaboration in ICT embedded product development activities. Although this situation has come forward in the literature review, it is determined that the said necessity is taken into consideration in the sector except for the leading design consultancies. The findings of interviews which consist the first phase of field research, support the literature review. As a matter of fact, design consultancies in which there are no in-house interaction designers, outsource interaction design at the end of Concept *Generation* and *System Level Design* phases. This situation which is supported by both literature review and interview findings is in contradiction with case study findings.

Table 1 The relationship between industrial design and interaction design in ICT embedded product development activity

<table>
<tr><th></th><th>INTERACTION DESIGN</th><th>INDUSTRIAL DESIGN</th></tr>
<tr><td rowspan="3">User</td><td>Mental models
Perception</td><td>Ergonomic factors
Anthropometrics</td></tr>
<tr><td colspan="2">Need and preference</td></tr>
<tr><td colspan="2">Experience</td></tr>
<tr><td>Feasibility</td><td>Software structure
Interaction generation environments
Facilities of generation environments
Hardware and software relation</td><td>Production techniques
Production feasibility
Material qualities
Form</td></tr>
<tr><td rowspan="3">Design Approach</td><td>Scenario based approach
Complex interaction
Graphical user interface
Typography, Color factors, Pattern</td><td>Form based approach
Mechanical interaction
Material
Color and pattern</td></tr>
<tr><td colspan="2">Dimensions of the product
Dimensions of the screen
Affordances</td></tr>
<tr><td colspan="2">Persona creation</td></tr>
<tr><td>Problem Solving Approach</td><td>Synthetic thinking
Text Language
Visual Language</td><td>Drawing and Synthetic thinking
Visual Language</td></tr>
<tr><td rowspan="2">Prototypes</td><td>Paper prototypes</td><td>Mock-ups</td></tr>
<tr><td colspan="2">Virtual prototypes</td></tr>
</table>

It is considered that industrial designers and interaction designers collaborate and cooperate starting from first step of the development process which is the *Planning* phase. The reason of this contradiction might be the 3 years time period between interviews and the case study and also the rapid developments in this field. Another finding that supports the mentioned development is that in-house interaction designers began to work in LUNAR Design, one of the product design consultancies which interviews were conducted within this period of time.

Table 1 shows that there are common factors that both industrial designers and interaction designers focus in terms of design processes. Thus these common factors, which did not come out in literature review but in interviews, constitute the steps that interaction design and industrial design are dependant to each other in ICT embedded product development activities. Although both industrial designers and interaction designers have been considered to propose alternatives about the mentioned common factors in the case study, it is seen that industrial designers' information is still needed (Author, 2009). Yet determination of ergonomic factors and form creation are still in the profession of industrial designers. In the case study although two design professions seem to propose alternatives about the screen dimension of the product, it is believed that interaction designers should be responsible because of designing the information and the functions embedded in that screen. Although both of the design professions seem to propose alternatives for affordances, it should be accepted as a problem to collaborate and cooperate. As a matter of fact, these relationships are being solved by using users' hands instead of other physical controls such as a mouse, handle etc. This situation is gradually shifting interaction design into its individual area from being dependant to industrial design profession. Affordance which is located under the user title also is moving into the profession of industrial design.

Redefining the Roles in ICT Embedded Product Development Activity

The subjects which were supposed to be solved collaboratively and cooperatively by industrial design and interaction design in ICT embedded product development activities have begun to move towards to the responsibility of interaction design profession (Author, 2009). Because the physical controls that take place in user product interaction have been gradually disappearing,

Disappearance of physical controls that take place in user product interactions shows that the activity area of interaction design will be wider and wider in ICT embedded product development activity. This extension points out that interaction design profession will have a leading role on the process and design management comparing with industrial design.

In Table 2 the roles of industrial design and interaction design are redefined in ICT embedded product development activity: in *Planning* phase, both industrial designers and interaction designers have active roles in identifying user needs and preferences, company and market needs. But at this point, as interaction designers focus on especially user mental models and processes, their role in user research studies have dominancy than that of industrial designers. At the end of *Planning* phase, both industrial designers and interaction designers have roles in creating concept, use and context scenarios. These steps in *Concept Development* phase are the ones which collaboration and cooperation are seen the most between industrial designers and interaction designers. Thus in *Concept Development* phase, the basic design decisions are taken. Due to the basic design decisions, both design professions create alternatives for the project. These alternatives are tested by gathering the mockups generated by industrial designers and paper prototypes generated by interaction designers. Both design professions generally work in their teams in *System Level Design* phase. At this point, although neither of teams are totally independent to each other, it is foreseen that they frequently cooperate in order to discuss and exchange ideas. In *System Level Design* phase both industrial designers and interaction designers continue creating design alternatives. Ulrich and Eppinger (2004) shows interface issues within the scope of industrial design. But creating an interface depends on creating physical controls which are not only in responsibility of industrial designers but should be also of interaction designers.

Table 2 Redefining the roles in ICT embedded product development activities (adapted from Ulrich and Eppinger, 2004)

	Marketing	*Design* Industrial Design	*Design* Interaction Design	Manufacturing	Other
Phase 0: **Planning**	Market opportunity articulation Market segments definition	User Company Market needs Product platform and architecture New technologies assessment Persona creation	Hypothesis generation **Research** Stakeholder research User research Field research **Modeling** Persona creation Workflow generation Use scenarios generation **Requirements Definition**	Production constraints identification Supply chain strategy setting	Research: Demonstration of available technologies Finance: Providing planning goals Management: Allocation of project resources
Phase 1: **Concept Develop-ment**	Customer's needs Lead users Competitive products	Use and context scenarios Industrial design concepts Form Feasibility of product concepts Building and testing experimental prototypes	Use and context scenarios Other requirements **Design Framework** Elements Framework Key path& validation scenarios	Manufacturing costs estimation	Finance: Facilitating economic analysis Legal: Investigation of patent issues
Phase 2: **System Level Design**	Plans development for product options and extended product family Target sales price points setting	Generating alternative product architectures Choosing materials Defining major sub-systems Refining industrial design	**Design refinement** Detailed design	Suppliers identification for key components Final assembly scheme definition Target costs setting	Finance: Make-buy analysis Service: Identification of service issues
Phase 3: **Detail Design**	Marketing plan development	Defining part geometry Choosing materials Assigning tolerances Completing industrial design control documentation		Piece-part production definition Tooling design Quality assurance definition Procurement of long-lead tooling	

disappearing as might be observed in ICT embedded products in the market. Consequently, industrial designers will gradually leave their roles in this subject to interaction designers. In this case, it is possible to foresee that interaction design profession will play role more and more in this mentioned step.

Starting from the above evaluations, it is possible to say that interaction design will have a wider activity area in Planning, Concept Development and System Level Design phases comparing with that of industrial design.

According to the results of this study, there are differences in terms of methods, techniques and design language in approaching the design problem and understanding users between industrial designers and interaction designers. Conducting more case studies regarding this result might contribute to affect and develop thriving techniques, design and representation languages.

The results of this study foresee that interaction design will gradually play a wider role in design and process management in ICT embedded product development activity. Hence a conducting a research in the near future on interaction design management might contribute to both interaction design profession and ICT embedded product development activity.

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A Survey of Definition and its Role in Strengthening Design Theory

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Abstract

This paper argues that an essential task for managing complexity in design is clarification of key terms within the field, and most importantly the term that defines the field itself: Design. This position rests on the argument that theory—a key tool for managing complexity in design—is weakened by ambiguous terminology, and crucially, ambiguity of the word *design*. Although it has been well documented that design is a highly ambiguous term and that this is problematic for the field as a whole, many designers are resigned to this fact since it is unclear how one can resolve differences of opinion about what such a central and sensitive term means. This paper argues, though, that once designers have a better understanding of the process of definition—a process that has its own complexities—they might see the benefit of trying to define design and other key terms. To this end, this paper provides an overview of definition, borrowing largely from philosophy, which includes a survey of the types and methods of definition and issues related to each. It will also explore methods and criteria by which one can evaluate various competing definitions. From this survey, I propose that designers use a stipulative and pragmatic approach to definition outlined by Edward Schiappa (2003). Schiappa's approach is useful because of these two key underlying assumptions: first, defining design (and related terms) is not a search for the record of past usage but an act to persuade others of how to use the word in the future, therefore the person defining must provide a compelling argument for why others' usage should be modified; second, defining design is not a search for the 'true' or 'real' meaning of a word but instead a goal-oriented process and, therefore, dependent on the context and purpose of those defining the word.

Keywords

design; complexity; definition; terminology; concept analysis; philosophy; language; ambiguity

Design research, education and practice have all faced greater complexity as the field has grown and matured over the past several decades (Buchanan, 1992; Meurer, 1999). This added complexity comes from several sources, including:

- A growing emphasis on *research and methods* in design, borrowing largely from more established disciplines such as psychology, sociology, anthropology, marketing and engineering (Meurer, 1999; Frascara, Meurer, Toorn, Winkler, 1997).
- A greater awareness in the business community (and to some extent the general public) that design plays a *central role in product and service development*. Thus, designers have seen their roles expand from stylist to “strategic consultant” (J. O'Grady, K. O'Grady, 2006, p. 10-11).
- A recent *expansion of new media and technology*, such as the Internet, social

networking and mobile computers/phones in which a designer can deliver a message or product through.

- A greater emphasis on *social responsibility, ethics and environmental stewardship*, requiring the designer to have a more informed view of the socio-political context in which their design will exist (Frascara et al, 1997; Papanek, 1975).

With each of these sources, theory is a critical tool for the designer. Theory helps designers understand this complexity and more importantly explain how it will impact their design problems and solutions. Epistemological theories are required so a designer can explain when to use qualitative or quantitative *research methods*. Helping a client determine long-term communication and marketing *strategies* requires theories about how they will impact product sales. Choosing a *medium or technology* in which to deliver a message requires theories of communications and semiotics to understand how it may be affected and interpreted. Lastly, all design solutions affect the *socio-political and environmental* contexts they are placed within, requiring the designer to have a world-view or ethos based on theories about politics and the environment. In each of these examples, the designer's understanding of the theories being applied have a direct impact on the design solution. For simple design projects, one does not have to be explicit about how their theories impact their design solution and can rely on intuition; but for more complex projects, a designer will be expected (most likely by their client) to explain why a certain world-view or method is used.

Building design theory

This brief examination brings us to two crucial points: first, theory is becoming more vital for design practitioners as their practice becomes more complex; second, as the examples provided above show, many of the required theories originate in other disciplines: sociology, psychology, political science, marketing, communication studies, etc. This second point leads us to a new source of complexity in design: the state of design research and how it informs design practice.

For this, I turn to two papers: “Language definition and its role in developing a design discourse” by Sharon Poggenpohl, Praima Chayutsahakij and Chujit Jeamsinkul (2004); and, “Constructing a coherent body of theory about designing and designs” by Terence Love (2002). These papers are relevant to the discussion about complexity in design because they both present a summary of the state of design research and they both argue that design must develop its own research discourse rather than rely on other disciplines to strengthen its theoretical development. According to Love (2002), there is growing interest “in the development of a unified body of knowledge and theory about designing and designs” (p. 345). This interest is shared by Poggenpohl, Chayutsahakij and Jeamsinkul (2004), who argue that design research and practice would be well served to have its own “core knowledge” which would lead to the development of “an intelligent discourse” (p. 588).

While Love (2001) believes creating a more unified body of theory is gaining interest among design researchers, it has “not yet emerged in spite of extensive research undertaken over several decades, across several hundred domains of practice, and from a wide variety of perspectives” (p. 345). Both list several key reasons for this lack of emergence. According to Poggenpohl, Chayutsahakij and Jeamsinkul (2004) there is a range of “stronger, weaker, or virtually nonexistent discourse traditions” in different sub-disciplines in design (p. 588). Overall, “[d]esign does not have a strong tradition of reflective or critical writing, perhaps because much design knowledge is tacit and formalizing this knowledge through language is difficult" (Poggenpohl, Chayutsahakij, Jeamsinkul, 2004, p. 588). This is because discourse is "dominated by trade magazines that follow trend and fashion in practice" (Poggenpohl, Chayutsahakij, Jeamsinkul, 2004, p. 588). While Love (2002) does not evaluate the quality of research in design, he does emphasize that it is often "tied" to the subdomain it was created within (p. 346). So, even if we found strong research within a subdomain, according to Love, it is not or cannot be shared with the other subdomains in design. For Love (2002), this inability to share research between subdomains feeds into what he sees as a fundamental reason design has not seen a unified body of theory emerge: "a lack of philosophical foundations" (p. 346). These foundations include: agreement upon "core concepts and terminology" in design to clarify "the scope, bounds and foci of fields of research and theory-making about designing and designs"; greater investigation into epistemological, ontological issues in design; and lastly, better "integration" of design theory and "other bodies of knowledge" (Love, 2002, p. 346).

Poggenpohl, Chayutsahakij and Jeamsinkul acknowledge there are critics of the creation of a unified body of theory. They argue these critics disagree because "design is necessarily a synthetic discipline" and, therefore, can rely upon research from research-based disciplines such as "human-computer interaction or social science" (Poggenpohl, Chayutsahakij, Jeamsinkul, 2004, 589). While they agree that design is a synthetic discipline, they disagree that this means it cannot have its own internal discourse. More importantly, they argue "a lack of a specific design discourse with ongoing development, argument, criticism, research findings, etc. hampers development of design as a discipline and prevents design from contributing its knowledge more broadly" (p. 589).

Strengthening design theory through definition

Clearly, the task of unifying design theory has its own complexities—both in defending the endeavor and in the foundational goals necessary to complete it—but as argued above, if design practice seeks to manage complexity, it must do so with a body of theory and knowledge of its own. To minimize the complexity in this task, the remainder of this paper will investigate the first philosophic goal that both papers argue for: "clarifying definitions of core concepts" (Love, 2002, p. 346).

One could argue that this is a primary philosophic goal since one's definition of design will inform the next two goals: epistemology and integration with other disciplines. This is a point not lost on Poggenpohl, Chayutsahakij and Jeamsinkul (2004), who see the task of definition as central, impacting design in mundane yet highly practical ways, from effective "tagging" of research (p. 579), to wider foundational implications such as: "how the design profession envisions itself—as a craft or a discipline; how curricular programs in design need to change or not based on its accepted definition; what other disciplines can hope to learn from design and its research; how design research can improve knowledge and performance in design practice" (p. 590).

While the following exploration of definition will be relevant to all core concepts in design, this paper will focus on the term that defines the field itself: design. Focusing on the definition of design is valuable not just because of the reasons listed above and the obvious fact that it names the field as a whole, but because it is also a highly ambiguous term. According to Love (2002), design has "different meanings in different domains, [is] used in different ways by researchers in the same domain, and [is] found in the literature referring to concepts at different levels of abstraction" (p. 347). This ambiguity results in theories and research where accounts of design are "contradictory," causing confusion about which findings are actually applicable from one domain to another (Love, 2002, p. 347).

While there are a myriad of reasons for this range of opinion, two are particularly significant: the dramatic change in the field of design in the last one-hundred years; and, the ambiguity of the word itself. First, the practice of design has seen dramatic change in the last one-hundred (or more) years—from an applied art at Bauhaus in the 1920s, to an attempt at an applied science at Ulm in the 1960s. Even the last thirty years has seen a shift from a more scientific approach to design to a more generalized notion of design that is not necessarily scientific, but understood as a type of planning (Buchanan, 2001). The second significant reason for this ambiguity is the many overlapping meanings of the word design itself. Design has a range of meanings from the abstract to the specific. To demonstrate how confusing using the word design can get, John Heskett (2001) provides the following sentence:

> *Design is when designers design a design to produce a design* (p. 18).

He then explains how all four uses of design are each a different sense of the word:

> The first usage is as a noun, connoting the field of design as a whole in a very general manner, as in the phrase: “Design is important to national economic competitiveness.” The second usage is as a verb, meaning the action or thought involved in the act of designing. The third also is a noun; this time connoting a plan or intention. Finally, the fourth usage again is a noun, this time meaning the finished product. All the usages have very different meanings, yet even people professionally involved in design continually slip between them, seamlessly moving from one meaning to another without distinction (Heskett, 2001, p. 18).

Few other disciplines are the victim of such a high number of multiple meanings or polysemy. While almost all words in our language are polysemic, design is particularly polysemous, and to make matters worse, the many meanings are very closely related. A very common error is to equate the noun design, used to describe the discipline or field of practice (ie. “architecture is a subdomain of design”), with the more general verb design, used to describe planning or scheming (ie. “that football play was by design”) (Bamford, 1990, p. 6).

This ambiguity begs the first question when defining design: which sense of the word are we using to define the *discipline*? Or, is it even one of the definitions given in Heskett's quote? If it is another definition, how does one formulate a new definition? How does one develop arguments for a definition and how are these arguments evaluated? As these questions suggest, the process of defining design is complicated. The difficulty for designers is they lack the philosophical background to navigate these questions, which according to Richard Buchanan (2001), is the source of the discipline's difficulty with definition:

> Efforts to establish a new field of learning require a definition of the field, and design is no exception. Unfortunately, our community has often foundered on the problem of definition. The literature is filled with contrasting and sometimes contradictory definitions of design, and efforts to define design have often led to acrimony. […] There has been an unfortunate misunderstanding about the nature and use of definitions, and this has caused our discussions to become unproductive and wasteful of time and energy (p. 8).

Some may argue that definition should be left for philosophers due to its complexity but the following quote from Schiappa (2003) reminds us of the central role designers must play in defining design: “definitions put into practice a special sort of social knowledge—a shared understanding among people about themselves, the objects of their world, and how they ought to use language” (p. 3). As designers, we maintain this shared knowledge through communities of research and practice, making us experts on how to define our world. So, if designers must play a central role in definition, we must clarify the process itself to make it more productive for designers.

A survey of definition

Outside of philosophy and law, definitions are normally quite mundane since the majority of the time we have strong tacit agreements about the words we use in conversation. Edward Schiappa (2003)—the central author used for this summary on definition—notes that definition as a method is not even required for good communication since a shared vocabulary is learned through a variety of social contexts that are far less formal (p. 28). Definition, though, is far from mundane when the use or application of a term is disputed or has large ramifications, for example, in legal or academic communities (Schiappa, 2003, p. 33). Philosopher Trudy Govier (2005) says the following about definitions:

> We look for a definition when we see a claim or argument that is unclear or hard to understand, or when a practical problem whose solution depends on our having an explicit definition. At such points, we begin to wonder what certain important words mean and it makes sense to look for definitions. (p. 95)

The tradition of definition started two thousand years ago with Socrates. As a philosopher, Socrates was interested in seeking and building knowledge, as opposed to opinion, about the natural, psychological and political world. He was interested in an important test of knowledge: the determination of the "essential" nature of concepts, such as "justice" and "courage" (Schiappa, 2003, p. 22). Aristotle continued this tradition with the development of the "standard definitional form involving genus and difference," which bears resemblance to methods used by Socrates and Plato (Schiappa, 2003, p. 23). The genus would establish what *similarities* the thing being defined had to other things, and the difference would be identified through *attributes* which differentiated it from other things within the genus. For example: "A chair is a piece of furniture (genus) used for sitting (attribute)" (Schiappa, 2003, p. 25). This approach has proved so effective that two thousand years later, the creators of the Oxford English Dictionary used it to clarify terms:

> There are rules—a word (to take a noun as an example) must first be defined according to the class of things to which it belongs (mammal, quadruped), and then differentiated from other members of that class (bovine, female). (Winchester, 1998, p. 150)

The longevity and effectiveness of Aristotle's method stems from the fact that he had gained insight into basic functioning of the brain that only recently, through psychology and biology, has been provided a scientific basis. Schiappa (2003) explains the scientific basis for the genus-species method of definition as follows: "[M]uch remains unknown about how the human brain processes sensations ... [f]or present purposes, the most important theory is that our sensory-perceptual activity *forms* experiences through a process of abstraction and categorization" (p. 13) He then links this process to evolution by quoting child psychologist Bowermann: "[t]he grouping of discriminably different stimuli into categories on the basis of shared features is an adaptive way of dealing with what would otherwise be an overwhelming array of unique experiences." (Bowerman, 1976, 105-6). In child psychology, this discrimination process is known as developing "similarity/difference relationships" or "SDRs" (p. 17-18).

For Aristotle, this method of definition was particularly important for knowledge-building because it allowed one to develop principles based on the categorization and listing of essential attributes. For example, one could start the process of defining design by first establishing the genus which it could belong to: “discipline.” A by-product of this first step is also clarifying which sense of the word we are defining; in other words, we are trying to define “design as a discipline.” Because “discipline” is a broad genus, the next step would be to determine if a further sub-categorization might be useful. For example, we could divide the disciplines into knowledge disciplines and applied disciplines. Now we have a narrower genus for design: “applied discipline.” A final step would be to differentiate design from the many species within applied discipline, so one could say design is a combined applied art and social science. Thus, we differentiate design from engineering which is the application of the physical sciences. While the example definition we ended up with is not important to analyze, what is important is to see how this process has given us useful attributes that could form principles of design. So, if one sees design as part applied art and part applied social science, one could develop the following principles:

- A design researcher could argue that the epistemological foundations of design ought to balance the subjectivity of aesthetic choices of fine arts with the objectivity of empirical science.
- A design educator could argue that design education must include a foundation in the fine arts and the social sciences.
- A design practitioner could argue to clients that the effectiveness of their design is based upon the satisfaction of both aesthetic and social scientific criteria.

While this example was quite brief and far from exhaustive, it demonstrates the usefulness of the genus/species (or similarity/difference) method of definition. Today, this method of definition is still important for philosophers and, as mentioned, lexicographers. But, other fields such as law and linguistics also use or study definition, which has led to the creation of various *types* of definition, each geared towards a particular purpose. The following is a survey of the three main types:

- An “*ostensive* definition” is one used to describe a thing that can be pointed to, and particularly useful for things that are difficult to explain using words, such as colour but not good for explaining abstract or complex phenomena (Govier, 2005, p. 96).
- A “*lexical* definition” tries to list and describe all common usages of a term (Govier, 2005, p. 96); These are the definitions you would find in a dictionary. This method often uses the etymology (study of the history of words and how their form and meaning have changed over time) to inform the definition of the word being defined.
- A “*stipulative* definition” states what a term ought to mean, and may be adopted as a lexical definition if widely used (Govier, 2005, p. 99). The notion of “ought” is crucial here because it implies stipulative definition is a persuasive act. That is, one must provide reasons to its listeners as to why they should change their usage of the term.

In relation to defining design, each type of definition has varying levels of use value. Ostensive definition is the least useful type because, as discussed above, it does not explain abstract terms very well; one cannot develop a foundation for a discipline by just pointing to a set of objects. Theory requires an articulation of definition that can be scrutinized through written or spoken language. That said, through the process of articulating a definition of design, it is highly useful to point to examples that are the product of design. This is especially important for when explaining a definition to a design audience that largely learns through visualization.

Lexical definition is valuable but, again, limited. In defining the discipline of design, if one simply referred to a dictionary, which of the twelve or so definitions provided does one use to define the discipline? Even if the dictionary provides a definition explicitly for the discipline, we then need to ask whether the definition is appropriate. For choosing one of the lexical definitions and in determining appropriateness of the definition chosen, one needs a justification or reasons. In other words, there is an element of persuasion involved through articulation, but not based on past usage of the word design, but rather on conceptual and pragmatic grounds. Arguing for a definition in this way means you are now using a stipulative definition.

In fact, this is the limitation of Poggenpohl, Chayutsahakij and Jeamsinkul's approach to definition in their paper. A large focus of the paper is on the organizational aspect of definition—that is, the problem of gathering thousands of word uses and definitions to be used in a design dictionary and then using this dictionary to help stabilize language used in design discourse (Poggenpohl, Chayutsahakij, Jeamsinkul, 2004, p. 582). Their emphasis on the organizational aspect of creating a dictionary demonstrates a possible misunderstanding regarding the types of definition. While collecting lexical definitions and creating a dictionary can serve a purpose within a community, it will not help one through the process of selecting and evaluating one dominant definition (or set of definitions) that a whole research community ought to use. This selection and evaluation process is primary and is where difficult theoretical debates about appropriateness and efficacy take place. According to Govier, dictionary definitions do not suffice for complex or abstract concepts where “fundamental” issues of “theory and value are involved” (Govier, 2005, p. 97). Therefore, if ostensive and lexical definitions cannot resolve the definition of design, stipulative definition seems to be the most appropriate type. Before a final conclusion is drawn, a full exploration of stipulative definition is required.

Exploring stipulative definition

Within stipulative definition, there are two important epistemological debates about *approach* that impact the method we will use: the essentialism vs. anti-essentialism debate and the real vs. nominal definition debate. In exploring these debates I will also introduce Edward Schiappa's approach since it is particularly useful for the definition of design.

An essentialist approach assumes one can define the essential features of a thing such that these features are universally true, with no exceptions. The essential features are also known as the necessary and sufficient conditions. For example, the necessary and sufficient conditions for being a bachelor are being “male” and “unmarried.” Being male and unmarried are sufficient because we don't need additional conditions for a person to be considered a bachelor and they are necessary because every bachelor is married and male. Opposed to this essentialist view, are the anti-essentialists of which there are several flavors. The most famous is Ludwig Wittgenstein's theory of family resemblances, which assumes that words such as “game” and “art” do not have such universally true features but rather a patchwork of related resemblances that may or may not fit to each application (Weitz, 2007, p. 190). In the case of defining design, the essentialism debate is very important, since “design” falls into the same category of ambiguous terms as “game” and “art.” One could argue that the elusive nature of the term and inability of the community to come to a shared definition is proof that a finite set of necessary and sufficient conditions does not exist. On the other hand, if we take a pragmatic approach to defining design, one could argue for the essentialist approach based on its utility. That is, creating a set of conditions for what constitutes design is useful because it allows the community to develop principles for the discipline, differentiate design from other disciplines, etc. While it is outside the scope of this paper to fully explore all of the arguments within these debates, the salient point is to know they exist. For purposes of this paper, I will use the essentialist position based on the utilitarian grounds.

The second key debate within stipulative definition is between those that consider definition to be “real” or “nominal.” For Plato, a “real” definition was a search for the Ideal Form, that is, a definition that describes the “true” and “universal” nature of a term (Schiappa, 2003, p. 36). This view depends on “metaphysical absolutism: the belief that things have independent, “objective” structures of essences that are knowable “in themselves” (Schiappa, 2003, p. 36; quoting Barnes, p. 79-83). While this approach may seem appropriate when trying to define physical phenomena like “tree” or “planet” which necessarily involves identification of properties that are *objectively* perceived, the approach quickly becomes complicated when defining social or metaphysical concepts like “justice” and “good.” What are the essential characteristics of “justice” that we can objectively perceive? Even with the definition of “tree,” a real definition is problematic because it is unclear how one can determine which characteristics are objectively essential. According to Schiappa, the essence of a thing depends on one's interest/context, therefore, one cannot search for the “absolute” essence of a thing. For example, a lumberjack may define a tree with an emphasis on characteristics that allow him to distinguish trees from things he cannot chop down, while a chemical engineer may define trees according to its molecular makeup. In other words, “[a] thing-as-experienced may have as many essences as we have interests” (Schiappa, 2003, p. 41). Based on this major critique, philosopher Richard Robinson, along with most modern philosophers, objects to the notion of “real” definitions because they are “at best a mistake and at worst a lie” (Schiappa, 2003, p. 48; Robinson, 1950, p. 170). Robinson uses the word lie because a real definition gives the “false impression” that definition is a matter of correcting “knowledge of facts” rather than a process of isolating characteristics that are relevant to a given purpose (Schiappa, 2003, p. 48; Robinson, 1950, p. 170). To resolve this confusion, Robinson and Schiappa argue that all definitions should be viewed as nominal—that is, arbitrary yet dependent on context. For Schiappa, one way of resolving this confusion is to rephrase the definitional question:

> Instead of posing the questions in the time-honored manner of “What is X?” ..., I suggest that we reformulate the matter as “How ought we use the word X?” given our particular reasons for defining X. Specifically, I advocate that we think of one appropriate form of definition as “X counts as Y in context C.” (p. xi)

Reformulating the question in this way does three very important things. First, the use of “ought” rather than “is” makes it clear that definition is a matter of persuading others to adopt a new usage of a word rather than a search for the essence of a thing. Second, clarifying that we are defining a word within a specific “context” makes clear to those engaged in the discussion that context matters, both in terms of how the definition is formulated but also in how it is evaluated. Thirdly, notion of “we” emphasizes the very social nature of the process of definition.

Although stipulative definition is persuasive in nature, this does not mean the process must be a one-way argument where the definer proposes a definition of design and the audience simply agrees or disagrees. If we return to the ancient Greeks, a key aspect of their process of definition was coming to a shared understanding of more than just the term being defined. This dialectical process is illustrated through Plato's dialogues where an interlocutor leads a discussion with one or more people. The discussion often revolves around clarifying important moral concepts such as “justice” and “the good” (Schiappa, 2003, 31). The role of the interlocutor is to help the discussants clarify their often tacit and vague notions of the concepts in question. Definitions are proposed and through scrutiny in the form of argument and examples, the interlocutor shows the discussants that their tacit notions require adjustment. This adjustment leads to a new definition which then bears more scrutiny. Much of the discussion involves clarifying not just the one term in question but a whole constellation of related terms. Discussion usually opens with a great deal of disagreement and confusion, but through the course of clarifying what each discussant means when using each related term, disagreement often turns to understanding (or, at least, an understanding of the complexity of what at first seems simple). This back-and-forth, give-and-take process is called dialectic. Poggenpohl, Chayutsahakij and Jeamsinkul (2004) note that the process of dialectic can be difficult in written form:

> Speech is less calculated and more spontaneous with the speaker observing (or listening) whether the response from an audience demonstrates understanding. There is a turn taking that allows repair and clarification. In contrast, writing is discontinuous; misunderstanding may reveal itself only over time and through response (p. 583-584).

Dialectic is not only significant here for its relationship to Poggenpohl, Chayutsahakij and Jeamsinkul's description of oral speech acts, but more importantly, it points to a method to be used for not only forming a definition but also achieving consensus among a group of users.

A second point regarding the social nature of definition, actually directs us back to lexical definition and the role it plays in conjunction with stipulative definition. One of the traps of stipulative definition is that it cannot simply ignore conventions of language users when making a stipulation. Ignoring convention is called the “Humpty Dumpty theory of definition”, which comes from Lewis Carrol's *Alice in Wonderland*, where Humpty-Dumpty “says that he can make words mean whatever he wants them to mean” (Govier, 2005, p. 99). Although it is certainly possible for one to define words however one wants, the value of doing so is very limited, since one will have no way of sharing this knowledge with others. Govier (2005) explains: “If a person defines words arbitrarily with no attention to public conventions, other people will not understand them and the *words will have no use”* (p. 100). She continues by reminding us of a fundamental value of words in language:

> Words in a language are public instruments for communication in that language, and a stipulative definition is useful only if it sets out predictable and comprehensible standards of use that are workable for the purpose at hand. (Govier, 2005, p. 100)

Seeing words as public instruments is valuable because all the reasons given for defining design at the start of this paper revolved around a community of language users: designers. Since one cannot define design in a bubble, lexical definitions or a record of previous usage must be a type of definition employed (although not central).

While this summary covers the key debates regarding definition, it is by no means exhaustive. The most important point this summary can demonstrate is that definition is full of complexities. Due to the great difference in purpose of and method used between a) type of definition, and b) definitional approach, it is essential that prior to all formal discussions about definition, discussants state their purpose and approach upfront. If this is not done and discussants jump straight into the process of definition with no knowledge of these dilemmas, it is likely that these dilemmas will cause great confusion and even great conflict about the proposed definitions without the discussants understanding that their differences lay in more fundamental issues than a simple difference of opinion regarding proposed definitions.

Based on the summary above, I propose that designers approach definition from a pragmatic perspective, seeing definition as a proposal for new usage that must be negotiated by designers according to the purposes of definition that they collectively determine. This community of designers could be small (a school faculty determining a definition or vision of design for curriculum development) or large, in the case outlined by Love, Poggenpohl, Chayutsahakij and Jeamsinkul (determining a common usage for a community of researchers). This approach assumes that definition is nominal and, therefore, avoids metaphysical dilemmas about the “true” or “real” nature of design, and instead evaluates proposed definitions based upon practical ends, such as the development of clear connections between other disciplines. Within this approach, several methods can be employed to form and then evaluate the definition. The species/genus method of definition is valuable for differentiating design from other activities and then establishing logical consistency between a constellation of terms required to understand the phenomenon of design. The etymological method helps provide an understanding of how and why the word has changed. The lexical method is used to avoid humpty-dumptyism that increases the chances others will take up the novel definition. Finally, the ostensive method can help one illustrate one's definition by pointing to examples.

Future directions

“What is design?” As this paper demonstrates, this question is highly complex. It is fraught with as many linguistic and theoretical difficulties as the age-old philosophical question: “What is art?” But, due to its relatively recent emergence as a discipline and limited discourse, there is only a fraction of the literature. This confusion poses problems for the teaching of design and for the sharing of knowledge about design. In fact, the ambiguity is so great, some argue that one cannot even call design a discipline; and as long as design remains as ambiguous as it is today, creating a body of theory unique to it will prove very elusive and, without which, complexity will be even more difficult to manage.

While Love, Poggenpohl, Chayutsahakij and Jeamsinkul make strong arguments for the need to build stronger philosophic foundations in design and, specifically, clarification of key terms through definition, these are only four voices. There are others who have written on this same issue (Buchanan, 2001; Bamford, 1990; Friedman, 2003; Galle, 2008; Owen, 1998) but the list is short and little progress has been made in the last ten years. Hence, there is still a need for greater research into establishing reasons for why focusing on the process of definition is *valuable* for design researchers, practitioners and educators. Many designers simply don't think a general definition of design is attainable even in small contexts (let alone the larger community as a whole) and even worse, they do not see the process of definition as being beneficial. Hopefully, through this paper and similar efforts by others, we can generate a greater, more informed and productive debate about the definition and foundations of design and how this impacts the research, teaching and practice of design.

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Interaction Designers' Conceptions of Design Quality for Interactive Artifacts

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Abstract

It is important to be aware of different ways of seeing design quality of interactive artifacts in order to appreciate the various aspects of a design, but how do professional interaction designers understand design quality? In theory, one way of approaching design quality of interactive artifacts has been the Vitruvian principles of commodity, firmness and delight, originally created for architecture. Such frameworks are, however, seldom directly employed in practice. This paper investigates what conceptions professional interaction designers have of design quality for interactive artifacts. Interviews were conducted with ten designers. The analysis disclosed four conceptions concerning: (a) Constraints & contexts, (b) motivations & purposes, (c) use-qualities of functions & content, and (d) experiential qualities of form & behaviour. An awareness of these conceptions may facilitate the appreciation for different aspects and opportunities in a design situation.

Keywords

interaction design; design quality; use-qualities; conceptions, user experience.

Interaction design has many fields of origin that potentially have different design ideals. This means that there is a complexity in the criteria and values that shape an interactive artifact. So what do professional interaction designers really mean when they say that an interactive artifact is an example of good or bad design? It is likely that different designers have quite different conceptions of what good design really is? It is important for researchers, students, professional designers, critics and managers in interaction design to be aware of different ways of seeing design quality of interactive artifacts in order to appreciate the various aspects of a design. Alternative perspectives can open up for reflection, learning, and change, but the lack of such awareness may obscure design opportunities (Hult, Irestig & Lundberg, 2006). The conception of design quality among interaction designers is the problem area of this paper, but first a few words on the notion of interaction design.

In their design effort, interaction designers focus on interaction with artifacts and experiences of interactive artifacts. Bill Moggridge and Bill Verplank coined the term interaction design in the late 1980s to describe their work at the intersection of industrial design, information design, graphics, human factors, and computer science. Moggridge (2007) pictured a creative and imaginative design discipline working with software, designing behaviours, animations, sounds, and shapes. Like industrial design the new design discipline would focus on qualitative values. It would start with the needs and desires of people who would use a product or service, and aim towards designs that would give aesthetic pleasure, lasting satisfaction and enjoyment. Verplank summarizes his view on the interaction designer's job by answering the three questions; how you "do", "feel" and "know" (Moggridge, 2007). Interaction design does, however, not only involve shaping conditions for the interaction between people and artifacts. It also involves shaping conditions for the interaction between people by means of artifacts (Arvola, 2005; Buchanan, 2001; Hernwall & Arvola, 2008). This points towards understanding interaction as conversation, which is a more complex process than the feedback loop used in Verplank's do, feel, and know questions (Dubberly, Pangaro, & Haque, 2009). The word interaction in human-computer interaction design, can be defined as a mutually and reciprocally performed action between several parties in close contact, where at least one party is human and at least one is computer-based (Arvola, 2005). This gives a background to interaction design, before returning to the issue of design quality in this field.

Design Quality

A multifaceted approach to design quality has been used in architecture since Antiquity, when Vitruvius described the virtues of a building in the terms utilitas, firmitas, and venustas. An often-used translation of those terms is commodity, firmness and delight. The same framework is still used today as in for example the Design Quality Indicator—DQI (Gann, Salter & Whyte, 2003)—where the three Vitruvian principles have been given a modern day interpretation in a conceptual framework consisting of three aspects: Function (use, access and space of a building), Build Quality (performance, engineering systems and construction), and Impact (form, materials, internal environment, urban and social integration, identity and character). DQI is pictured as a pyramid with sides representing function, build quality and impact. The form of a pyramid highlights the multifaceted nature of design quality. Gann et al. (2003) give the example of lighting in a building, which has a functional quality of providing a bright and accessible work area, but also has an impact on the pleasure and wellbeing in use of the building.

The Vitruvian principles have also been introduced in interaction design theory by Ehn and Löwgren (1997) who defined a framework for quality-in-use of interactive artifacts. Their interpretation of the Vitruvian includes structural aspects assessed from, a constructional quality perspective, functional aspects assessed from an ethical quality perspective, and formal aspects assessed from an aesthetic quality perspective.

Dahlbom and Mathiassen (1993) have introduced a similar framework for quality of IT-artifacts. Their work is built on the design movement of the Swedish functionalists during the first half of the 20th century (Paulsson & Paulsson, 1956). Their framework includes four quality aspects for evaluating technical artifacts: functionality, for evaluating practical use; aesthetics for evaluating looks and experiences; symbolism, for evaluating social use, what it means to us and signals to others; and politics for evaluating wider effects on peoples' lives, including power relations, coercions, and liberties supported and encouraged by the artifact. The political aspect is also closely related to ethical issues concerning what practices and behaviours are supported and required from users.

These theoretical frameworks for design quality have also been used in combination (Arvola, 2005, 2007; Johansson & Arvola, 2007), but they are still theory; the question here is instead how practicing interaction designers conceptualize design quality.

Conceptions

The units of analysis in this paper are conceptions of quality that interaction designers have. A 'conception' is a specific way "in which people understand a particular phenomenon or aspect of the world around them" (Marton & Pong, 2005, p. 335). Conceptions are represented by qualitatively different meanings or 'categories of description' of the phenomenon. A 'conception' has in earlier research also been called 'ways of conceptualizing', 'ways of experiencing', 'ways of understanding' 'ways of apprehending' and 'ways of seeing' (Marton & Pong, 2005). Conceptions are also structurally linked to each other in what is called an 'outcome space' that describes logical relations (often hierarchically inclusive) between different ways of seeing a phenomenon.

The aim of this study is to explore the range of different ways of conceptualizing design quality among professional interaction designers. The result will be an analysis of categories of description and a clarification of structural relationships between these categories.

When describing designers' ways of conceptualizing quality one can distinguish between structural and referential aspects of experience (Marton & Booth, 1997). Structural aspects refer to the discernment of the whole from the context and discernment of the parts and their relationships within the whole. Referential aspects of experience refer to identification of what something is; the assignment of meaning.

Another distinction, used in phenomenology, is between an external and an internal horizon of experience (Marton & Booth, 1997). The external horizon of experience is that which surrounds the phenomenon experienced including its contours. The internal horizon of experience is the parts and their relationships, together with the contours of the phenomenon.

The research question for this study is: What are the conceptions interaction designers have of design quality in relation to interactive artifacts? The theoretical framework for design quality and conceptions forms the background to the study. Next, the method for answering this research question is presented.

Method

Semi-structured interviews were conducted with ten professional interaction designers. Interviews were recorded and transcribed into a verbatim transcript, which was analyzed using qualitative content analysis.

Participants

Ten interaction designers (four female and six male), with four to thirteen years of work experience, participated in the study. Two participants were based in Finland and eight were based in Sweden. The designers in Sweden had an educational background in cognitive science and human-computer interaction with a profile in interaction design. One of the designers in Finland was originally from Spain, but had lived in Finland for eleven years. He had an educational background in business and new media with a design angle. The other designer in Finland described himself as a media artist and designer, and had an educational background in photography and installation art. The different areas that the participants worked in covered government websites, intranets, office applications, electronic medical record software, air traffic management software, concept design for future home communication, ambient media, interactive exhibitions, and mobile television applications. Participants worked as freelance designers, at small and medium-sized usability and design consultancies, and as in-house designers at software companies.

Data Collection

The interviews were semi-structured and ranged from 45 minutes to 1 hour 40 minutes. Five of the interviews were conducted face to face and five were conducted over distance via video calls. Three interviews were audio recorded and seven interviews were also video recorded. The two interviews conducted in Finland were made by one interviewer, and another interviewer made the interviews in Sweden. The interview guide was revised after the first two interviews. It focused on the participants' workplace, role, projects, background, views on design quality, and design processes. All taped material from the interviews was transcribed and partly normalized to a written form. Names of clients were removed from the transcripts.

Procedure of Analysis

The procedure of analysis in this study builds on Graneheim's and Lundman's (2004) review of the methodological literature on qualitative content analysis.

The interviews were read through and listened to several times to obtain a sense of the whole. Overarching content areas in the interview text was then identified. Sections concerning design quality were extracted and brought together into one text. The extracted text was divided into meaning units that subsequently were condensed. The condensed meaning units were abstracted and labelled with a code. The various codes were compared based on differences and similarities and sorted into 19 sub-categories and 7 categories, which constitute the manifest content. The tentative categories were discussed by a group of researchers and revised. What differed between the researchers were assessments about sub-categories, and the wording of specific codes and categories. Reflection and discussion resulted in agreement about how to order the codes. Finally, the underlying meaning, that is, the latent content, of the categories was formulated into themes.

The empirically driven qualitative content analysis was followed by a more theoretical analysis. The relations between categories of description were analyzed in more detail to map out the space of different ways of seeing design quality of interactive artifacts. The theoretical concepts of referential aspects, structural aspects, internal horizon and external horizon were used in this analysis to clarify the structure of that space.

Results

Two overarching themes emerged in the analysis: Getting the right design and getting the design right. As a side note, the two themes also form the title of a paper on usability testing of alternative design solutions by Tohidi, Buxton, Baecker and Sellen (2006), as well as the subtitle of the book Sketching User Experiences by Buxton (2007). The different conceptions are presented in Table 1.

Theme	Conception of Design Quality of Interactive Artifacts as:
Getting the right design	A: Managing constraints on the interactive artifact
	B: Delivering a motivated interactive artifact
Getting the design right	C: Creating opportunities for usage of the interactive artifact and its contents and functions
	D: Creating opportunities for experiences of the interactive artifact and its form and behaviour

Table 1 Conceptions of design quality of interactive artifacts grouped around the two themes The right design and The design right

Conceptions A and B concerns getting the right design in relation to constraints and motivations, while conceptions C and D concerns getting the design of functions, content, form and behavior right. Getting the right design answers the question of why a design should be developed. Getting the design right answers how the design should be composed.

Conception A: Design Quality as Managing Constraints on the Interactive Artifact

Design quality can be seen as adapting to the conditions of a design project. An example is provided below:

I sometimes feel that you may have focused a bit more on this like ideal design on what you would have wanted to do if all preconditions where there, like time and opportunities, and no, for example, particular tool is chosen and so on. Such fixed parameters, you just have to take them into account because they're not gonna change during the project you do. (Interview 9, Row 118, translated from Swedish)

In the example above it is highlighted that it is one thing to have high standards and high ideals, but quite another to reach those ideals under the constraints of a particular project. The design quality of a product or service can therefore be seen in the light of the conditions under which it was produced.

Participants noted that a design project is performed in relation to technical conditions of what can or cannot be done within given financial constraints. The design project is often scoped in relation to already made decisions regarding technical platforms, or there might already be, for instance, a publishing system in place to which the design of a website needs to adapt. In such cases there must be a technical fit between the design and the existing technical context. Design projects are also performed in relation to organizational conditions of issues like roles and power structures that one cannot change and must adhere to.

The focus, when viewing design quality this way, is on the preconditions and the context of the design project; factors that are external to the interactive artifact as such.

Conception B: Design Quality as Delivering a Motivated Interactive Artifact

Design quality can be seen as delivering an interactive artifact motivated by different stakeholders. An example is provided below:

Yeah, well that is a question of design quality then. What is, what is good quality in… a design, a product that you have participated in developing then, service. And now you come back to you know why did we build this in the first place, who are, what needs have we really been trying to satisfy. Both for users and customers and the organization as such. And that is of course, that is the answer to the question somehow. (Interview 3, Row 214.b, translated from Swedish)

In this example the participant returns to the question of why something was built in relation to latent needs of users, customers and organizations. The basis for design quality can thus be seen as whether an interactive artifact meets its purposes or not, given that the design fits the already existing technical and organizational contexts. The interactive artifact needs to have values in use for the people and the organizations it concerns. Values in use, exemplified by participants, may be to contribute to experiences, effectiveness and business utility.

A design can communicate a business strategy or contribute to strategic ways of working. A focus on experience and beauty, which is a higher standard than mere elegance, can also be part of the purpose of the interactive artifact in relation to a business strategy.

A focus on usefulness as an overarching goal is a more instrumental view than user experience. This view indicates efficiency in the organization, effects before form, design solutions that are sustainable over time, and meeting the user, customer and business needs behind the design brief.

Related to the purpose of the design are the intended and unintended effects of the design and the ethical consequences of those effects. The purpose of interaction design can also be to create new conditions for a strategic way of working, by supporting a particular way of using the interactive artifact in a specific situation.

The focus in this conception of design quality is on the motivations that drive people and businesses.

Conception C: Design Quality as Creating Opportunities for Usage of the Interactive Artifact and its Contents and Functions

Design quality can be seen as concerning the use of content and functions of the interactive artifact. An example is provided below:

Good design, it has to... fulfil a few requirements, it has to be something that fulfils the main objective of being something that is useful, you know? … So that people can really use it … in the most efficient and simple way. (Interview 1, Row 90–95)

In this example the participant started out in Conception B with ”something that is useful” and then specified that to something that people can use in an efficient and simple way. The things that are used are functions and content of the interactive artifact. The use of the functions and contents of an interactive artifact must also be safe.

The focus in this conception of design quality is on qualities of the interactive artifact in use.

Conception D: Design Quality as Creating Opportunities for Experiences of the Interactive Artifact and its Form and Behaviour

Design quality can be seen as concerning experiences of form and behaviour of the interactive artifact. An example is provided below:

*On a personal level I think it’s easy to talk about good and bad design insofar that a solution is kind of obviously elegant, right. That it is simple, it’s clear, you have taken away lots of fuss that makes it easier to zoom through it, or it’s cool, it has cool interaction, it’s, it’s kind of modern at the forefront of what’s currently considered good interaction design. And form. (*Interview 3, Row 214.b, translated from Swedish)

In the example above, the same participant as in the example from Conception B, continues to describe his way of conceptualizing design quality by covering Conception C in terms of simple and clear usage, but he also covers the area of elegance and cool, modern or even interesting form. The form (including interactive form – i.e. behaviour) of the interactive artifact can accordingly also be the basis for design quality. It should ideally be interesting and modern, even though this may be an issue open to interpretation and taste.

Beside from interesting, the form and behaviour should as indicated by the example above, also be elegant in its simplicity and clarity. In this way of seeing design quality, beautiful form and behaviour follows function, and the aesthetics are contrasted to the practical.

The focus in this conception of design quality is on experiential qualities of the interactive artifact.

Space of Conceptions for Design Quality of the Interactive Artifact

The outcome space of design quality can be summarized as in Table 2.

Conception	Referential aspects	Structural aspects	Horizon
A	Design quality as managing constraints on the interactive artifact.	Focuses on preconditions and contexts of the design project.	External
B	Design quality as delivering a motivated interactive artifact.	Focuses on the purpose of the interactive artifact and how it meets the motivations that people and businesses have.	External, Internal
C	Design quality as creating opportunities for usage of the interactive artifact and its contents and functions.	Focuses on the use of the interactive artifact, and its functions and contents, and the qualities displayed in that use.	Internal
D	Design quality as creating opportunities for experiences of the interactive artifact and its form and behaviour.	Focuses on the experience of the form and behaviour of the interactive artifact, the qualities of the experience, and the constituents of the form language.	Internal

Table 2 Conceptions of design quality of the interactive artifact

In Table 2, the referential aspects refer to the meaning of design quality. The structural aspects refer to the discernment of the whole phenomenon, and its parts. In Conception A the whole is the design project; in B it is the people and the business; in C it is the use of the interactive artifact; and in D it is the experience of the interactive artifact. The parts discerned are preconditions and contexts in A, the purpose, motivations and goals in B, and qualities, functions and contents in C, and qualities, form, behaviour and form language in D.

The external horizon of design quality of the interactive artifact is the constraints for the design project in the specific situation that the designers find themselves in. The internal horizon, i.e. the parts and their relationships, of design quality of the interactive artifact consists of motivations and purposes, functions and content, behaviour and form.

The relations between the conceptions of design quality as well-designed interactive artifact can be represented as a logically inclusive structure in an outcome space. This is depicted in Figure 1, and it also illustrates the internal horizon (B, C and D), and the external horizon (A and B). B belongs to both the internal and the external horizon of experience, by forming the contours of the phenomenon, since the purpose belongs to the interactive artifact while the stakeholders' motivations belong to the context.

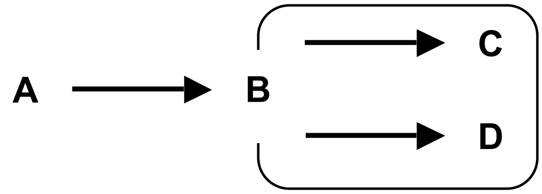

Figure 1 The hierarchy of logical relationships between conceptions of design quality of the interactive artifact

The figure means that Conception B is implied by Conception A since the conditions of the design project form the backdrop for the purpose of the interactive artifact. Conception B implies both Conception C and D in that the contents and functions, and their form and behaviour are means that contribute to the purpose, which is to deliver an interactive artifact that meets stakeholders' motivations and fit the context.

Discussion

The results can be interpreted using the theoretical frameworks for design quality presented in the introduction. Such an interpretation is depicted in Table 3.

Conception		Design quality aspects
A	Design quality as managing constraints on the interactive artifact.	Structural, ethical, political.
B	Design quality as delivering a motivated interactive artifact.	Functional, aesthetic, ethical.
C	Design quality as creating opportunities for usage of the interactive artifact and its contents and functions.	Primarily functional, secondarily symbolical.
D	Design quality as creating opportunities for experiences of the interactive artifact and its form and behaviour.	Primarily aesthetic, secondarily symbolical.

Table 3 Relations between interaction designers' conceptions of design quality and design quality aspects derived from the theoretical framework

Conception A: Design quality as managing constraints on the interactive artifact, has to do with what can and cannot be done in terms of technical and organizational structure. It also has to do with political and ethical issues related to power structures. This conception belongs to the external horizon of design quality for the interaction designers, and is thus something they experience as framing but not something that is focal for them.

Conception B: Design quality as delivering a motivated interactive artifact, has to do with the purpose of the design and the motives of the stakeholders. It is about delivering value in use of the artifact, whether it is functional usefulness and strategic ways of working for users or organizations, or aesthetic experience.

Conception C: Design quality as creating opportunities for usage of the interactive artifact and its contents and functions, has primarily a functional dimension in simple efficient ways of using an artifact. In simplicity there are also symbolic or communicational dimensions since functions and contents need to be presented in a clear and efficient way.

Conception D: Design quality as creating opportunities for experiences of the interactive artifact and its form and behaviour, has primarily an aesthetic dimension in elegant behaviour and form. It is also concerned with a symbolic dimension in creating interesting experiences.

The results indicate accordingly that the participants conceptualized symbolic, social and communicational aspects as secondary to, or at least not separate from, functional and aesthetic dimensions. The functional also seems to come before the aesthetic. Both these aspects are conceived as instrumental to the purpose.

No interaction designer had only one conception of design quality. In fact, in order to discern qualities of a phenomenon (such as an interactive artifact) one needs to experience variation in that which is discerned (Marton & Booth, 1997). One way to achieve variation of experiences is to actively shift conceptions (Hult, Irestig & Lundberg, 2006). Both Gann et al. (2003) and Ehn & Löwgren (1997) indicate this when arguing that a specific feature or quality does not belong to only one quality aspect. Participants in this study constantly moved between conceptions in their reasoning.

Verplank has three questions an interaction design has to answer (Moggridge, 2007): How do you do, know, and feel? An interaction designer does, however, not directly shape how people do, know and feel. He or she can only indirectly affect these issues. So what is it interaction designers do shape directly? It has been argued that it is the conditions for interaction that are shaped (Arvola, 2005; Hernwall & Arvola, 2008). Although not the focus for this study, the results indicates that shaping these conditions includes deciding the form and behaviour at the surface of the interactive artifact, and deciding the functions and content at its core, in relation to contextually dependent purposes and motives for users and businesses.

When interpreting the results of this study some caution is called for. The interview material analyzed here has to do with how interaction designers talk about design quality in general. It is not connected to specific design projects, and it is not situated in design action. An analysis of project specific quality judgements, or situated quality judgements may show that they in reality reason differently from how they say they reason. Future research will have to tell.

The results do not represent the full range of possible ways of conceptualizing design quality for this group at this time. Such a study would not be possible to conduct. All participants were from Sweden and Finland, and most of them had an educational background in cognitive science and human-computer interaction with an interaction design profile. Another sample may disclose other ways of seeing design quality in interaction design.

Design quality is always a topic for discussion in the design community, but do we talk about the same thing? The results would be interesting to contrast with the conceptions human factors specialists, industrial designers, graphic designers, and engineering designers have. Or why not game designers or artists in interactive art?

At face value, the results may seem equally applicable to industrial designers or graphical designers as to interaction designers. If we, however, look at the results more closely we see issues like supporting specific ways of working and interacting among users in organizations, and we find issues about behaviour, and combinations of content and functions of interactive artifacts that are typical to the interaction design discipline.

Conclusions

Four different conceptions that interaction designers have about design quality for interactive artifacts were identified, and they can be expressed in a condensed form as: (a) Constraints & contexts, (b) motivations & purposes, (c) use-qualities of functions & content, and (d) experiential qualities of form & behaviour. An awareness of these conceptions may facilitate researchers, students, practitioners, critics, and managers of interaction design in their appreciation of different aspects and opportunities of a design situation.

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Émergences du design et complexité sémantique des sextoys

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Résumé

L'exposition « Love design », en 2009, et notamment le *8ème ciel* de Matali Crasset, manifeste l'intérêt du design pour l'érotisme et les sextoys. Nous traiterons ici des glissements sémantiques opérés ces dernières années dans le monde des objets à usage sexuel. Le phallus, devenu un artefact hypertechnologique ou bien un objet habillé d'une iconographie issue d'un bestiaire, évince le registre pornographique au profit d'une apparence ludique ou raffinée. Les sextoys mettent donc en lumière la complexité sémantique à l'œuvre dans la construction d'un nouveau champ de pratiques afin de faire accéder le produit à l'univers commun. A travers cet objet d'étude, le design est interrogé dans une démarche à double tranchant. L'élaboration d'une cohérence sémantique repositionne le discours des sextoys mais elle se limite souvent à l'iconographie et à la technique en quête d'efficacité. Dès lors, le design, vecteur de cohérence sémantique au sein de ce terrain hétérogène émergent, reste en deçà de ses capacités à construire des scénarii complexes des diverses pratiques sexuelles.

Abstract

The exhibition « Love design », in 2009, and in particular the *8ème ciel* of Matali Crasset, shows the interest of design for the eroticism and the sextoys. We deal with semantic movements operated these last years in the world of objects with sexual usage. The phallus, become a hypertechnological artefact or an object dressed in an existent iconography of a bestiary, ousts from the pornographic reference in benefit of a funny or refined appearance. Sextoys highlights therefore semantic complexity in the structure of the new practice's reference in order to democratize the product. About this research, the design is asked in a double-edged approach. The structure of a semantic coherence redirect the speech about sextoys but it often limits itself in the iconography and in the technological in search of efficiency. From then, the design, vector of semantic coherence within this emergent heterogeneous subject, stays on this side of its capacities to construct complex screen play of various sexual practices.

Keywords

Design and sex; sextoys and society; perception/cognition of sextoys; design of sextoys for well being; sex efficiency; sexual practice and creativity.

Nous avons observé depuis le début des années 2000, l'apparition de sextoys dans les vitrines des centres villes en Europe et en Amérique du Nord, des sextoys ludiques, colorés ou encore élégants et raffinés qui s'éloignent de l'univers pornographique. L'émergence de ces sextoys dans les love-shops sous entend un nouveau niveau de visibilité sociale important. Ces sextoys, expression que l'on pourrait traduire par « jouets sexuels » ou plutôt jouets érotiques, constituent l'objet de notre étude au titre de territoire d'un design émergeant. Notre approche traite d'une étude contextuelle en France, susceptible d'être vérifiée dans les pays occidentaux. Le basculement stylistique de ces sextoys fait état d'un rhizome sémantique complexe, c'est-à-dire qu'il utilise des unités esthétiques permettant d'opérer des glissements du point de vue de sa lisibilité, de la cible visée et par là-même, de l'univers social dans lequel il fonctionne. L'émergence de ce nouveau marché associé à de nouvelles cibles et usages constitue un observatoire privilégié pour comprendre l'apparition et les implications du design au sein même des complexités qui articulent de nouveaux usages à la société, de nouvelles entreprises à leurs clients et de nouveaux produits aux cultures établies. Ce terrain est en fait relativement vaste et nous présenterons ici l'élaboration de notre projet d'étude et les premières conclusions observées. Cette étude est un travail de recherche en cours par le regard croisé de chercheurs en science de l'Art, en design et en sémiotique, nous proposons une première analyse du terrain qui vise à mettre en place et à structurer un projet de recherche plus vaste, interrogeant la part du design dans ces pratiques sexuelles intégrant l'artefact.

Le développement des sextoys nous semble relatif à une évolution du terrain des pratiques sexuelles et de la société avant d'être un phénomène lié au design. Ce serait parce que des initiatives concrètes disparates des distributeurs et des usagers sont apparues que les sextoys ont connu un renouveau. Ils sont en effet, les héritiers des traditionnels godemichés issus de pratiques ancestrales et vibromasseurs mis au point au XIXème siècle dans le milieu médical. Longtemps cantonné à l'univers des sex-shops, ils sortent aujourd'hui de cet univers déclassé et jugé socialement vulgaire pour intégrer au même titre que les pratiques qui y sont associées une nouvelle norme sexuelle. Pour les promoteurs des sextoys, la revalorisation des produits a nécessité une redéfinition des codes sémantiques associés aux produits qui correspond au passage d'un paradigme négatif à un paradigme positif que nous montrerons plus loin. Comment un tel glissement catégoriel s'est-il opéré ? Que nous apprend ce glissement sémantique sur l'évolution des valeurs associées à ces produits ? Quel est le rôle du design dans l'élaboration de cette nouvelle sémantique ? De plus, ce type de jouet sexuel excluant le corps de l'autre au sein d'une pratique autonome où le complétant au sein d'une pratique partagée, nous conduit à se demander ce qu'il reste de l'amour et du sexe quand cela ne fonctionne pas. La contre-performance peut-elle être entendue comme un ressort créatif du sexe ? En d'autres termes, et à une plus large échelle, le design cherchant systématiquement à proposer des solutions performantes, ne conduit-il pas dans le cas du sexe et peut-être à une plus large échelle à un épuisement des ressources créatives de l'humain ainsi qu'à une standardisation du plaisir sexuel ? Ces questions concernant la créativité de l'usager montrent la portée des enjeux que constituent l'implication du design dans les plaisirs sexuels.
Notre étude portera dans un premier temps sur le rôle du design en tant que vecteur corrélatif de la complexité sémantique associée aux produits. Nous nous aiderons pour cela des conclusions actuelles de certains sociologues comme Coulmont et Bozon ainsi que d'une approche intuitive du terrain étudié. Du point de vue du design, la complexité sémantique repose à la fois sur la technique, la manipulation, la sensorialité et l'image du produit ainsi que sur tout le discours et la rhétorique « marketing » qui l'entourent. Au sein de cet ensemble de valeurs (technique, usage, esthétique, sociologique) que l'objet intègre, chacune est porteuse de sens. Ce qui fait design en l'objet constituerait entre autres choses, l'unification de cette complexité sémantique. Il nous semble que dans le cas des sextoys, la complexité des sens construits et portés par l'objet est renforcée par le modèle intime et relationnel des usages au sein duquel il s'inscrit. Dans notre enquête de terrain, nous avons observé à quel point ses produits, même possédant une forte valeur d'image, semblent fortement tributaires des discours qui en font la promotion, organisés par les médias, par les vendeurs, ou encore par les témoignages organisés au sein de cercles de femmes tenus à domicile ou dans les boutiques spécialisées. De l'objet aux espaces de distribution, en passant par le packaging et les discours médiatiques (séries TV, etc.), nous avons affaire à un processus global de transformation, duquel il serait vain d'isoler la dimension « objet » comme dimension autonome et lieu du design. Ici, il s'agit plutôt d'une économie générale en

mutation, dont le design est vraisemblablement un instrument privilégié. L'intérêt de cette étude est de pouvoir observer ces phénomènes en direct et peut-être d'entrevoir à terme, et à titre d'anticipation prospective, les futures transformations possibles en matière design de sextoys.
Du point de vue de la méthode et de l'échantillonnage de l'objet d'étude, l'offre en matière de sextoys « nouvelle génération » est très étendue et elle est structurée en catégories variables selon les marques, et plus ou moins cohérentes selon le critère catégoriel considéré : genre d'objet (boules, godes, anneaux, etc. objets inédits), cibles (H/F, Homo/hétéro, âge, secteur (luxe/...), valeurs (ludique, technique, performant, « hardcore », aventurier, familier, etc). La définition d'un corpus d'étude étendu présentait donc des difficultés objectives, et à ce stade (inchoatif) de notre travail de recherche. A titre d'entrée en matière, et de manière plutôt intuitive et phénoménologique, nous avons simplement choisi des objets présentant des « saillances fortes » et des niveaux de « présence » élevés ; objets auxquels nous avons conféré une valeur d'échantillons-types pour commencer notre étude. Ainsi, notre étude se limitera ici à un échantillonnage choisi de vibromasseurs. Il est question d'étudier le degré d'esthétisme, de performance et la valeur sémantique observable dans cet ensemble d'objets afin de comprendre les glissements sémantiques sur plusieurs niveaux. Dans un deuxième temps de l'étude, nous projetons de vérifier cette analyse en évaluant la perception des potentiels usagers mais aussi des utilisateurs afin de repérer précisément les valeurs et les parcours sémantiques en jeu, ainsi que les modes subjectifs d'appréhension de ces valeurs chez les utilisateurs (féminins et masculins) de ces objets de désir. Un différenciateur sémantique soumis à un panel d'utilisateurs et de non-utilisateurs permettra d'évaluer la perception et les usages des sextoys étudiés ici.
Enfin, cette nouvelle génération de sextoys, nous semble démonstrative de l'irruption du design au service du développement de nouvelles pratiques du sexe récréationnel. Cela nous invite à nous poser la question suivante, à partir de quand, de quels phénomènes peut-on estimer qu'il y a émergence et développement d'un design au sens d'un projet cohérent. Quels sont les données et les éléments qui vont nous permettre d'évaluer l'apparition ou non de celui-ci ? Y a-t-il différents types de design ou, différents degrés d'application du design détectables au sein de ces émergences ?

Notre hypothèse est que le design est un outil d'intégration de la complexité. Lorsque de nouveaux usages ou besoins, apparaissent ou se répandent, le design intègre les complexités des nouvelles significations pour construire une forme de cohérence sémantique au sein de l'environnement quotidien. Outre le plan s*émantique,* le design apparaîtrait ici en tant que vecteur corrélatif entre les sphères marketing, social, sémantique et stylistique. L'émergence d'une nouvelle génération de sextoys est l'occasion pour nous d'observer comment et sous quelles formes le design apparaît au sein d'un terrain hétérogène en recherche de lisibilité. Dans un premier temps, nous traiterons des mutations sociales actuelles liées aux sextoys afin de contextualiser l'émergence d'un design dans une seconde partie. Cette étude sera enfin approfondie par l'analyse de plusieurs cas. L'élaboration de ces glissements sémantiques nous conduira aussi à pointer les limites d'une quête d'efficacité.

Mutations sociales

En 2001, Elisabeth Bernstein « évoquait le déplacement de certaines conceptions de l'intimité sexuelle, d'un modèle relationnel vers un modèle « récreational » (Coulmont, 2007 : 231). L'évolution des modèles relationnels de la sexualité serait partie prenante du développement des sextoys. Ce déplacement des valeurs a permis l'apparition de ces nouveaux produits destinés à compléter les pratiques récréationnelles et ludiques du sexe qui devient un loisir comme un autre. Il s'agit en fait d'une redéfinition sémantique d'appareils déjà existants comme le godemiché et le vibromasseur opérant un déplacement sémantique des codes de la pornographie vers ceux de l'érotisme, du sexy, du ludique et du bien-être.

Dans son ouvrage *Sex-shops : Une histoire française*, Baptiste Coulmont explique que la manifestation de ce glissement sémantique est d'abord apparue avec un nouveau type de magasins qui se démarquaient des sex-shops en s'installant hors des quartiers chauds associés à la pornographie, dans des rues plus passantes et jugées moins vulgaires. Dans ces magasins, explique-t-il « les gadgets sont présentés en terme de « récréation ». Attwood souligne donc le rapprochement constant des vibromasseurs avec les jouets et surtout les vêtements, ainsi que l'éviction des formes visuelles de la pornographie » (Coulmont, 2007 : 232). Celle-ci est rejetée « vers le sale, le malsain, l'atteinte à la dignité humaine et [l'objectif devient] d'élever l'objet sexy vers le sain, le beau, l'éthique. Les promoteurs des sextoys sont donc des producteurs de normes sexuelles. » (Coulmont, 2007 : 237) Ces « love-shops » ou « sexy-stores » par le nouveau nom qu'ils se donnent, montrent bien que le développement de ces nouveaux produits est dans un premier temps fondé sur une redéfinition sémantique du discours sur l'objet. L'élaboration de ce nouveau discours vise essentiellement la valorisation de nouvelles pratiques sexuelles récréatives s'opposant à la pornographie, jugée vulgaire, et s'intègrent selon leurs promoteurs à une sexualité positive : c'est-à-dire « en couple, à la maison, hétérosexuelle, stable ». Si le sociologue B. Coulmont juge que le sextoy fait entrer la sexualité « normale » dans « une zone contestée ni entièrement reléguée dans le pathologique, ni entièrement acceptée » (Coulmont, 2007 : 231) la journaliste Elisabeth Weissman, quant à elle, considère qu'en « massifiant [la production du sextoy], en le médiatisant, en le commercialisant, en le banalisant ainsi, le marché a même réussi ce tour de passe-passe : faire perdre au gode son pouvoir transgressif » (Weissman, 2008 : 108). Nous le voyons, les sextoys ont ouvert une brèche dans les usages sexuels acceptés comme norme et continuent à poser question à la société et aux consommateurs. Beaucoup de choses semblent à inventer et notamment le sens de ces pratiques à l'heure où il incombe « aux sujets […] d'établir la signification de leur conduite sexuelle et d'en résoudre les contradictions. » (Bozon, 2009 : 112). Un vaste réseau sémantique est donc encore à établir pour répondre aux diverses significations que l'utilisateur de sextoy peut donner à ses conduites sexuelles, variables selon les situations.

L'émergence d'un design

Conscients des mutations actuelles, les revendeurs n'hésitent pas à ré-emballer les produits pour valoriser une image sensuelle et sensible de la femme à l'aide par exemple, de papiers de soie et de plumes. Ceci dans le but d'évincer l'image de la femme présentée sur les emballages d'origine, jugée dégradante car pornographique. Ce nouveau discours donne un autre rôle à la femme qui n'apparaît plus comme le réceptacle des fantasmes masculins mais devient maîtresse de son propre plaisir et de son bien-être. Ce déplacement sémantique du « sex » vers le « love » et le « sexy » correspond donc à la définition d'une nouvelle cible largement plus féminine, - B. Coulmont parle d'un « processus de féminisation pluriel » (Coulmont, 2007 : 232) - sensible à des valeurs comme l'humour, la sensualité et le beau, sensible à la mode et au design. Les sextoys sont aujourd'hui vendus comme de véritables accessoires de mode, présentés dans des emballages à jour des nouvelles tendances et des magasins décorés avec goût dans des tons allant du pourpre au rose bonbon. Le design de ces magasins est souvent proche de celui du magasin de lingerie, ou d'accessoires de mode et de décoration. Les vibromasseurs sont couramment présentés en position verticale qui leur procure une visibilité attractive. Regroupés par types ou par marque, ils sont exposés comme des objets possédant une certaine aura proche de celle du bijou ou parfois de l'objet d'art. Cette mise en scène fait partie du processus de transformation entre les champs sémantiques que nous avons évoqué.

De manière générale, les sextoys s'émancipent des représentations mimétiques du membre masculin et deviennent de véritables entités indépendantes, des corpuscules aux déclinaisons figuratives variables. Si dans les années 70, l'imitation du membre masculin a pu être un canon érotique, aujourd'hui il semble que les critères ont évolué et s'appliquent à des registres formels variés. Dès lors, le sextoy s'éloigne des représentations mimétiques et revendique une part d'artifice. Cela le rapproche des conduites sexuelles actuelles caractérisées par ce que Lasch appelle « the flight from feeling », c'est-à-dire « la fuite devant le sentiment » (Lasch, 1979 : 61). Selon cette idée, les émotions sont jugées dangereuses, voire même embarrassantes, elles sont en effet susceptibles d'altérer l'équilibre intérieur de l'individu. L'exemple de la série *Sex and the City* est illustratif de ces comportements. Cette série américaine traite du sexe selon le point de vue de quatre copines, sans aucun tabou. Elles expérimentent la vie, le sexe, les hommes, les sextoys. Leurs conversations tournent autour de leur rendez-vous manqué, de la taille des pénis de leurs amants ou encore de leurs ex-petits amis. Ces filles trentenaires, représentent le désengagement émotionnel, elles prônent la liberté et exaltent la relation amicale. La protection est de rigueur dans cet individualisme qui conduit à consommer l'individu et à le réduire à un objet de plaisir. Lipovetsky précise que « c'est moins la fuite devant le sentiment qui caractérise notre temps, que la fuite devant les signes de la sentimentalité (Lipovetsky, 1983 : 111). » Au-delà d'une réduction artificielle de l'autre, c'est l'usager lui-même qui se trouve également privé de sa dimension d'auteur-créateur. En effet, lorsque la personne détourne des produits du quotidien pour satisfaire ses plaisirs sensoriels et sexuels (plume, bougie, concombre etc.), il interprète le monde en en proposant une lecture personnelle (décodage sémantique), en cohérence avec son propre système de valeurs en perpétuelle évolution. Les sextoys le privent de cette lecture singulière par laquelle il affirme son individualité. Les sextoys, fixent et figent les figures sémantiques du sexe au sein desquelles l'usager est réduit à un choix nécessairement limité, qui risquent à terme de standardiser les valeurs personnelles de la sexualité. La dimension humaine n'est pas prise en compte, à travers les sextoys, même la morphologie organique de l'autre est évincée. Cette consommation du plaisir par le truchement d'un artefact sans référence directe au corps d'autrui conduit à considérer le sextoy comme une entité à part entière. Le sextoy étant présenté comme un acteur permettant de relancer ou d'agrémenter la libido du couple apparaît comme un tiers, au sein même du couple. D'ailleurs, le love-store *Les passages du désir* (Fig. 1 et 2) dans le marais à Paris se revendique déjà comme un promoteur du « développement durable du couple ». Pour le sociologue Serge Chaumier, « c'est l'intervention ou la menace du tiers qui relance la mécanique de la passion amoureuse » (Chaumier, 2004 : 25). Son essai sur le nouvel ordre amoureux, n'est pas sans intérêt pour notre étude puisqu'il explique que « le retour du refoulé semble particulièrement s'exprimer dans le domaine de l'érotisme, présent dans de nombreuses créations culturelles. L'inflation des productions érotiques n'est pas sans lien avec l'idéal d'autosuffisance du couple ni sans effet sur la régression progressive de l'adultère comme façon d'extérioriser ses pulsions. (Chaumier, 2004 : 30) » L'érotisation des marchandises constituerait un exutoire à l'extériorisation des pulsions. Les sextoys issus d'une stratégie intégrant le design possèdent à la fois le statut d'objet de mode désirable et d'objet associé au sexe, ils sont probablement le type de biens répondant le mieux à cet assouvissement d'autosuffisance du couple ou de l'individu, ils évoluent donc dans un moment propice à leur développement. Si le glissement sémantique et l'évolution des pratiques se sont d'abord produits de manière diffuse dans la société, le design est intervenu sur ce nouveau terrain de consommation et a permis à de nouvelles marques de se développer avec des concepts originaux. Au sein de ces pratiques émergentes, le design semble avoir favorisé l'intégration des complexités sémantiques en jeu à travers les sextoys en proposant une cohérence plus lisible entre les marques, les gammes, les packagings, les produits et leurs lieux de distribution (magasins et sites web).

Figure 1 et 2 Le love-shop « Les passages du désir », Paris

Etude de produits

Pour débuter notre étude de terrain, nous avons opté pour une approche intuitive et effectué une sélection après une large observation des produits via les magasins et les sites internet. Nous avons choisi un échantillonnage de travail afin de refléter la diversité des univers de gammes proposées en vibromasseurs, selon les marques. Une méthode de travail empirique s'est imposée pour appréhender cet univers. Nous nous sommes rendues aux réunions du soir proposées dans les love-shops. Exclusivement réservées aux filles, la potentielle acheteuse est dorlotée avec champagne et petits fours. Nous intégrions dès lors un univers féminin, convivial chic et presque secret à l'abri des hommes. Après avoir détendu l'atmosphère, la vendeuse nous explique à quoi servent et comment utiliser ces vibromasseurs ou ces stimulateurs clitoridiens. A l'écoute, les jeunes femmes manipulent, touchent la matière, appréhendent le lisse, le doux. Elles évaluent les degrés d'intensité de vibration sur le bout du nez ou sur le ventre, elles testent les mouvements rotatifs, le nombre de mouvements différents et les créativités interactives possibles. Au final, ces réunions et la plupart des visites opérées dans les love-shops, ont rendu compte d'une nécessité de pratiquer, de toucher, de prendre connaissance de ces objets et des performances offertes. Nous avons également questionné les vendeurs et les attachés de presse afin de mieux connaître leurs buts et leur type de clientèle. Les registres formels, esthétiques et techniques repérés dans ces love-shops présentent un ensemble cohérent, une unité qui coordonne leur discours.

Nous résumons ici les résultats de nos observations en nous concentrant sur les cas les plus parlants.

Figure 3 En dessous, le Magic Rabbit

Le *Magic Rabbit* (édition internationale, Fig. 3), le *Vibro chenille* (un modèle représentatif de la gamme de vibromasseurs de la marque *Fun Factory* (Allemagne), Fig. 4) et le vibromasseur *Iris* de la marque *Lelo* (Suède, Fig. 5, 6 & 7). Notre méthode consiste à s'appuyer sur les conclusions actuelles de la sociologie pour situer les nouvelles valeurs véhiculées par ces produits puis à repérer les discours spécifiques de chaque marque pour comprendre comment le design les a fait évoluer. Nous repérerons donc au moins deux niveaux de valeurs dans les discours : le premier, générique, est celui qui permet de faire glisser ces produits de l'image pornographique vers l'image d'un paradigme positif ; le second niveau, plus spécifique, concerne les valeurs propres à chaque marque. Celles-ci constituent en effet des discours distincts contribuant à enrichir par différenciation et segmentation, le discours de ces nouveaux produits. Un autre niveau questionne les valeurs de la discipline du design, celui de la technicité et de l'optimisation des performances orgasmiques en un clic, au risque de négliger les scenarii créatifs des usagers.

Le *Magic Rabbit* est reconnu comme l'un des must du genre. Popularisé au début des années 2000 par la série *Sex and the City*, ce modèle est fabriqué en Chine, et distribué dans plusieurs pays sous des marques différentes. Il est pourtant issu des pratiques sexuelles établies au Japon où les sextoys sont répandus depuis longtemps et leur usage très courant. Le *Rabbit* est un produit misant principalement sur la technique au service de l'orgasme. Il assure à la fois une stimulation clitoridienne et vaginale à l'aide de deux moteurs qui actionnent indépendamment la vibration du stimulateur clitoridien et la rotation des billes de la partie phallique. L'iconographie employée dans le produit semble ambiguë. L'ensemble paraît peu cohérent car les stylisations figuratives mixent des représentations à la fois humaines et animales avec des degrés d'abstraction différents. Cela s'explique en partie par le fait que la représentation mimétique du phallus est prohibée au Japon. Les producteurs du *Rabbit*, ont donc dû « habiller » l'appareil d'une iconographie suggestive non mimétique. Le petit personnage figuré peut apparaître anecdotique et renvoyer l'appareil au rang du gadget. Néanmoins dans la culture nippone il symbolise la Déesse Kanon, déesse de l'amour et de la compassion présente depuis de siècles sur les godemichés et les vibromasseurs japonais. Le cas du *Rabbit* est intéressant, il est typique des gadgets vendus depuis plusieurs années dans les sex-shops et gagne aujourd'hui les *love-shops*. Il fait partie des appareils souvent ré-emballés ou présentés hors de leur emballage trop connoté. De plus, le *Rabbit* montre une incohérence entre l'emballage, le produit et son mode de distribution. Comparé à certains de ses actuels concurrents, le *Rabbit* conserve l'image du gadget valorisant la partie technique de l'appareil grâce à la transparence du plastique coloré employé. La transparence offre la possibilité de voir les billes rotatives et axe le produit sur la qualité de la performance obtenue.

Figure 4 A gauche, le Vibro Chenille, Fun Factory

Le *Vibro Chenille* de *Fun Factory* quant à lui, apparaît ludique, ses codes formels sont amusants et doux. L'objet tente de séduire un vaste public féminin sur les terrains du plaisir lié à une hygiène sexuelle et non plus uniquement à une masturbation. C'est un objet de détente. Évinçant toute ressemblance marquée avec l'imitation du membre masculin, cet appareil n'apparaît plus comme un membre tronqué, mais bien comme un personnage ou une figurine intègre et autonome. Cette impression d'autonomie est renforcée par l'emploi des piles, l'objet n'est alors quasiment plus perçu comme dépendant de l'univers artificiel auquel il appartient. L'identification du produit au petit animal représenté est plus aisée, elle relie l'objet au monde du vivant auquel nous appartenons. La référence animalière et ludique procure également au produit une aura transgressive tout en restant dans le domaine de l'acceptable grâce à l'humour. L'objet conserve donc l'attrait de la transgression tout en restant dans le domaine du familier. Cette petite figurine animalière apparaît tel un habillage illustratif favorisant la dédramatisation du jouet érotique et le plaçant sur un niveau récréationnel et relationnel. Cela peut sembler paradoxal, mais la figurine favorise sans doute une approche relationnelle à l'objet qui, dans son autonomie, peut devenir un petit être de plaisir à part entière. L'effort de *Fun Factory* a essentiellement porté sur une redéfinition stylistique du sextoy visant à intégrer un nouveau discours dans le dessin même des produits. La cohérence stylistique entretenue entre les produits, les gammes et leurs environnements a contribué à plus de cohérence entre la sémantique du produit et l'usager. La marque communique également sur les progrès apportés par le design en termes d'ergonomie, de matériaux (introduction du silicone), de techniques et de manipulation. Néanmoins l'évolution la plus visible et la plus marquante pour l'usager est avant toute une stylisation ludique du produit. Pourtant, même si cette stylisation formelle peut apparaître comme le ré-habillage d'un objet technique déjà existant, elle constitue en soi une étape importante destinée à marquer un changement notable dans les pratiques courantes et ses effets vont au-delà d'une stylisation purement décorative. L'encodage esthétique des nouvelles valeurs sémantiques associées aux pratiques du sexe permet de développer une familiarité avec l'objet technique grâce à une valorisation de l'usager face à un produit qui sollicite son sens de l'humour. Les aspects relationnels des pratiques sexuelles, grâce à la figure rassurante de l'animal et à l'autonomie formelle et technique de l'objet déplacent ce modèle relationnel du partenaire vers l'objet, qui devient lui-même un partenaire familier. L'acceptation des appareils à forte valeur technique semble passer par une apparence anthropomorphe ou zoomorphe. La figure familière est alors garante de sympathie tandis que des morphologies plus abstraites véhiculent un sentiment d'angoisse (Mori, 1970).

Par ailleurs, le design apparaît ici comme un outil permettant de faire passer une pratique déclassée dans le champ du familier. Nous pouvons parler de design, car l'effort de redéfinition stylistique est bien motivé par une stratégie globale destinée à optimiser l'entrée en relation entre de nouveaux produits et de nouveaux usagers. À ce stade le design apparaît encore essentiellement consacré à l'encodage de nouvelles valeurs sémantiques dans l'habillage formel du produit destiné à la construction d'une cohérence lisible permettant au produit de se démarquer des anciennes générations de sextoys.

Figure 5,6 & 7 Modèles Iris(au dessus) et Gigi de Lelo

La marque *Lelo*, enfin, fait partie des nouvelles marques qui proposent des produits spécifiques à la clientèle des love-shops. Elle propose des appareils jouant sur le registre de l'évocation formelle abstraite. Ses produits sont visuellement lisses et clos dans une coque bicolore qui sépare l'interface de commande de *l'interface de plaisir*. Le lisse, le blanc, l'épuration, la sobriété et l'élégance de ces courbes le positionne à la fois du côté des objets haut de gamme et raffinés. L'épuration lui octroie un mystère symbolique, il semble être un concentré technologique tout en manifestant une simplicité extérieure. Il intègre l'esthétique épurée des téléphones cellulaires tactiles comme *l'Iphone*, le *Corby* de Samsung, le *Viewty* de LG, mais aussi d'un raffinement très féminin, proche de la lingerie féminine de par ces couleurs et sa prestance. Tout comme les téléphones portables, l'*Iris* fonctionne avec une batterie rechargeable sur le secteur. Sur le site internet de la marque l'appareil est représenté par des vues en image de synthèse renforçant son lien avec les produits technologiques. Curieusement, la référence au téléphone portable nous ramène encore à un modèle relationnel et récréationnel qui participe à un phénomène de familiarisation avec l'objet technique. Ici l'objet est peut-être plus conçu comme une interface de mise en relation plutôt que comme une entité figurative autonome comme peut l'être le *Vibro Chenille*.

Malgré une morphologie abstraite, les produits de la marque Lelo, sont également exposés sur des fonds suggérant l'univers associé aux produits. Ainsi, les vibromasseurs pour femme, sont-ils présentés sur fond de dentèle chic et sexy, le fond de satin noir souligne le modèle luxe en plaqué or. Cela nous permet de penser que la marque élabore un discours visuel autour de ses produits pour construire une identité lisible. L'épuration formelle des appareils ne suffit donc pas à rendre lisible l'identité du produit. Cette présentation ajoute un ensemble de références à la sensorialité qui complète le discours du produit. Ici, le design apparait comme un vecteur d'organisation et d'intégration de la complexité sémantique au sein du produit et de son environnement de distribution et d'usage. Comme pour le modèle de *Fun Factory*, *l'Iris* manifeste une cohérence entre le produit et ses environnements issus d'une stratégie intégrant le design à plusieurs niveaux.

Les deux derniers exemples montrent une cohérence sémantique entre l'usage, la technique, l'image et l'environnement du produit, il se construit un discours sémantique sur deux niveaux. Le premier consiste en effet en une stratégie de valorisation du produit qui passe d'abord par l'image et la stylisation du produit, dans le but d'associer le produit à des valeurs positives. La référence à la figure animale ou au téléphone portable semble indiquer une stratégie visant à rendre les vibromasseurs familiers en réduisant, voire en supprimant la barrière existante entre des appareils d'usages courants. La suppression de cette barrière est non seulement garante d'une facilitation de l'usage de ces produits, car ils empruntent des interfaces de commande communs à d'autres appareils électriques, mais elle agit aussi sur une déculpabilisation de l'acte d'achat. Le second niveau sémantique de ces produits, montre les positionnements différents qu'ont choisis les marques. Il désigne des stratégies de familiarisation opérant sur des cibles différentes et révèle un marché lisible ou la complexité peut être lue par les utilisateurs comme une variété d'offres et de possibles. A ce niveau là, le design apparaît comme un vecteur structurant la variété afin de la rendre lisible. Il devient un outil de facilitation de l'usage grâce à l'intégration structurée d'une complexité sémantique assurant la lisibilité du discours de l'objet au détriment parfois de la lisibilité de l'usage. La conception des deux derniers exemples exprime une forte orientation stylistique. Il est clair que cet effort paraît nécessaire pour affirmer la nouvelle rhétorique identitaire des sextoys. Du point de vue de l'analyse, même si les objets sextoys constituent un point d'entrée sur le phénomène étudié, il est difficile de distinguer clairement les niveaux de l'objet, de la pratique (de ses styles), et du marché. L'une des hypothèses interprétatives consiste à affirmer que les configurations repérées sur les objets, notamment au niveau thématique et figuratif, configurations qui peuvent être premièrement perçues comme de simples variations stylistiques, assument en réalité une fonction rhétorique qui s'explique par l'état du marché et les intentions d'en modifier les équilibres de la part des promoteurs des sextoys, principalement des marques.

Figure 8 Delight, Fun Factory

Nous avons par ailleurs remarqué d'autres produits annonçant une implication plus marquée du design dans la conception de nouveaux usages. Le *Delight* de *Fun Factory* ou les *masseurs sensuels* de *Philips* proposent des formes aux ergonomies originales, renouvelant la typologie du vibromasseur et suggérant d'autres manières de les utiliser. Nous pourrions y voir alors, un troisième niveau où le design comprend une intégration sémantique beaucoup plus synthétique de l'ergonomie, de l'esthétique et de la technique.

Conclusion

Il est probable que cette nouvelle génération de sextoys ait été rendue possible grâce au travail stylistique que nous avons décrit et qui a rendu lisible le changement de paradigme de ces appareils. L'analyse que nous venons de mener semble montrer plusieurs mouvements de la relation entre design et complexité sémantique. Un premier mouvement de contraction et de synthétisation des tendances sociales émergentes dans l'élaboration d'une stylisation nouvelle. Un second mouvement semble alors rendu possible, celui de la construction d'une diversité structurée et lisible pour l'usager.

Dans notre étude nous avons montré un processus de familiarisation grâce au discours visuel de l'objet, or il nous est apparu simultanément une difficulté de lecture de l'usage et des emplois de ces produits. Cela est confirmé par l'organisation des réunions organisées par les magasins de sextoys. Par ailleurs, dans les perspectives de cette recherche, il apparaît essentiel de développer une étude de la sémantique de l'usage. En outre, nous souhaitons évaluer la lisibilité des usages auprès de panel par le biais d'enquêtes de perception. De ce point de vue, les sextoys sont des objets qui engagent le rapport à notre propre intimité, que cette intimité soit partagée ou non.

Au-delà d'un remodelage stylistique et sémantique, le design met en scène une cohérence déplaçant ces objets pornographiques vers une dimension sensuelle et féminine. Ce glissement n'est pas sans limiter ces artefacts du sexe à une question technique qui tourne autour de problèmes de dimension, de diamètre ou de vitesse. Au final, plusieurs aspects du design sont évincés dans le cas des sextoys à l'heure actuelle. En se concentrant sur la notion de performance, le sextoy évince l'imaginaire, la place de l'expérience et du développement de scénarii liés au plaisir et aux émotions. Notre étude ne se borne pas à une réflexion d'ordre stylistique, elle dénonce les limites actuelles du marché des sextoys. Nous ne pouvions pas faire l'économie des rapports de complexité entre des niveaux de lecture différents. Il s'agit maintenant de savoir si ces objets pourraient mettre en route une créativité originale de l'usager. Cela nous conduira à interroger les limites de la notion de performance et d'efficacité fonctionnelle qui constituent souvent des objectifs fondamentaux du projet. Serait-il souhaitable dans le design de sextoys, d'impliquer la contreperformance du produit comme ressort d'un plaisir intégrant la créativité des usagers ? Par ailleurs, un projet de design global pourrait prendre en considération de manière plus vaste les ambiances, les scénarii et les expériences sensorielles liées au plaisir. Cette recherche pointe une difficulté quant à des définitions objectives ou standardisées du plaisir, elle révise les définitions usuelles du design comme recherche optimale et efficace d'une réponse à un besoin.

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Sustainable collaborative services on the digital platform: Definition and application

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Abstract

Information communication technologies (ICT) have emerged as an enabling solution that facilitates grassroots social innovations. Among them are collaborative services in which the final users collaborate to provide solutions to their unmet social needs. These alternative solutions aggregate to result in radical innovations towards a sustainable society (Meroni ed., 2006). Examples of collaborative services on the digital platform include Hitchhikers, a service created by hitchhikers to connect people with empty seats in their cars and people in need of a ride, thus allowing them to meet new people and reducing carbon footprint; Vicini Vicini, a service that aims to strengthen social fabric in Rome by helping people to organize parties with neighbors; Peladeiros, a service in Brazil that helps people to organize soccer matches; GROFUN, a service organized by people in Bristol to promote urban gardening, share the produce and dine together.

We introduce the notion of collaborative service and showcase the examples of collaborative services supported by ICT, mainly web-based. The cases studies reveal that collaborative services have a common structural system and that they can be classified into seven categories based on their meta-function. Collaborative services produce two elements – a solution and a social network. Based on theories of social network analysis, we argue that the two elements influence the formation of each other, i.e., a solution generates a social network as a byproduct and the social network in turn become a medium to diffuse innovations and creates opportunities to start new collaborations and that this virtuous cycle is amplified by ICT.

Keywords

social innovation; sustainability; service design; information communication technologies (ict); social network.

Social innovation is moving from the margins to the mainstream with the launch of President Obama's new Office of Social Innovation and a new push in Europe from President Barroso to link innovation strategy to social goals (The Young Foundation, 2009). However, this is not because social innovations have suddenly grown in number. What has changed is people's attitude. They have become more conscious of alternative and sustainable solutions due to the failing system of the current paradigm. At the same time, technologies that can democratize and accelerate innovation have diffused to our everyday life. These two conditions create a favourable condition to diffuse social innovation with an urgent need for designers to participate. One possible role of designers is to facilitate the on-going transition by creating conditions for people to use creativity and innovate at the local scale and that of design researchers is to provide designers with a theoretical ground by understanding the environment in which collaborative services are created, developed and replicated and supporting them with appropriate methodologies.

This research discusses issues on design for social innovation and sustainability which specializes in service design for social innovation at the grassroots level and sustainability. Social innovation is defined as "innovative activities and services that are motivated by the goal of meeting a social need and that are predominantly developed and diffused through organisations whose primary

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[1] The paper was prepared by the three authors together. Manzini wrote a part of section 3.1 and 3.2 and Rizzo wrote a part of section 3.3 and 3.4. Baek wrote the rest.

purposes are social" (Young Foundation, 2006). Design for social innovation and sustainability is a domain of design that deals with services for people whose social needs are not met and their relation to sustainability. A role of a design researcher in this field is to understand the phenomenon of social innovation at the grassroots level in various contexts, identify its relation to sustainability and to design conditions that empowers people to use their creativity to ideate, implement and disseminate the solutions for their needs as Manzini claims, transition towards sustainability is a social learning process that requires active involvement of social constituents (Manzini in Meroni ed., 2007). How social innovation at the grassroots level contributes to sustainability is not discussed exhaustively here but it can be stated in summary that the radical innovations of local systems, i.e. discontinuities with regard to a given context, that challenge traditional ways of doing things introduce a set of new, very different and intrinsically more sustainable ones and that these micro-transformations become the groundwork for great systemic change (Manzini in Meroni ed., 2007).

With this in background, a series of projects have been conducted to collect the cases of social innovation at the grassroots level around different parts of the world. In 2006, the cases of so-called creative communities were collected in Europe (Meroni ed., 2007). Creative communities are groups of people who creatively solved social problems around them rather than complying with existing solutions that were proven to be ineffective. Similar research was conducted in developing contexts such as China, Brazil and India (Manzini & Jègou, 2007) and finally in Africa (work in progress). Although these cases consist of a wide range of ideas from diverse cultural and technological contexts, they share one thing in common in that they are social services in which the final users collaborate to produce solutions to a wide range of social needs that have failed to be met by existing solutions. For this reason, they are called collaborative services and the people who designed them are called collaborative organizations (Jègou & Manzini, 2008).

Collaborative service is distinguished from other services in that it requires relational qualities as a prerequisite to function. Relational qualities as the expressions of the "genuine dialogue" established between the participants of collaborative service and include trust, intimacy, friendship and a common identity (Cipolla, 2007). Figure 1 is a matrix that illustrates where collaborative service is positioned in relation to other services.

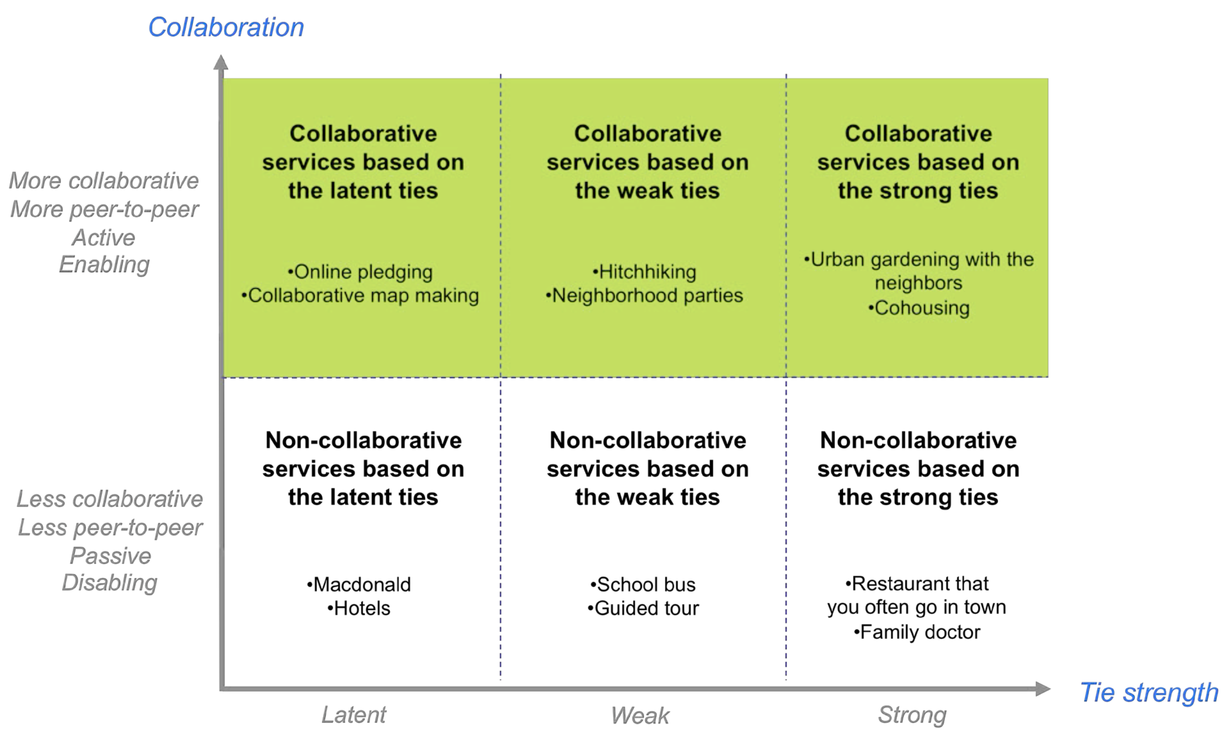

Figure 1. Positioning of collaborative services

1. Collaborative services on the digital platform

In recent years, peer-to-peer and collaborative production has emerged as a powerful trend in the digital, networked industries. Just to mention a few, Wikipedia, an archive of distributed knowledge; Google and Amazon which provide a peer-to-peer platform for sharing information and trading products; various open-source software projects based on Creative Commons licenses. Exhibiting characteristics of anti-rivalry and inclusiveness (Cooper, 2005), collaborative production in digital world is distinguished from traditional ways of production in the market economy in that it is more democratic in political aspect and more efficient in economical aspect (Benkler, 2006). They are examples of socio-technological innovation that are changing our ways of production and living and show possibilities that technologies, especially ICT, can be used an enabling solution to promote social innovation at the grassroots level.

Collaborative service shares several aspects in common with digital collaborative production. Both of them require collaboration rather than competition, inclusiveness rather than exclusiveness and are based on a platform that is decentralized rather than centralized. They also aim to improve the quality of the commons rather than privatized goods. Digital collaborative production aims to expand the repository of digital commons that are mainly information whereas the latter focuses on improving social commons such as relational qualities and social network. In addition, collaborative service and digital collaborative production can supplement each other when they are combined and produce a synergy effect. Firstly, when digital, networked platform is applied to collaborative service, it can increase the accessibility and replicability of the given service, making it available to people of wider social and economical status. Secondly, it can enhance communication between stakeholders within a service and between similar services, thereby strengthening the social fabric and making a service more resilient. Finally, advanced ICT, collective knowledge and innovative business models in open networked platform can reduce the technological, bureaucratic and economical burden of creating and supplying a service respectively.

As the first step to understand how collaborative organizations use ICT to improve their services, case studies of collaborative services on the digital platform were conducted.

2. Research method and the result

Case studies consist of two stages: in the first stage, 30 cases were selected from different parts of the world and analyzed using so-called a ‘light format’. The aim of the light analysis is to obtain basic information – both qualitative and quantitative - of the cases in order to understand and affirm the phenomenon. In the second stage, 10 cases were selected from the 30 cases for in-depth analysis in order to understand how ICT facilitate the diffusion of collaborative services.

In order to select the cases that satisfy our definition of collaborative service, over 100 cases were reviewed using the following criteria:

1. A service uses ICT to promote itself and enhance communication within community.
2. A service involves collaboration in physical and/or digital spaces.
3. A service is designed and provided by users with an intention to satisfy their unmet social needs.

In addition to these criteria, factors such as the service area, age of service, organizational size, aim and type of the services were taken into consideration to give diversity to the cases. The result is the 30 cases in table 1.

Case	Form	Service area	Origin	Since	Size
Hitchhikers	Enabling solution	Mainly Europe	The Netherlands	1999	Unknown
Hope institute	Enabling solution	South Korea	South Korea	2006	3365 ideas
Peladeiros	Enabling solution	Brazil	Brazil	2001	32250 users
Vicini vicini	Enabling	Rome, Italy	Italy	1999	Not known

	solution				
Green map	Enabling solution	Worldwide	US	1995	400 cities, 51 countries
Open green map	Enabling solution	Worldwide	US	2008	+ 4000 sites
Grofun	Collaborative service	Bristol, UK	UK	2007	10 people
Couch surfing	Enabling solution	Worldwide	US	2004	+ 950000 users
Meetup	Enabling solution	Worldwide	US	2001	4700000 users
Pledgebank	Enabling solution	UK and 12 other countries	UK	2005	91625 users
Katrinalist.net	Enabling solution	US	US	2005	4000 users
Shelfari	Enabling solution	Worldwide	US	2006	Six digits (confidential)
Bookcrossing	Enabling solution	Worldwide	US	2001	740000 users
Mapo dure	Platform	South Korea	South Korea	1997	+ 2500 members
Activmob	Enabling solution	Kent, UK	UK	2008	+ 20 mobs
Aka aki	Enabling solution	Germany	Germany	2008	1494926 encounters
Carrotmob	Enabling solution	US	US	2008	Not yet launched
Economia solidale	Enabling solution	Italy	Italy	1994	4736 users
No 10 Petitions	Enabling solution	UK	UK	2006	+ 5000000 participants
FixMyStreet	Enabling solution	UK	UK	Unknown	31628 problems reported
WiserEarth	Enabling solution	Worldwide		2007	Unknown
Solidarius	Enabling solution	Brazil	Brazil	2008	22319 users
mySociety.org	Platform	Worldwide	UK	2003	1000 users
Sistema FBES	Enabling solution	Brazil	Brazil	Unknown	Unknown
RED Open Health Project	Enabling solution	UK	UK	2004	509 users
Diabetics' meetup	Collaborative service	US	US	2009	55 users
Zero relativo	Enabling solution	Italy	Italy	2006	217 users
Timebanks	Platform	Worldwide	US	1980's	Unknown

Table 1 Case list (data accessed February 26, 2009)

3. Discussion

Despite the diversity in nature and context of the cases, several patterns were identified. Firstly, the cases could be categorized into 7 types according to their meta-function. Secondly, all the collaborative services have a commons structural model and thridly, they produce two essential elements. Finally, ICT contributes to facilitating the production of the two elements.

3.1. A typology of collaborative service on the digital platform.

Each case has a specific function that is performed in a form of a service (e.g. to purchase high-quality agricultural produces directly from the local producers, to exchange used books). These functions can be grouped into what we call meta-goals. Based on these meta-goals, the 30 cases were categorized into 7 types:

Producer/consumer network. In this typology, producers and consumers pursue mutual benefits by establishing a direct network. It is often found in the food industry where producers and consumers create networks to solve problems caused by long supply chains such carbon emission and degeneration of local food industries and to promote critical and responsible consumption.

e.g.) Mapo Dure, a food cooperative in Mapo district of Seoul, South Korea; GAS (Gruppi di Aquisto Solidale), a food purchasing group in Italy; Solidarius and Sistema FBES (Fórum Brasileiro de Economia Solidária) both of which are digital platforms to promote solidarity economy in Brazil.

Figure 2. GAS, the solidarity purchasing groups and the GAS website (http://www.economia-solidale.org/)

Mapping diffused information. In this typology, users collaborate to map diffused locational information.

e.g.) Green Map and Open Green Map which aim to create a global map of sustainable sites and events through grassroots collaboration; FixMyStreet, an open-source project that reports, views, or discusses local problems like graffiti, fly tipping, broken paving slabs, or street lighting which can then be solved by the local councils.

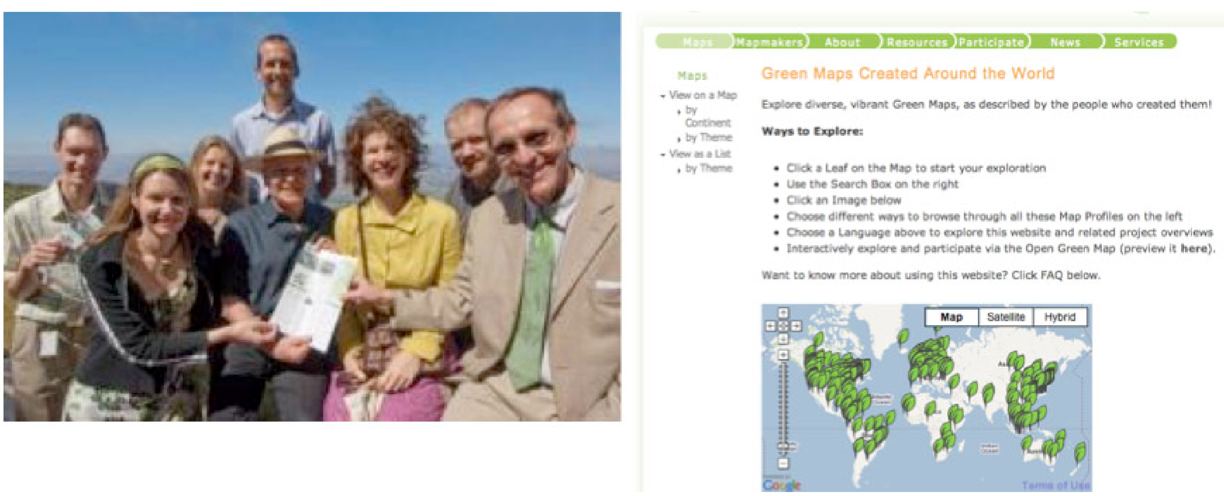

Figure 3. Green Map makers and the Green Map website (http://www.greenmap.org)

Aggregate social action. In this typology, people act together and use their collective power to achieve certain social goals.

e.g.) Pledgebank, a website that enables people to achieve their goals by asking other people to do the same; No 10 petition, an e-petition solution in UK that delivers people's petitions to the Prime Minister; Carrot mob, a network of consumers who buy products in a form of a mob in order to reward businesses who are making the most socially responsible decisions. Its goal is to leverages consumer power to make the most socially-responsible business practices also the most profitable choices.

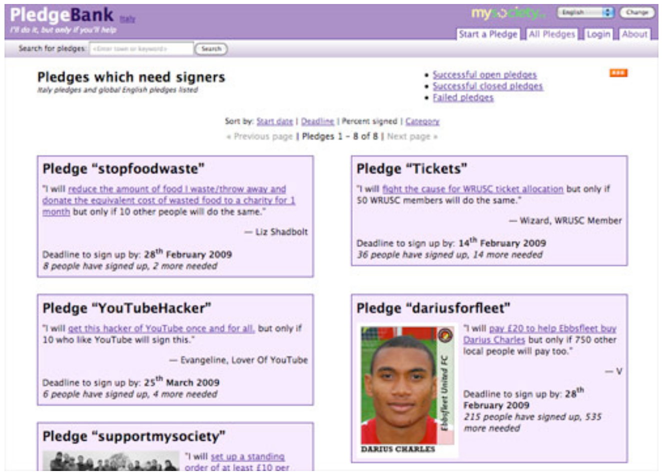

Figure 4. The Pledgebank website (http://www.pledgebank.com)

Creating a network for social conviviality. In this typology, the primary goal is to improve social conviviality by forming and reinforcing a social network. Users are often from the same locality and interact face-to-face and virtually on a regular basis.

e.g.) Meetup, an enabling solution that allows people to form a network of local groups hosts numerous collaborative services, i.e., individual meetups. Among them ones that are organized by users in a specific region for socialization such as Milano meetup; Peladeiros is a solution in Brazil that helps people organize soccer matches; Vicini Vicini is a service initiated by the Municipality of Rome to promote social conviviality of the community. It provides people with tools to organize neighboring parties.

Figure 5. Peladeiros users and the Peladeiros website (http://www.peladeiro.com.br)

Mutual support circle. In this typology, users provide mutual support to one another in order to solve problems that they have in common.

e.g.) Open Health project by the Design Council of UK intends to empower patients of chronic disease and their family members to support themselves and those who have the same problem. One result of this project is Activmob, a service organized by people in Kent to do physical activities together.

Figure 6. A Local Vocals Singing Group mob and the activmob website (http://www.activmob.com/)

Competences, time and products exchange. In this typology, people collaborate through the exchange of competences, time and products.

e.g.) Time bank, a reciprocal service exchange based on a time-based currency in which community members exchange their time to satisfy their needs. Zero Relativo, an online bartering system in Italy which allows people to exchange secondhand products.

Figure 7. The Zerorelativo website (http://www.zerorelativo.it)

Products, places and knowledge sharing. In this typology, people collaborate through sharing products, places and knowledge.

e.g.) Hitchhikers, an online service that connects people in need of rides and people who have empty seats in their cars; Couch surfing, a global initiative of sharing couches between travelers while exchanging different cultures and creating social network; Bookcrossing, a global book sharing scheme in which one leaves a book in a public place to be picked up and read by others, who then do likewise.

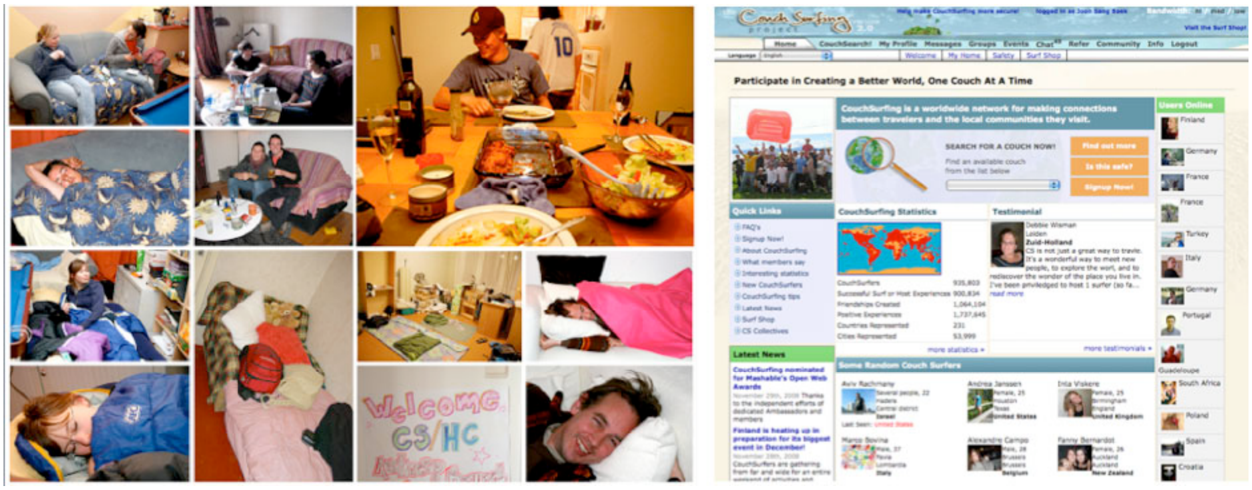

Figure 8. Couch surfers and the Couch Surfing website (http://www.couchsurfing.org)

3.2. The structural system of collaborative service on the digital platform.

In defining collaborative services on the digital platform, there was a hypothetic idea of what it requires to be formed (3 criteria for selecting the cases). The result of case studies clarified this hypothesis and confirmed that all the cases exhibit a common characteristic regarding the environment in which it is formed and develops. The structural system of collaborative service on the digital platform consists of 3 elements: an event, a collaborative service and an enabling solution (Figure 9).

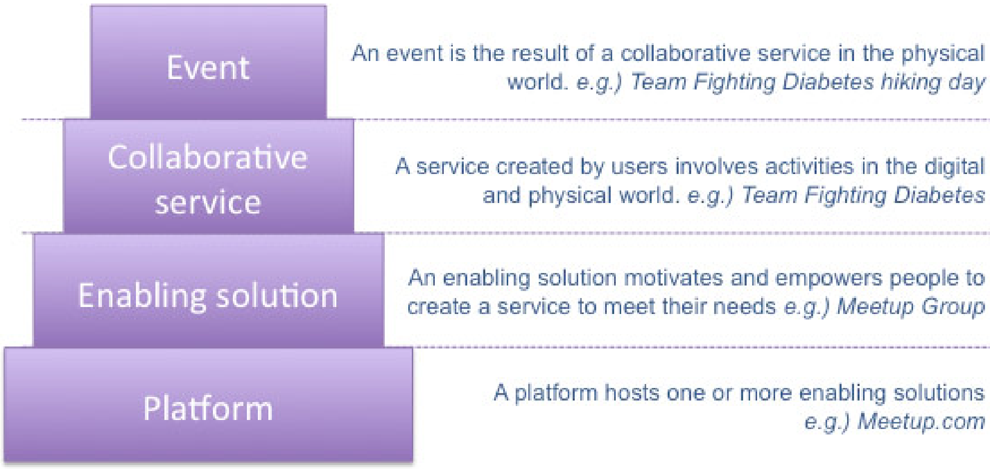

Figure 9. The structural system of collaborative service on the digital platform

1. *A platform.* A platform is a base of the structure that hosts one or more enabling solutions. It may not exists in some cases where there is only one collaborative service. An example is a social networking service called Meetup.com that supports organization of local groups across the world (figure 10).

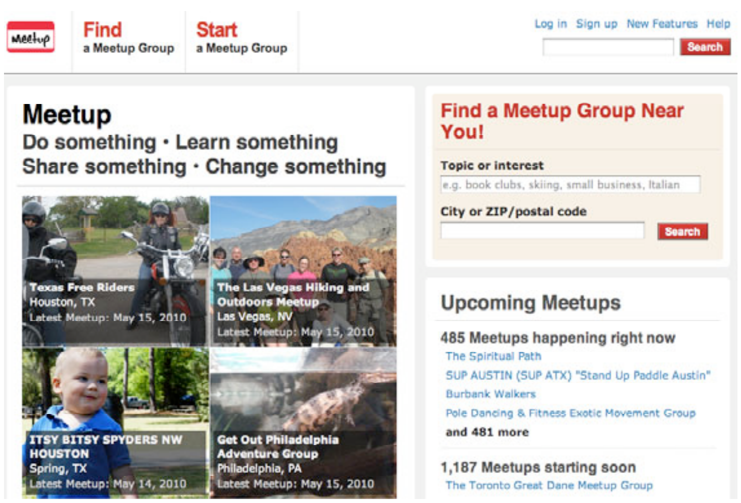

Figure 10. Meetup.com is a digital platform that hosts diverse Meetup Groups (http://www.meetup.com)

2. *An enabling solution*. An enabling solution is a system of products, services and communications that empower people to collaborate to meet their needs and to diffuse their solutions. Democratization of ICT provides people with a variety of effective tools to organize, manage and participate in collaborative services more efficiently than ever. Figure 11 is the homepage of Team Fighting Diabetes Meetup Group. Meetup.com provides groups with a set of tools that support group activities.

Figure 11. Team Fighting Diabetes Meetup Group homepage (http://www.fightingdiabetes.org/)

3. *A collaborative service*. On top of the enabling solution lies a collaborative service created and accessed by users. In Meetup.com, there are tens of thousands of collaborative organizations in places around the world (figure 12).

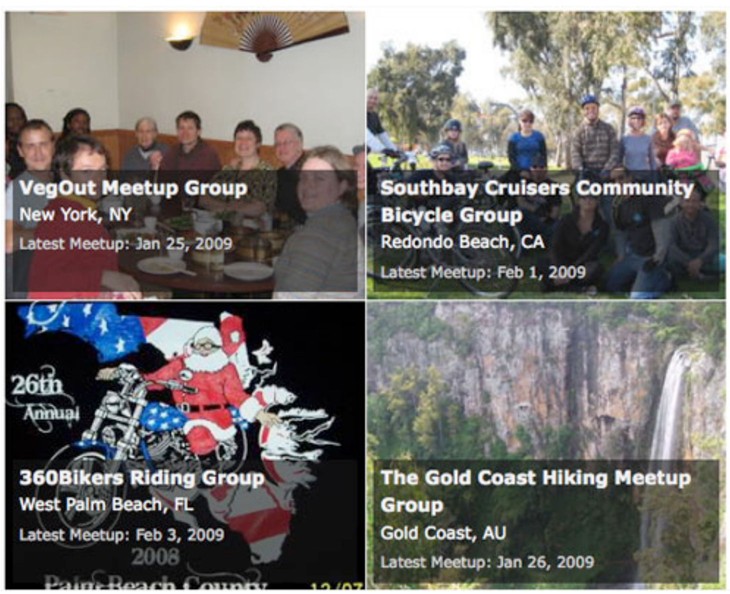

Figure 12. Collaborative services in Meetup.com (http://www.meetup.com)

4. *An event.* An event is the result of a collaborative service in the physical and digital world. An event may vary in the size of participants, the degree of interaction and the knowledge or physical assets required by the participants (e.g. a large smart mob vs. two people sharing couches). These variables need to be considered when designing a collaborative service and an enabling solution. Figure 13 illustrates a scene from a hiking day organized by Team Fighting Diabetes Group where the members – diabetics and their families – exercise together and promote a healthy lifestyle.

Figure 13. Team Fighting Diabetes' hiking day (http://www.fightingdiabetes.org/)

3.3. ICT and the dual dimension of collaborative service

Collaborative service by definition has a dual dimension of production: the first dimension is the production of a solution, i.e., a service that meets the social needs of users. Because this is the main goal of a collaborative service and the outcome is visible and measurable, current service design tools are dedicated to this dimension, i.e., how to design a solution that effectively solves the existing social problems.

However, we also look at the other dimension, the production of social network. Social network is crucial to the existence of a collaborative service. As Cipolla (2007) claimed, a collaborative service requires relational qualities as a prerequisite and if this service manages to be scaled up or replicated, the existing relations among users are reinforced and new relations are formed in the process of collaboration. These relations in turn become a ground for new collaborations and, as it will be discussed, contribute to the diffusion of social innovations (or solutions). In short, the production of a service and a social network is mutually beneficial and creates a virtuous cycle. Furthermore, we argue that the production of the two elements can be amplified by ICT (figure 14).

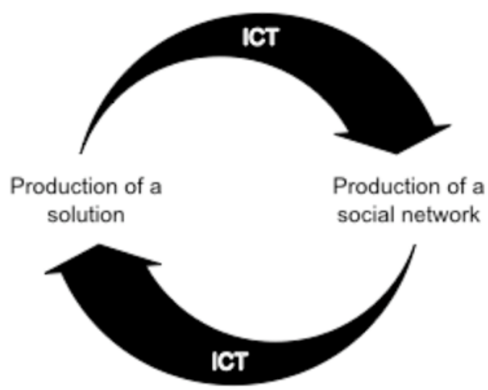

Figure 14. Production of a solution and a social network in a virtuous circle and its amplification through ICT

ICT and the production of a solution. The degree to which each case of collaborative service makes use of ICT varies from a simple mailing list to a highly customized database. However, in all of them, ICT plays a role of "democratizing innovation" (Hippel, 2005). It has introduced novel ways of production based on peer-to-peer relation that are more democratic in political aspect and more efficient in economical aspect than the traditional mode of production (Benkler, 2006). The case studies revealed that collaborative services on the digital platform benefit from ICT mainly by:

- Sharing and creating the Creative Commons. Many examples in our case studies have been developed using open source code or solutions that are free for non-commercial uses, thereby reducing the cost and more importantly allowing others to replicate their initiatives. These cases include No 10 Petitions, FixMyStreet, Pledgebank and Open Green Map.

- Improving productivity and efficiency of communication. In the cases of Meetup and WiserEarth, organizing a face-to-face meeting has become easier than ever thanks to a set of digital tools such as social networking service, calendar, blog and RSS. Carrotmob, a so-called flash mob[2], uses ICT to organize collective social actions. In Green Map Service, users have collaborated to create maps of over 400 cities from 55 countries since 1995 and with the launch of Open Green Map in 2008, a mashup version of Green Map, more than 4000 sites have been created in less than one year (counted in December 2008).

- Lowering the threshold of participation. As much as the creation of a collaborative service has become easy, so has been the participation and withdrawal. This contributed to lowering the psychological pressure put upon users and gave users more freedom. This consequently eliminated barriers that kept people from participating in collaborative services such as economic burden, dedication of time and effort to the service.

- Motivating people to collaborate. Some cases employ incentive mechanisms used in a crowd-sourced system in order to motivate people to participate and collaborate. Pledgebank, a website where people publicize their pledges and ask others to join, shows the number of people who have joined the registered pledges, thus creating a bandwagon effect to attract people to participate.

ICT and the production of a social network. As ICT facilitates the production of solutions, at the same time it reinforces the social network of engaged communities and creates new ones, mainly what is known as weak personal ties. The importance of weak ties was first recognized by sociologist Granovetter in his work 'The strength of weak ties' (1973). In this work, he claimed that personal ties can be categorized into strong, weak and absent. The tie strength can be measured in terms of a combination of the amount of time, the emotional intensity, the intimacy (mutual confiding), and the reciprocal services which characterize the tie. Strong ties arguably takes decades to be formed and are observed in intimate relations such as families and cliques. On the other hand, weak ties take relatively shorter time to be formed and are observed among friends, colleagues and acquaintances.

According to Granovetter (1973), information tends to remain isolated in a group formed by strong ties whereas it tends to diffuse through weak ties. It is because people connected through strong ties share a large part of their social network and therefore tend to form an isolated group. In such a group, information is likely to be self-contained and inaccessible by those outside the group. On the other hand, people with many weak ties often play a role of bridges that connect groups and it is through these bridges that information, including difficult innovations, diffuses. As a result, the social network of an organization whose members are connected mainly through weak ties forms an open network where information is widely shared among the members while an organization whose dominant ties are strong turns into fragmented cliques (Granovetter 1983).

The case studies show that both weak ties and strong ties are essential to collaborative services and that they play different roles (Baek 2009): The strong ties exist mainly in a community where collaboration initiated and was incubated. A collaborative service is initiated by a group of people who share the same value and are often tied in strong ties. They are usually friends, families or long-time neighbors. They are the ones who maintain the core values of a service and incubate the service until it becomes ready to diffuse. On the other hand, the weak ties maintain a collaborative organization open and allow its innovation to diffuse and replicate. As the innovation diffuses through the weak ties, the collaborative organization develops from a closed group into a network and the impact of innovation is amplified. Once the innovation is adopted to a new context (through weak ties), it requires strong ties between the adopters and the whole process repeats. In short, the diffusion of collaborative services is an iterative process where the generation and incubation of an innovation are mainly achieved through strong ties and the development and the diffusion are achieved through weak ties.

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[2] A flash mob is a large group of people who assemble suddenly in a public place, perform an unusual and pointless act for a brief time, then quickly disperse. (The Concise Oxford Dictionary, 2004)

3.4. The role of ICT in design process

In design for social innovation and sustainability, the aim of design activities is to foster grassroots social innovations and facilitate their diffusion so as to increase the impact on society and ultimately to trigger a systemic transformation towards sustainability. One approach to do this is by designing enabling solutions, a system of products, services and communications that empowers people to collaborate and innovate to meet their own social needs. The role of ICT in this context is to be a building block of this system. In other words, ICT can be a tool to design a favorable environment for individuals and communities to collaborate and innovate. Then it is absolutely necessary to understand how the technologies can be used most effectively under which circumstances. The role of ICT in designing collaborative services can be threefold: to diffuse information such as innovative ideas, to connect people and to improve the functionality of services. Identification of these roles leads to providing designers with guidance to use ICT to design a product service system that reinforces a sense of community among users, allows people to get connected to those who share the same values and interests and thus to diffuse their innovative ideas to outside their community.

4. Conclusion and future work

In this paper, we introduce the notion of collaborative services, an example of grassroots social innovations, and show how ICT can support their implementation and diffusion using case studies and literature studies. Despite an effort to cover the cases from diverse contexts, this research does not comprehensively explore the ubiquitous phenomenon. Neither does it contain an application of the findings to a design project. Instead, this research identifies the characteristics of collaborative services on the digital platform and the role of ICT in design process. It is a preliminary step to design a digital platform that supports grassroots collaborations for sustainability and improve the social network of engaged communities.

The future works will include an investigation of the roles of ICT in a more specific context, sustainable food production and consumption and applying the findings to a design project, more specifically, to develope a digital platform that supports various initiatives related to this topic. The project is called ‘Feed Milan (in Italian, Nutrire Milano)’ project[3] and it aims to build a sustainable food network in Milan and its peripheral rural area called the Agricultural Park South of Milan in collaboration with Slow Food and the University of Gastronomy.

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[3] http://www.nutriremilano.it/

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Figure 2. GAS, the solidarity purchasing groups and the GAS website. From http://www.economia-solidale.org/ (assessed June 17, 2009)

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Figure 10. Meetup.com website. From http://www.meetup.com (assessed June 17, 2009)

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Figure 13. Team Fighting Diabetes' hiking day. From http://www.fightingdiabetes.org/ (assessed May 5, 2010)

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A competitive game-based method for brainstorming and evaluating early stage design ideas in terms of their likelihood of success in the marketplace

Professor Tom Barker, University of Technology Sydney

Abstract

This paper considers a game-based method for the early evaluation of design ideas in terms of the likelihood of success of the designs in the marketplace. The method was developed in the format of a multiplayer competitive team game for up to 120 participants. Known as the Marketplace Casino, it has been applied in both design education and industry. The paper reviews the evolution of the game with international play testing and refinement involving over 400 participants in Europe (UK), Asia-Pacific (Japan, Korea, China, Australia), and Africa (Ghana).

The research innovation discussed in this paper relates to the combination of game play and brainstorming with a real world simulation component for evaluation, aimed at improving both the quality and ranking of outputs. The research draws on game theory, game typologies, and game research and development methods using play testing and iteration that are comprehensively described in “Rules of Play” (Salen, 2004). Effective brainstorming principles are well practised and described (Osborn, 1963) as are case studies in design brainstorming (Kelley, 2001), along with pitfalls (Sutton, 1996).

Bringing a contemporary design to market can be complex and expensive. Techniques that improve the likelihood of success in the marketplace can potentially reduce the associated risk and cost. The aim of the Marketplace Casino is to link creative ideas generation to a marketplace evaluation through a simplified model (the “game”) of a complex situation (the “reality”). The format is based on play specifically to enable a non-threatening and exploratory environment for participants.

The development of the game-based Marketplace Casino has focussed on product design and service design outputs. The author also considers its possible application to other disciplines in which creative output has to compete in the marketplace.

Keywords

Design management and strategy; brainstorming; design enterprise; design evaluation; game play; design; marketplace simulation; design methodology

The evaluation of early stage or concept design ideas in terms of likely success in the marketplace can be an elusive and risky process. When designs are at a very preliminary stage, much of the data that could be used when evaluating a more developed design is yet to be generated. For businesses, this uncertainty of information equates to risk: the risk of investing in products or services that may fail in the marketplace. This paper discusses a game-based method, called the Marketplace Casino, that has been developed to assist in the early stage evaluation of products and services in the marketplace context.

Aim

Bringing a contemporary design to market can be complex and expensive. Techniques that improve the likelihood of success in the marketplace can potentially reduce the associated risk and cost. The aim of the Marketplace Casino is to link creative ideas generation to a marketplace evaluation through a simplified model (the “game”) of a complex situation (the “reality”). The format is based on play specifically to enable a non-threatening and exploratory environment for participants.

Issues

The research innovation discussed in this paper relates to the combination of game play and brainstorming with a real world evaluation component, aimed at improving both the quality and ranking of outputs. Game theory, game typologies, and game research and development methods using play testing and iteration are comprehensively described in “Rules of Play” (Salen, 2004). This book was influential on the game designers’ approach, in particular play testing and iteration.

In developing a game simulator, a key challenge for the research was how to take a complex real world situation and simplify this into a reduced set of “features” with core rules that could still result in a complex and relevant process and outputs.

Effective brainstorming principles are well described (Osborn, 1963) and these were reviewed by the author, and a number tried in advance of the Marketplace Casino development work. Brainstorming case studies in design (Kelley, 2001) were also reviewed, along with pitfalls (Sutton, 1996). Sutton in fact questions the value of brainstorming compared with individuals working on ideas in isolation.

From the review of other brainstorming methods, the development of the Marketplace Casino aimed to address a collective of issues that have previously been difficult to capture in their entirety in brainstorming for early stage design evaluation. The range of issues that the game was intended to reflect and incorporate were:-

- The competitive element between newly launched products and services
- The ranking of ideas in a hierarchy that indicates likelihood of market success
- The random intervention of significant events, known as Force Majeure, that upset market conditions
- The use of a simplified set of assessment criteria for ideas
- Briefing starting points that were inspirational but not constraining
- The use of a consumer panel to influence idea evaluation
- A gaming technique that was both easy to learn and entertaining
- Self-documenting output

The innovation of the Marketplace Casino is in the combination of these elements into a single ideas generation and evaluation method.

Context for play

Donald Winnicott perceived creativity to be a thing in itself that is present in all individuals and expressed through play. “..in play, and perhaps only in playing, the child or adult is free to be creative, and to use the whole personality, and it is only in being creative that the individual discovers the self..” (Winnicott, 1971). Winnicott believed creativity gave a person's life meaning. The use of play with adults, that is playing with ideas, and imagination add to one's creativity. He described Transitional Space as the space situated between the inner and outer reality, between subjectivity and objectivity. In the organization, transitional space refers to a situation where past and future are present at the same time; it is a transition, it is not 'real' yet. Fantasy and creativity are central in this space and the aim is to prepare for the future.

In terms of the psychology of play and environment a game essentially creates a small world for the players – a safe world in which the rules are known but the outcomes uncertain. The ontological framework that sets up the rules within the game enables the complex systems of ideas to interact and provides the dynamic and didactic impetus for the players. The players learn to decode the frameworks and forms that underpin the games as they play them, essential to understand in our quest to "win", which is what makes them so useful as Learning Tools.

Conceptual framework

The game methodology and mechanics described by the paper evolved from investigating ways to facilitate the forms that groups of creative people employ to achieve outcomes. The particular processes, resources, cycles and sequences of events used by a group to achieve an objective, carry the *imprimatur* of that group's success. What may appear as chaotic to an outsider, may contain extremely complex codes of behaviours, and a culture which mark the success of one group against another. Consider the unique *modus operandi* that distinguish one leading design studio from another, or what the Italians term *sopra la bottega*, the "all hands on deck" atmosphere of creativity that pervades the small family factory above the store.

The research context relates to these forms (processes, resources cycles, sequences, cultures) and in particular those that govern the successful development of creative ideas. The research interest is in mapping these forms and synthesising them sufficiently to create games that seek to teach, simulate and generate the complexity of successful early stage design.

Kokotovich (2008) points out that the problem with treating design as a game per se is that there are few rules in design. The author's approach is to propose the framing of a game as just one element *within* the design process. Hence, a simplified and restricted rule-based component is possible that aims to enhance the overall freedom of the design process. Additionally, the game milieu, taken as a group exercise, aims to benefit the personal pattern of experience of the individual designers (Harfield, 2007), in both a professional context and an educational environment – reflecting the value of group working in design (Barlex & Rutland, 2008).

Value in the marketplace is qualitative and quantitative, so a system was required that considered both of these. For the distillation of value into simplified but highly focused elements, the game designer Jameson drew on a method developed through his marketing consultancy, known as the Jameson Criteria.

Research Method

The early evaluation of design ideas was developed in the format of a multiplayer competitive team game for up to 120 participants. Known as the Marketplace Casino, it has been applied in both design education and industry.

The game development was initiated with a games brainstorming activity between the two creative practitioners: their backgrounds were a designer and educator (the author of this paper), and a marketing expert. Through a series of workshops, the game designers roughed out a gaming process that reflected their combined experience of designing and marketing commercial products and services. The rough games were mocked up with physical components and then a further series of workshops was undertaken with a number of play testers, typically 4-6 in a session. The gaming rules were refined as a result and the game was given its first full play with 64 people drawn from a range of disciplines in the design and creative industries, including: product design, retail, marketing, innovation investors, management. Following this large scale test of the Marketplace Casino, which lasted around 3 hours, the rules were adjusted to improve playability.

The game design team was expanded in 2007 when a creative industries expert joined the developers, and with this contribution Version Two became the definitive version for subsequent extensive use.

From 2005-2009, the game received international play testing 400 participants in Europe (UK), Asia-Pacific (Japan, Korea, China, Australia), and Africa (Ghana). The aim was to expose the system to many cultures and players, while documenting the outputs and evaluating these with the help of a multidisciplinary group of experts.

Participant feedback was also collected in various ways, for example: through interviews, discussions and feedback forms.

The game rules

Introduction

The Marketplace Casino is all about creating great ideas that can succeed in the marketplace. But unlike conventional brainstorming, the Marketplace Casino also selects the best ideas. The game is competitive and it is about survival of the fittest ideas. The Jameson Criteria are used as the basis for judging success. These are: better, more, cheaper and wow!

To generate ideas, the game has over 60 briefs that are dealt out to teams. These are deliberately vague but also interesting and often humorous puns. A selection of the briefs is: the 7 year niche; buy 1 pay for 2; the divine right of ultimate selfishness; supersize me; million dollar baby food; a funeral service to die for; senior moments; an inconvenient truth; times squared; the pleasure principle; eclectacity; patients is a virtue; truth or dare; property is theft.

The game is for 8-120 players - the system becomes unwieldy beyond that. These rules give a “knockout” format for 24 players, which can be adjusted.

Key gaming elements

- JAMESON CRITERIA TOKENS (round poker chips are used): Blue = Better; Red = More; Green = Cheaper; White = Wow!
- CONSUMER PANELS (4 people at a table): Will make your idea live or die
- FORCE MAJEURE (cards): Can upset even the most winning ideas

Rounds

- Practice Round: the game begins with 4 gaming tables. 3 teams (each team has 2 people) sit at each table. Each team is numbered (team 1 to team 12). The practice round is for everybody to get to know the rules.
- Round 1: as per the practice round, the game begins with 4 gaming tables. 3 teams (each team has 2 people) sit at each table. Team numbers can very a little and do not have to match between teams, eg: 1-3 people is fine in a team]

- Round 2: the winning teams from each table then join one of two new gaming tables. For this round, there are just two teams per table.
- Round 3: the two winning teams from each table then join a single gaming table for the final round.

Order of play in each round

Each team starts with six white tokens in front of their marketplace casino placemat.

A briefing card is dealt to each table face down. This card has the brief from which the ideas have to be generated.

The card is turned over and the teams have 5 minutes to come up with their idea. The idea must be a product or a service that responds to the brief. Each team must write their idea on a blank card as a sentence or a couple of sentences. The teams also write their team number on the card.

Each team the nominates a member who takes the idea to a consumer panel to make the pitch. The pitch lasts for 1 minute. During the pitch, the panel are not allowed to ask any questions. The consumer panel will form a view about how good the idea is. The panel marks the idea on the basis of the Jameson Criteria to compare the idea with competition in the marketplace:-

- Better: it is simply a better product
- More: the consumer gets more functionality or more of it
- Cheaper: it costs less
- Wow! It is unique, instantly desired and creates an impulse to buy and own

The consumer panel will award up to 5 tokens of each colour at the end of the pitch. The team member returns to their team with these tokens and now goes head to head in the marketplace with their gamble.

Tokens are placed by each team without the other teams seeing where they go or how many there are. The coloured tokens have to be placed on their respective positions on the team placemat. The white tokens can go on any position.

When the tokens have been placed, one person from each table goes to visit the Force Majeure facilitator to have a go on the computer fruit machine. If a strawberry, cherry, or pear shows up on any of the fruit reels then a Force Majeure card is given out for each fruit type (if a particular fruit shows up more than once then only one card for that fruit is given out). Fruit types are as follows: Strawberry = Better; Cherry = more; Pear = Cheaper.

Any Force Majeure cards are taken back to the gaming table and turned over. They will affect the tokens of every team at the table (they may be increased or decreased, or moved around).

The tokens of each team are then revealed. If a team has a bigger pile of tokens in a particular placemat position than the other teams, then the other teams have their tokens in that placemat position removed.

The winning team at a given table has the most tokens remaining on their placemat. The winning team then returns their tokens and goes through to the next round.

If there is a tie with the number of tokens then more than one team can go through to the next round. If it is the final round, the teams become joint winners.

Results

In addition to the individual documented ideas resulting from the game, the outputs from the game play were sorted via the knock-out selection process into a hierarchy of ideas. In each game these outputs were reviewed by expert facilitators to see if the selection hierarchy was credible. Additionally, in cases where there was a known standard of the designers that produced the ideas, the quality of each designer was reviewed against how well they did in the games.

The facilitators included a mixture of disciplines typically with 10-20 years of experience in their respective fields. The disciplines were drawn from industrial design, marketing, design management and innovation design.

The outputs were also reviewed by pseudo clients in the situations where these were involved. Pseudo clients were leaders from collaborating businesses or institutions - government or academic.

The outputs from the game play were split reasonably equally between ideas for artefacts and ideas for services. Some ideas (around 25%) incorporated a combination of both artefacts and services.

The ideas were often lateral and insightful. A characteristic of many design proposals was an element of humour, both in the way the teams presented and in the ideas themselves.

The collection of ideas from the game play over several years has been extensive. Some examples include: a new movie format called Hollywood 2.0 in which audience individuals can participate as actors on screen; a funeral service that you can enjoy well in advance of your own death; an honest promotion system for affordable products rated as worse, worser, worst; an instant $100 home; new no-effort dieting products; a boy band pop competition for the homeless; fashion that comes in tin cans; a loan system for artworks at home; tradable religious components to bring together faiths.

Participant feedback was almost wholly positive and varied to an extent between stakeholders – players, reviewers and clients. Positive comments reported as feedback by stakeholders were: good to have the link between brainstorming and marketplace factors; encouraged lateral thinking; good collaborative and competitive mix; entertaining and enjoyable; good for networking with participants; best ideas tended to go forward each round; caused the participants to think more about the market when designing. Negative comments were that the practice rounds were generally very chaotic as people struggled to assimilate the rules in advance of playing the game; apart from a few people joining the consumer panel, those who were knocked out early only had a subsequent role as an audience to the game.

The principle game plays carried out were: 2005 in the UK at the ICA with professional design practitioners (64 players); 2006 in Thailand with TCDC and professional young designers (30 players); 2006 in the UK with student designers from Royal College of Art (30 players); 2007 in Korea, with student designers from IDAS (120 players); 2007 in China, with student designers from Tsinghua (60 players); 2008 in Japan, with student designers from Tsukuba (60 players); 2008 in Australia, with professional design practitioners (30 players); 2009 in Africa, with student designers from KNUST (60 players).

In many cases, the game play was part of a collaboration between participants from institutions in different countries. For example, Figure 1 shows the game being played by graduate students in 2009, in a collaboration between two academic institutions: Royal College of Art in the UK and KNUST in Ghana.

Figure 1. Marketplace Casino being played in Ghana, Africa, 2009. Top row: participants at the gaming tables, engaged in a knock out tournament. Bottom row: consumer panels deliberate on how many tokens to award pitching designers, based on the Jameson Criteria assessment.

Discussion

The absolute quantitative measurement of the success of the Marketplace Casino in selecting the best design ideas for development was not possible without subsequently developing the ideas and launching them into the marketplace. Even if this had taken place, the establishment of similar conditions for each idea would be very challenging – and the random “Force Majeure” aspect would demand a very large product sample. Hence, the value of the game as a tool could only be ascertained from the responses of stakeholders: players, expert reviewers and clients. These stakeholders were very positive about the game value and relevance.

The slightly humorous, puzzling and provocative nature of the briefing cards was an important benefit, particularly in encouraging participants to relax and be creative.

Generally, in situations where the game was played by design students, more talented students did in fact achieve better results in the game, getting closer to the final round. Of course, game mechanics such as Force Majeure and the quality of opponents on a given gaming table made it impossible for the best designers to win consistently. This is just as in the real world.

There was interesting feedback for the game in Ghana, Africa. This was a collaboration between local design students at the KNUST University and UK graduate design students. The Ghanaian students had no prior teaching exposure relating to design markets. The feedback from many of the Ghanaians was that the game had provided them with a lot of valuable insights that would influence their design thinking in this context for the future.

The consumer panel was an important key to real world simulation. The consumer panel was a “focus group” but with the important distinction of being comprised of both general consumers formed from several of the early drop-outs from the game, and experts drawn from the game’s facilitators. Additionally, the award of tokens for the value argued during the 1 minute pitch was a collective decision made by the focus group. This helped to smooth extreme responses from individuals.

It was clear that on infrequent occasions the Force Majeure element of the game eliminated strong ideas which would otherwise have come first in a given round.

This became a salutary lesson in the uncontrolled events that occur within a marketplace and the outcomes were taken in good humour by the participants.

Although development of the game-based Marketplace Casino has focussed on product design and service design outputs, the game mechanics have potential application to other disciplines in which creative output has to compete in the marketplace. The Marketplace Casino is currently not a generic brainstorming method tool like the IDEO Method Cards (IDEO, 2003). By being specific in it's play mechanics context, the Marketplace Casino offers the advantages of a being a real world simulation. To use the game in a different discipline, the briefing cards would need to be customised. This approach was tested successfully to some extent when the game was used in Korea with briefing cards that were localised to Korean culture. Adapting the cards to other disciplines could be of interest.

Conclusions

The Marketplace Casino introduced participants to market factors when generating and prioritising design ideas. The competitive element and the resulting single "winner takes all" game play mechanism proved extremely motivating to the participants and it also had the advantage of sorting ideas out into a hierarchy of likely success in the market. The Force Majeure element provided a sobering element to the mix: that events beyond the control of design, marketing or business will always maintain risk and uncertainty in the face of planning.

The game format encouraged playfulness and this was reflected in the humour of many of the design ideas, even though they were still often very practical.

In undertaking further development of the Marketplace Casino, there are several options that the system would benefit from:-

- Incorporating more real world elements into the game play and additional detail into the existing elements
- Running the tool over an extended period of time within a product or services development department of a commercial business for the creation of a range of products, and benchmarking the success of those products against those generated by other means.
- Establishing an annual league competition between participating academic institutions as part of their design teaching programs (this could possibly be run online).

For real world use, the author concludes that it would be appropriate for the Marketplace Casino to be used as one of several techniques in a commercial context. The game offers complementary outputs to other brainstorming and selection methods. The tool also has some value for use in design education, as well as introducing businesses to design and its benefits.

Facilitators and participants felt that the game produced more diverse, richer, and better concepts when compared with the approach of individuals working alone on creating ideas (Sutton, 1996), although this was a qualitative assessment that was not tested through experiment.

The Marketplace Casino game was able to take a complex real world situation and simplify this into a reduced set of features with core rules. The game resulted in a useful competitive creative process and generator of design outputs, ranked with consideration for market factors. The game can be a useful addition to the range of brainstorming techniques currently available, addressing a suite of criteria that are not dealt with collectively other methods.

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The impact of modular product design on innovation compared with design from first principles

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Abstract

The research looks at whether modular design methods can compromise innovation when compared with design from first principles. The questions that the authors investigated were: to what extent does modular product design restrict innovation in design? Is design from first principles a better starting point for innovation, and if this is the case, then what methods and environments facilitate design from first principles among design teams? The authors were also interested in the relationship between industry and academia when taking these differing approaches.

The authors consider design from first principles to be where there is a significant shift in a product or system which - while addressing similar societal wants, needs and desires - is not built upon nor based on previous technological modules, or on existing design paradigms. These shifts derive from “tabula rasa” design research and lateral thinking, often in combination with new technologies or innovative technological combinations. These innovations are radical as they force creative and/or technological discontinuity.

Informed by their projects with industry and academia, the researchers argue that modular-based physical products are generally more appropriate for evolutionary designs or mature products, and that a design from first principles approach is better suited to genuine innovation and step change design. However, in terms of the creative design process, a design from first principles approach can be accommodated in both modular and non-modular products or systems.

Keywords

Modular design; industrial design; design education; design innovation; design methodology

Through action-based research case studies of collaborations between industry and academia, and an industrial case study, this paper considers the pros and cons of design from first principles versus modular design for products. The differences relate to both the design methods employed and innovative outputs that result, as well as the design thinking.

Objectives

The objective of the research was to undertake and review a number of case studies to investigate the impact on innovation of modular design methods versus design from first principles methods. Another aim was to investigate the relationship between academic design teaching and industrial collaboration, and to see how the teaching process could be improved and better orientated towards practice-based requirements through one approach or the other. A final objective was to determine the extent to which process (design thinking) predetermined the format and success product outputs.

Research proposition

The framework for our work emerges from the view that the rationale for component based design is well established in manufacturing (Dahmus, 2001). Modularity can produce cost savings on tooling, assembly and maintenance, improve quality and reduce design cycles. However, this consolidation and organization can mitigate innovation (Senge, 1990) for example for 'green' auto design. This notwithstanding, the software industry has achieved phenomenal improvements in innovation, productivity and quality through the adoption of object-based modular programming over the last 25 years (Sutherland, 1999). But it is difficult to apply physical design methods that correlate with software modularity methods (Gabriel, 1998). Modular strategies appear to allow for, what may be called 'significant' improvements ; it can be argued these alone may not assist greatly in developing step change innovations.

The research proposition here is that modular design methods could compromise innovation compared with design from first principles. In this context, the research questions were: (1) to what extent does modular product design restrict innovation in design; (2) s design from first principles a better starting point for innovation, and if this is the case, then what methods and environments facilitate this among design teams? For this research, the context was design as artefact-based industrial design, conducted in teams - typically with a technological component. We present the following case studies:

- **Unilever** project which had successfully created paradigm shifts in a product range.
- **3 mobile** case study demonstrating that design from first principles is able to contribute to 3 Mobile's future phone design thinking.
- **Swarovski and Sharp solar** project that used a modular methodology coupled with a second stage using design from first principles.
- **McLaren Group** case study where they employ more subtlety to the distinction between modular design and design from first principles

The themes that resonate within these studies highlight relationships between issues and design processes as they relate to Modular design, Design from First principles, and 'Step Change' innovation. In order to contextualise these issues we first discuss what is meant by modular design and Design from First Principles.

Design Methods

Design from first Principles

The authors consider design from first principles to be where there is a significant shift in a product or system which - while addressing similar societal wants, needs and desires - is not built upon nor based on previous technological modules, or on existing design paradigms. These shifts derive from "tabula rasa" design research and lateral thinking, often in combination with new technologies or innovative technological combinations. These innovations are radical as they force creative and/or technological discontinuity, and they are similar to the discussions in the technological change literature where they address the notion of S curves and discontinuity and the importance of it (Girifalco, 1991) (Porter, 1980 and 1991).

The web has greatly helped make innovative "learning how to learn" (Senge, 1990) methods more realistic. Thomas Edison (Josephson, 1992) stated that it took 100 days to become a sufficient expert in any area to permit invention – with the internet, this was reduced dramatically. With a deep understanding of first principles and how these may be applied in alternate contexts, teams could methodically and creatively apply information. Without this, technology information did not equal technology, or for that matter new highly innovative designs (Porter, 2005).

Modular Design

Modular design can take the form of physical hardware components or software, or a mixture. This paper is not concerned with the notion of modular design that relates to the ability to add products together for consumer benefit. It is concerned with the design of products by selecting and using existing components or assemblies to build a new product. Such a product may still have original parts or the parts may be scaled to some extent physically. Components and assemblies can be manufactured in-house, or sourced from suppliers.

Modular design is considered to be fundamental to the computer industry and software in general (Clark & Baldwin, 2000). Software modularity is generally the only way of writing contemporary code - with exotic exceptions such as neural networks. The authors acknowledge the crossover influence of software systems design methods into product development (Gabriel, 1998).

There are examples of physical product manufacture where modularity has been embraced that have an evolutionary approach to new product development. One of these is the automotive industry, where the approach increasingly extends outsourcing to modular consortia (Collins & Bechler, 1998).

Research Investigation

For experimental results, the authors reviewed pedagogical and industrial projects. A number of projects undertaken by the authors were reviewed as case studies for the research. These were academic-commercial case studies and interviews. Four of these are described.

Case studies

Academic-commercial projects

The academic-commercial projects were commissioned by corporate clients and undertaken by students at the Royal College of Art, a postgraduate Masters course that takes students from a range of backgrounds: industrial design, engineering and science, materials, architecture, marketing, business. The focus of the course is collaborative working.

Unilever

This 2006 case study relates to a commission by the international food, drink and household products company Unilever. The project was for a team of 15 graduate students to come up with new formats for ice cream. Unilever is the second largest ice cream manufacturer in a global $59bn industry (Scott & Flanagan, 2007), holding 16% of the market to Nestlés 17.5%. However, most of Unilever’s market share has been through aggressively expanding through acquisition of established brands such as Ben and Jerry’s in 2000. Although this was a successful strategy, growth was not coming from in-house ice cream innovations to the extent that such a large business required. Generally, previous innovations related to maximising the variations that could be offered by existing brands and product components – the ice cream industry’s equivalent of incremental and modular design. So the project was brought to the Royal College of Art by Unilever’s R&D and marketing departments to see how design from first principles from a group of mixed discipline students could lead to innovative product concepts.

To facilitate the ideas generation, an unusually formatted brainstorming day was held which blended concept design methods with marketing aspects. Participants came from Unilever to join the graduate students. The format started without any assumptions and went back to the principles of what being an ice cream means. The session is summarised below.

- **I am an Ice Cream**

  One by one everyone describes themselves (what kind of ice cream are you...). When am I liked when am I not liked? When am I allowed, not allowed? What people like me, who doesn't? How am I different? Where am I liked where am I not liked? How am I liked how am I hated? These become some of the catalyst for 'What's the Problem'.

- **What's the Problem**

  Format: for this, once the problems are written down, sketch doodles only are made. The groups brainstorm problems by noting them down on blank cards which are then shuffled between both groups and redistributed "blind". The groups work on solutions sketching lots of possible ideas. Example: A problem is that ice cream melts in a fridge (as opposed to a freezer); so solution may include a "high temperature" ice cream (like yoghurt).

- **Speed date**

  Each group shares out the designs among the team (one idea per team member) and then these are speed date presented as 1 minute per idea one-on-one to each of the other group members. Everybody hearing an idea has to find 3 ways of improving it. These should be noted on the drawing.

- **Killer Rabbit**

  A positioning statement is made and then the groups come up with the designs backwards from this point. What would have happened in 1989 if you had been asked to design an iPod? Example: Positioning Title: Global Hypercolour; Positioning Statement: a kaleidoscopic ice cream that reflects the national colours, the time of day, or the mood of the user. How to: illustrate how it could work..

- **Run the Gauntlet and wrap up**

  Selected work is presented and discussed at a final ideas review.

The brainstorming generated a number of ideas that appealed to Unilever and these were subsequently developed by the graduate students. Although the work was confidential, it can be revealed that none of the ideas had any relation to existing ice creams on the market. Two of the ideas were taken on by Unilever for subsequently bring to the market. Unilever was delighted with the result which had successfully created paradigm shifts for their product range.

Hutchison Whampoa's 3 Mobile

In this 2007/8 case study the mobile phone company 3 Mobile, owned by Hutchison Whampoa, commissioned a group of 30 graduate design students from the Royal College of Art in London to respond to two briefs. The two briefs were: (1) design the best phone ever for today, and (2) design the best phone ever for the future. The company made losses in 2008 of HK$3.2bn on global revenues of HK$32bn, with a customer base of 19 million people worldwide (Middleton, 2008). These losses were large and the company had lost money since launching with 3G phones in 2003. When 3 Mobile briefed the graduates on this project they observed that they had launched with 3G too early for customers and with phones that were complicated and had too many features.

The purpose of coming to design graduates was to see if they could get a fresh and innovative approach to their future phones. 3 Mobile had identified the market as moving towards specialist phones which offered features related to websites, particularly social networking sites. Hence, they were looking at a Facebook phone and they had already launched a Skype phone offering free calls Skype to Skype. The approach taken by 3 Mobile prior to this graduate design commission was that early 3 Mobile products attempted to incorporate as many general purpose functions as possible.

The commission to the students was looking very much for a "design from first principles" approach. The results of the work were richly varied and the designs were of great value to 3 Mobile in terms of provoking their own design teams' thinking. Additionally, several concepts had aspects which 3 Mobile felt they could develop into real products. A question, not covered by this paper, is the extent to which outsourcing of detailed phone design impacts on 3 Mobile's product success.

This case study does demonstrate that design from first principles was able to contribute to 3 Mobile's future phone design thinking when undertaken as an academic collaboration, at least complimenting the in-house process. The award of the contract to the Royal College of Art was made at a time when 3 Mobile had moved away from the modular, scaleable feature-rich product model. Figure 1 shows some of the phone designs from the project. Note that several design anticipated subsequent commercial products: "Free Key" anticipates the Blackberry Storm with a flexible LCD button surface; the "Teiko" phone anticipate kids' phones; "Touch" the rise of gesture-based interfaces.

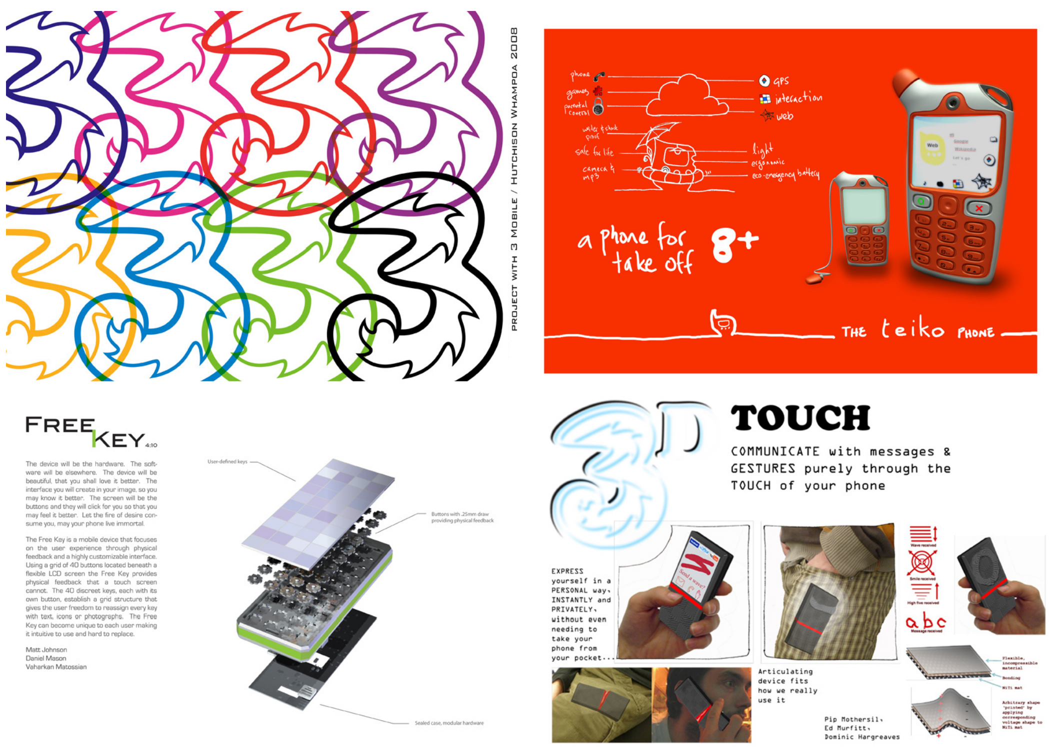

Figure 1: "design from first principle" mobile phone concepts for 3 Mobile, 2008.

Swarovski and Sharp Solar

In 2008, Swarovski Crystals sponsored this project for graduate designers at the Royal College of Art. Over 6 weeks, the project was co-run with Lovegrove R., an internationally recognised industrial designer with expertise in advanced materials and solar design, and The project received technical support, equipment and materials (photovoltaic solar panels and wafers) from Sharp Solar. The project brief is summarised below.

- *Located in the near future, and on the outskirts of a Northern European city, Sunny delight will be home to a few lucky residents who will benefit from a town that uses the very latest solar power, and related technologies, to create the world's first ever integrated zero energy housing and transportation system. It is your job as cutting-edge designers to make Sunny Delight. The challenge is to create a vision for a near future that works seamlessly in terms of both design and technology.*

For this case study, there were two distinct stage to the project. An initial stage used a modular methodology and the second stage used design from first principles. Although the two parts of the project were in response to separate parts of the brief, the graduate students were the same and it offered some comparison between the outputs offered up at each stage.

An important first stage of the project was set up as a Skunk Works (Jenkins, 2001) using working hardware components and systems, for modular systems design:

- *Design and build something interesting in 48 hours with the solar and other kits that are provided. You can make whatever you like but it needs to be an experiment from which you learn (and can tell us about) to help you understand the technologies involved.*

The second stage of the project encouraged a holistic integrated innovative approach:

- *Individual team members will each champion one or more of the Sunny Delights components to resolve in more detail: house, garden / outdoor areas, car, car port / street, marketing / services, energy system, business / economic case. It may be that your design merges or redefines these almost beyond recognition. For example, you may drive a piece of your house into work!*

Although the Skunk Works stage resulted in some very interesting working experimental design test rigs, none of them offered a real step change in innovation. The combinations of solar hardware (all using photovoltaics), sensors, mechanics, and software resulted in some interesting ideas, but the real innovation came with the second stage of the project. For the second stage, the graduate students were not asked to follow a specific methodology although they were asked to work in teams of 3-4. The students had a free hand at how to interpret the brief. Some of the project results are shown in figure 2.

Interestingly, the projects in stage two moved away from variations on use of photovoltaic solar panels for energy supply alone, and looked at comprehensive integration, as well as alternative solar energy cycles such as ammonia and hydrogen from algae. Although these stage two projects were mostly created as non-working models and animated illustrations, the science and technology research to prove feasibility was done fairly thoroughly convincingly.

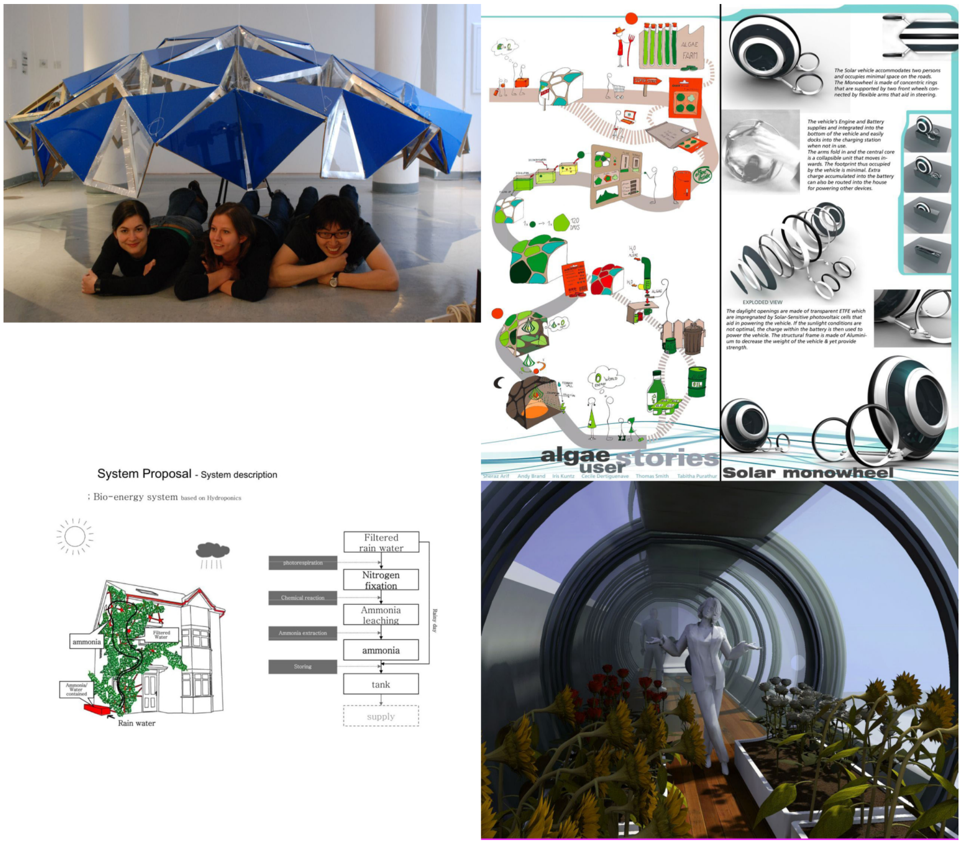

Figure 2: design proposals from ‘Sunny Delight: Solar Living’ a Swarovski / Sharp Solar project. Clockwise from the top left: a deployable solar shelter; Algae-based hydrogen solar cycle; a solar powered ‘wheel vehicle’; ammonia solar cycle; a hydroponic solar living unit.

Industry: McLaren Group

In 2009, Van Manen P. a CEO of control systems at McLaren Group the Formula 1 race team was interviewed. McLaren is currently contracted provide a modular, programmable electronic control system to all race teams in Formula 1, and this system is Van Manen’s responsibility. Previously, each race team designed and built their own control system, comprising sensors, computer and casings. Figure 3 shows the McLaren vehicle. McLaren are also contracted to develop high technology telemetry systems for other industries, including ranging public rapid transit rail systems.

Figure 3: McLaren Formula 1 racing car.

The interview with McLaren lent more subtlety to the distinction between modular design and design from first principles because, although McLaren create modular systems, their design thinking takes a more conceptual and design from first principles outlook when looking for innovation.

In the case of high technology electronics, systems are typically modular in nature, with microprocessors and other embedded circuitry forming parts of larger modular systems. The thinking required to develop these systems is far from being a simple reconfiguration exercise of mixing and matching modular sub-systems in order to develop a larger more complex system. This was evidenced in the McLaren interview. The McLaren electronics group rely on a few core guiding values for modular system design.

Firstly, in order to cope with the increasing technological changes that are advancing at an exponential rate a core understanding of the physical principles is imperative. In essence, when step change in design is required it can be argued that what is being manipulated is not mere components but the creative manipulation of divergent sometimes opposing physical principles. Secondly, McLaren's designers (ie: design students) also need to understand which are the nonnegotiable parts of design or the semi-negotiable, if they are going to develop technologies even further in innovative ways. Thirdly, McLaren regard it as important to have confidence in one's capabilities and a willingness to work together as a collective intelligence. When a high technology design team is working together they must see the relevance of what they are trying to accomplish and more often than not the divergent design specialists must communicate through a language of metaphor, where these metaphors relate to key physical principles not technological modular blocks. Fourthly, is an acceptance that what one learns today won't be the same as what is around in five years' time. But that the underlying principles - first principles - will be the same. McLaren's fifth and final value is the ability to have a vision and to develop a shared vision, because in talking about clarity of vision the ability to be agile and listen to others is key so they can operate with networking. This core principle not only relates to the physics but to the social dynamic as well.

When Van Manen is looking at a problem outside of his immediate area of expertise he will consider it in terms of metaphors. And as long as it is done with care he generally starts extending his knowledge into different applications and often new and innovative ways. It is important to understand a lot of this also comes back to the basics, because the better understanding one has of the basics, the easier it is to move between these metaphors. Because we can see the common elements and say "yes, I understand that now". For example, a bigger battery is like starting up higher on the Hill, so it will flow longer and faster and that is clear now. And so we can start building our experiences and metaphors any time.

Van Manen considers that it is important to remember a lot of the innovation that people do is building things, building business, building technologies. This comes about by being able to collaborate to understand how things fit together. There aren't that many sort of light bulb inventions, there are few inventors, there are a lot more people who can see how things/principles fit together. Therefore, reasonable working knowledge of the general way in which the world operates, physical laws, chemistry, mathematics, are all viewed as being important when involved in any sort of technological area. This notwithstanding Van Manen assumes that if he talks to anyone within his organization that they understand the basic laws of physics so he does not need to explain to them if something is heavy then it would accelerate slower if a force is applied, so just basic ground knowledge of physical principles is very important.

One of the things that Van Manen observed from working in the motorsports industry and its environment is that he is certain that one of the reasons that we have such good engineers in motorsport is they get the opportunity to design something, make it and put it into service in a time frame which is short. And every time they make something they get better and better at making things. And they increase their confidence. They know when something's not going to work. They know if they are at a dead end and have to change something. It is strongly arguable that a successful educational environment should also embed the understanding that balance between theory and praxis, between making and doing, and thinking about making and doing is necessary.

The McLaren approach is that when developing a system, whether it is a machine, a business system, or whatever, the key element is to understand what it is there for. If one is clear what is there for and what the important outcomes for it are, then this can properly frame what the important characteristics of that system are that are allowing innovation to occur, even if a design team member does not understand all of it and does not have a big picture. Once one understands what the importance is, and identifies the important characteristics of a system, that then frames whether one breaks it down and analyses it, or whether one looks at how something flows through the system. This in turn assists in innovation development.

By way of example Van Manen suggests that if we take a transmission system of a car, asking what is the reason behind having an engine and a gearbox and a differential, the reason is so that you can apply traction at the wheels. So the complex systems are there for managing the delivery of torque. Once you start thinking of that as a torque manager, then you can focus on the engine as a source of torque for the gearbox and that it controls this torque. In this conceptual model, the reason that these things interrelate is just to manage the torque running from the combustion chamber to the wheels. Via a first principles perspective, it immediately gives you a way of thinking about the system and how you exchange the torque, and then an understanding of trade-offs in terms of mechanical advantage. When thinking about a power train in that way it always come back to the core principles. A McLaren designer ends up saying “what we are interested in is this torque, and how we dealing with the torque”, as opposed to starting from a classical engineering perspective which tends to be very modular in nature.

Discussion and Conclusions

Based on the case studies, the research findings indicated that a modular approach to industrial design is generally but not exclusively more appropriate for evolutionary designs or mature products, and that a design from first principles approach is better suited to genuine innovation and step change design. The case studies indicated that, when faced with the need for step changes in innovation industry-academic collaborations could bring particular value.

The role of academia in offering a step change approach to established businesses was apparent. Many companies are better suited towards steady state and incremental design changes, so the academic partnering can give opportunities for tabula rasa design approaches, possibly even more so than design practices which will have preconceptions through practical experience. The authors found that creativity and lateral thinking were able to make up for lack of experience among graduate students, particularly when mentored by experienced facilitators from both academia and industry.

The research also highlighted difficulties and challenges presented to corporations in accommodating the culturally different approaches of design evolution and revolution within a single design environment. Another finding highlighted tensions between a culture of formalised experimentation, as opposed to a more chaotic or intuitive one, as part of an innovative creative design process. Modular design was more likely to mitigate creative leaps, but these could also be compromised by homogenous use of methodologies.

In addition to the obvious requirements of a brief and a project plan, the research found evidence that there is merit in the adoption or adaptation of design methods to use as creative scaffolding in both education and practice. These can be bespoke, such as the unusual design-marketing hybrid method used in the Unilever case study, or established systems such as TRIZ (Orloff, 2003; Savransky, 2000) which have first principles at their core.

However, as evidenced by the McLaren approach of conceptual thinking and team working, design methods are not exclusively necessary for innovation. The McLaren case study also indicates that although the division between design from first principles and modular design may be explicit in terms of physical product, the method used to design the product does not have to follow the physical outcome. In other words: a modular product can be designed from first principles. The 'aha!' innovative moment (Gardner, 1978), is an important tool also. But the authors conclude that the frequency and quality of the 'aha!' increases within catalysing design methods in conducive cultures.

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Beyond the Designers' View: How People with Autism Experience Space

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Abstract
Harnessing all different dimensions of space is an immense, if not hopeless task. Thus the design of space is challenged by a complexity of meanings. The meaning attributed to a certain physical environment depends to a large extent on the personal interpretation people attach to this environment, influenced by their personal interests, attention and perceptual possibilities, whatever the designer's line of thought that generated this built environment.

Aware of the diverse ways in which a designed environment can be received, this paper attempts to understand the built environment from another perspective. It reports on a study that starts from different people with autism spectrum conditions, throwing light on their spatial interpretation and the way they deal with the physical environment. Insights from an analysis of autobiographies of people with autism, tinged with the experiences of engaging with people with autism in different contexts, give an idea of what understanding another view on the built environment could imply.

This paper presents fragments of a particular autistic world of experience as a challenge to open our eyes. It illustrates how some people with autism place an enforced confidence in the direct perception of the built environment, and it highlights the influence of extra connotations—exceeding the directly perceptible—which are inherently connected to space in our society. In an attempt to look at the built environment from this perspective, this stance enables us to be critical of the way we—architects and designers—think about designing space and it spurs us to be alive to the multiple complexity of space.

Keywords
architectural design, autism spectrum, built environment, design thinking, interpretation of space, interaction with space

Harnessing all different dimensions of space is an immense, if not hopeless task. The wide range of meanings the built environment may have adds even further to the complexity of space. This complexity is an intriguing challenge to the design of space. A design, nourished by the architects' line of thought, finally acquires a meaning in the way people deal with it. In view of the diversity of people dealing with the built environment, this paper takes up the challenge to take another view on the built environment, in order to trigger the complexity that captivates the design process.

Architectural Design and Autism
Space is a complex idea. Through the years, all kinds of scientists made frantic efforts to grasp the entire world, aiming to set up an informational dominance over it (Thrift, 1999). Without avail, Nigel Thrift (1999) poses, because thinking about space complicates immediately. The infinite web of meanings we are living in loads even the physical space with a distribution of meanings, meaning that are continuously regenerated by people interacting with the built environment. The meaningful entities of space are interpreted by their habits of action (Määttänen, 2007). In this way, one place in natural space may well have different meanings; it may be a place for different habits and practices at the same time.

Physical space incites people to a certain way of dealing with it, it affords certain behaviours. And even the meaning of this space, the meaning of architecture, can be interpreted as an affordance, Jonathan Maier and Georges Fadel (2009) argue. In the sense of James Gibson's idea, this implies that the interaction between people and the built environment depends not only on the physical form of architectural elements, but also on the observer's past experiences, beliefs, aesthetic preferences, etc. The meaning of any architectural attribute, therefore, depends on the individual (Maier & Fadel, 2009), which complicates the built environment even more.

The idea of affordance may also mark the process of designing space, in which possible behaviour response can be anticipated (Maier & Fadel, 2009). However, designers do not only work with certain attributes or elements, related to previously defined meanings or affordances, as signs which has to be combined and recombined (Louridas, 1999). By seeing things in different ways, designers succeed in determining meanings, and organizing them in a structured whole. Designers reorganize meanings depending on the result, they redefine meanings, and in this way, designers do not only speak with their work, but they also speak through their work. Designers pour themselves into the design process, they disclose themselves through the design. The result of a design carries some part of the designer/s in it (Louridas, 1999). But whatever the considerations from which designers organize a certain environment as a structured whole, eventually, the built environment acquires a meaning through interaction with people. What is meant (or not meant) in a particular architectural setting depends on the prior experiences of the individual (Maier & Fadel, 2009), and people interpret the built environment based on their own habits of action.

Starting from a wide diversity of people, this paper investigates the interpretation of the environment and the use of space by people with conditions on the autism spectrum, shortly people with autism[1]. While neuroscientists are still looking for a biological explanation, autism is diagnosed on account of a characteristic behaviour, known as restricted and repetitive actions (Wing, 1997; Happé, 1999). Nevertheless, according to most theoretical approaches, the true essence of autism underlying this distinctive behaviour is supposed to be situated in a characteristic difference on a cognitive level (Baron-Cohen, 1995; Lawson, 2003; Noens & van Berckelaer-Onnes, 2004). Their specific 'distinct' way of perceiving and information processing causes people with autism to make sense of their surrounding world in a unique way (de Roeck, 1997), moulding the way they view, and engage with, reality (Lawson, 2003).

Both the characteristic behaviour and the particular way of sense-making of people with autism, influence their spatial experience and interaction with the physical environment. This is a central argument to confront the perspective of people with autism spectrum conditions and the design of the built environment. Gaining insight in the built environment from the perspective of people with autism, this paper aims to open up the designers' view on (designing) this environment.

Accessing Another Perspective

To get an idea of an 'other' view on the built environment, i.c. an autistic perspective, this study intended to engage extensively with people with autism in different ways. However, since impairments in social interaction and communication are considered as common characteristics of the autistic spectrum (Happé, 1999; Wing, 1997), it is not obvious to gain access to the range of thought of people with autism. This prompted us to explore other approaches. To start with, our study took advantage of the fact that some people with autism poured out their reflections on the surrounding world—including the built environment—by writing them down (Baumers & Heylighen, 2010). A number of autobiographies were selected on the dual condition of having been written by people with autism themselves and about

[1] The autism spectrum consists of divergent pervasive neuro-developmental conditions, entailing difficulties in social interaction, communication and flexible thinking or acting (Wing, 1997).

experiences of their own lives (see Sellin, 1993; Gerland, 1996; Rand, 1997; Willey, 1999). The analysis of these sources investigated the way people with autism talk about space and the importance they attach to their physical environment, as reflected in written stories.

Joining onto this earlier analysis of writings, the first author also engaged with the doings of people with autism in various settings. Associating with people with autism in three different contexts, he tried to understand their bodily interaction with the physical environment, paying attention to the way they use space, to their behaviour in relation to the built environment, and to the influence of the physical environment on their doings.
A first setting comprehended a short introductory period in the daily living environment of a young woman with autism, living in a common housing facility for people with an intellectual disability. In this house, the woman with autism was living together with seven other persons with an intellectual disability. The researcher joined the daily life in the house during one day, giving attention to the woman with autism both in the common spaces and her private room.
A second engagement occurred in a housing facility only for people with autism. For several successive days, the researcher participated the evening-activities in a house of six people, starting from the moment they came home from the workshop until the time they went to bed. During these days, the principal point of interest was the interactions in the collective places, although in personal contact with the occupants, the researcher also explored some private rooms.
A third setting considered in this paper, is the audit of a university building in which the researcher collaborated with a student with autism (Heylighen *et al.*, 2010). In close cooperation with the student, the integral accessibility of the facility was questioned. Because the audit was focused on the accessibility of the building itself, this personal interaction clearly revealed the view of the student with autism on, and his engagement with, the built environment.

In this study, we want to give depth to a few insights from the earlier study of autobiographies of people with autism by relating them to an interpretation of the observations in different settings. In this way, fragments of an autistic perspective on the built environment are sketched, as a basis for a critical reflection on our own way of thinking about the built environment.

Fragments of the Built Environment

Interpreting their Writings

The analysis of a selection of autobiographies of people with autism—shortly *auti*-biographies—revealed some characteristic aspects of an autistic view on the built environment (Baumers & Heylighen, 2010). Within the scope of this paper, we want to throw light on three of the mentioned aspects, three particularities of an autistic world of experience that were noted in the written stories of people with autism: the confidence offered by physical space, the hidden logic associated with space, and a direct and conscious way of experiencing the world.

Living in an incomprehensible world, a lot of auti-biographers push forward the physical space as a source of certainty. Physical space, presented as a fixed and self-evident feature of the environment, gives a sense of grip the authors are looking for. The physical characteristics of space, which are directly perceivable, seem to inspire more confidence than human beings. Even though some authors write that, from a physical point of view, there is no essential difference between people and objects, the meaningful world behind human beings arouses some unpredictability and uncertainty. “When I’m not concentrating on people,” Brad Rand (1997) writes, “they just look like shapes, like furniture and trees are shapes.” But Birger Sellin (1993) clearly differentiates this view: “Because of important reasons I can find safety only in things. People are incalculable and distinct monsters.”
The incalculable feeling in associating with people is also reflected in the behaviour people

with autism describe in their stories. In this way, Liane H. Willey (1999) relates she knew how to control herself, if she started to lose her bearings. “Whenever things became too fuzzy or too loud or too distracting; whenever I began to feel as though I would come unravelled, I knew I could crawl into my alcove and crunch up into it until I felt as square and symmetrical as the alcove itself.” In the alcove, she could always find herself. And just like Liane, most of the authors describe how they—faced with unsteady situations—seek comfort in reliable spaces, where they find a tangible source of peace and safety, rather than to seek comfort with other human beings.

However, even though in most stories of people with autism the physical space features as a source of grip, the built environment—brought into use in society—reveals an unpredictable side too. Each of the considered auti-biographies reports about problems experienced in dealing with the built environment, or rather ‘maladjusted’ behaviour compared to the expectations of society. Gunilla Gerland (1996) describes her struggle to interpret the built environment 'correctly', so as to be able to deal with it in an appropriate way. Musing on the way other people deal with space, she tries to explain her 'maladjusted' behaviour. “There *must* be a sign of some sort on the doors, because the others didn’t hesitate over where they should go.” Not sure to find a traceable proof of what the others seemed to see, she had a fleeting thought that “maybe the others knew automatically which lavatory they should go into, and so needed no special labels in the way I did. Perhaps they had innate abilities for knowing that kind of thing?” (Gerland, 1996) And probably, Gunilla's explanation is not that far-fetched; there may be such an invisible logic in the built environment, owing to the cultural and social connotations associated with it. Not only human beings, but also objects and the whole built environment are loaded up with additional layers of meaning which, in our society, are assumed to be inherently connected to space. Such layers of meaning cannot yet be perceived just like that.

This raises a third remarkable aspect in the stories of people with autism. In each of the auti-biographies, the authors explicitly testify to a direct and conscious way of perceiving the physical environment, in order to position themselves in the world. Gunilla Gerland (1996) describes how she, scared by the sudden sound of a moped, tries to find a way not to lose herself. “So as not to fall over or explode from inside, I would grab the fence where I was standing, pressing myself against it and holding on hard. I had to feel something that stood still, something anchored, in a world that had suddenly become totally unpredictable.” (Gerland, 1996) Clutching the rails of a fence, or crawling into an alcove under the bed, the authors succeed to come to their senses again, starting from a conscious experience of the physical environment.

Witnessing their doings

The fragments of an autistic perspective on the built environment presented above arose from an analysis of written reflections of people with autism. These fragments are reconsidered in the light of the behaviour regarding space, observed during real interactions with people with autism.

In the interaction of people with autism with space, it also dawned how the physical elements of space are able to give some grip, and even more, how the sense of grip can be qualifying to the use of space. In this respect, the first author witnessed the weekly cleaning ritual of the young woman living in a housing facility for people with an intellectual disability. After she had accurately dusted every little spot in reach, persuading herself that every object in the room was still present in the way she expected, she put the bucket with water in the middle of the corridor. A somewhat ill-chosen place, perhaps, but while completing every next stage of the cleaning plan, she had to walk conscientiously around the place where the bucket—coincidentally or not—had been arrived. A similar situation struck the researcher in the other housing facility, where the plan to play a game fell through because the playmate was not able to take the game. An ironing board, awkwardly placed in front of the cupboard, prevented him to open the cupboard. A simple object, be it a cleaning bucket or an ironing board, was standing convincingly on its own spot, exuding an immovability that was able to determine the following moves.

But the built environment contains more than only this convincing aura, as also illustrated by the use of space of people with autism in different settings. In one of the houses, the counsellors resolutely connected all activities to a particular place in the house. When one of the occupants caught the researcher red-handed in the entrance hall while he was quickly writing down a few notes, she severely reprimanded him: “Hey, without any problem, you can take a seat in the living room to write, you know!” Even in the world of the occupants, each place carried the meaning of the connected activity, and they convincingly proclaimed it to others. However, not all the meanings connected to spatial aspects in our society are as obvious. The audit of the university building in the company of a student with autism revealed that spaces and spatial elements are not always understood according to the meaning we associate with it. The student confided that the staircase of the building did not invite him to go upstairs, and the doors did not show him in a unquestionable way whether he was allowed to come in or not, even though this seemed obvious in the researcher's eyes (Heylighen *et al.*, 2010). And the other way around, when the researcher purposefully opened the dividing door to allow some circulation of air in the house of people with autism, one of the occupants abruptly closed it again. He started to pace up and down nervously, quickly looking around as if something unsuspected was on the verge to happen. The researcher understood that his intentions were probably not clear to the occupant. Only after the next day the dividing door was closed at the moment all occupants quietly had started their evening activities, it dawned that the interpretation of this spatial configuration in the occupant's world was not understood right away by the researcher either.

Finally, the interactions with people with autism also revealed an impressively attentive way of perceiving. During the exploration of the university building, the student frequently pointed at details, which passed the researcher completely: a door handle that was missing at the end of the corridor, or a tiny date indication hidden in a scutcheon next to the ceiling. But also the sounds of the wind around the building, or moving chairs a few rooms away, were details that would not have drawn the researcher’s attention. And the conscious perception of space even seemed to exceed the researcher's own capacity of experience. When in the housing facility for people with autism, after a hot summer's day, an unexpected shower of rain provided some cooling, one of the occupants positioned himself under the cupola in the center of the living room. Noticing the occupant blissfully dancing back and forth, the researcher wondered what it was that this guy experienced. Was it the image of the falling raindrops that made him that happy? Or the sound of the raindrops on the glass? A light cooling breeze slipping into the room? Perhaps the very thought of relief? Probably, space contains a lot more aspects; aspects we cannot easily get hold of, but that a particular perspective on the built environment, in this case a consciously focused—maybe hypersensitive—experience of space, can bring to light.

Facing the Complexity of Space

Each of the considered examples lay bare a particular aspect of the world of experience of people with autism. Discussing these different aspects, we do not intend to give a decision on the world of experience of people with autism. The fragments of an autistic perspective on the built environment, put forward both by the analysis of auti-biographies and by the moments of interaction, offer an occasion to reflect on our own view on the built environment and to question the 'truth' behind this view.

In the study of the world of experience of people with autism, the attention was attracted by the grip offered by physical space and the sense of certainty and confidence this can bring about. Analogously, Ruud Hendriks (1998) explains how people with autism often feel rather supported by non-humans than by humans: “The nonhuman predictable behaviour and iron regularity are thing-like traits that people can only try hard to simulate.” The predictability and regularity of the physical space even turn out to cause objects, as immovable entities, to qualify the spatial behaviour of people with autism. This notion of grip, offered by physical space in an autistic perspective on the world, can value the physical entity of objects. Even banal objects, like a cleaning bucket and an ironing board, or a small space beneath a bed, are essentially physical anchor points of the built environment, which can draw attention to what is undeniably here.

But even though the view on reality of people with autism would be focussed on those features that are given in direct experience, there is more to reality than actualities, as stated by John Lawson (2003). Emma Williams (2004) too describes how objects exist in a social world, and are an enduring source of social influence. Our world is shaped by human activity, and is full of things designed by people to be used in specific human activities by people who share a common body shape, similar needs, and a same cultural history. The same difficulties experienced by people with autism in social or interpersonal relationships constitute part of their problems in relating to objects and the built environment (Williams, 2004). Those difficulties come also to the fore in the stories and actions of people with autism, described above. They show that the additional layers of meaning, in our society inherently connected to space, follow from our own view on reality, which is no less an interpretation of this world. Which logic concludes that our own interpretation of space could be considered as being better adapted to 'reality'? Simply because it is self-evident—in accordance with our own interpretation—that a door is used to enter or exit, this layer of meaning is assumed to be generally accepted; but why would it be less appropriate to consider a closed dividing door as a promising sign of general quiet?

Also the conscious way of perceiving, noticed in both the stories and actions of people with autism, incites us to think. Different theories confirm that people with autism are characterized by a particular view on the environment, be it restricted to what is directly perceptible (Lawson, 2003) or just fragmentary (Happé, 1999). Due to a fundamentally different way of information processing, adequate sense-making needs to be consciously constructed step by step (Noens & van Berckelaer-Onnes, 2004). The conscious experiences of people with autism show that bringing a space into use can signify much more than only performing a certain action on a given place. Even the smallest details of the built environment can attract the attention, and in this way, using space includes seeing, hearing, feeling, smelling, ... and thoroughly experiencing different dimensions of that space.

The particular way of experiencing, consistent with the cognitive style of the autism spectrum, makes us aware of the fact that this world of experience may exceed our own experiences; it raises questions about our own view on the world. Considering these fragments of an autistic world of experience in the context of designing space may also inspire designers to burst the banks of their own world of experience. The complexity of the design challenges designers to question the way they think about (designing) the built environment.

First, the awareness of the sense of grip exuded by the physical environment can be put in the light of the design of space. Each designed artefact acquires a meaning in interaction with people, but are we—as designers—also aware of the meaning a 'beneath-the-bed' can imply? Moreover, a lot of extra layers of meaning are provided to a design. A design is loaded up with inherent meanings, which can afford certain behaviours—conscious or not. But do we—as designers—still question how a door can be designed so as to look inviting to enter? And third, the design of space can be influenced by many aspects, connected with the experience of the built environment. Different senses, but also those various layers of meaning, play a role in the experience of space, and this diversity of perception and sense-making could challenge—perhaps inspire—designers. Which aspects of a cupola are important in the design, if besides the incidence of light and the sound of rain, it is also possible to carry the blissful idea of cooling? The complexity of space, couched in the diverse perceptions and meanings, can invite designers to take up the challenge of questioning their own way of thinking, in order to be aware of the relativity of the designers' view.

However, it needs to be mentioned that the view of this research is relative too, simply because of taking a particular perspective on the built environment as a starting point. Furthermore, the analyses rely on a first exploration of the possibilities of this research. Both concerning the auti-biographies and the moments of interaction, we do not pretend to give a complete image of a general perspective on the built environment according to *the* cognitive style of people with autism, if only it should exist. The interpretation of a selection of autobiographies happened from our own limited perspective. And it is not improbable that the image, shown during the interactions, is to a certain extent a disruption of the habitual rhythm, among other things because of the researcher's presence in the different settings. In a next stage of this research, the insights gained through this first analyses are used to refine the method, to consequentially look for more depth in exploring the perspective of people with autism concerning the built environment. Finally, although the discussion of the fragments in the light of architectural design raises more questions than offering answers, it also keeps open a lot of lines of thinking. To get a hold of the implications of these insights for architects, the frame of this research seeks to investigate design cases. The study of realized design projects intends to get a variegated idea of what designers can take in from insights from an 'other' perspective on the built environment.

Despite the mentioned limitations, this study tried to take on an autistic perspective to exceed the designers' view on the built environment. By elaborating fragmentary aspects of an 'other' way of thinking about space, which we do not always give a moment's thought, this paper raised a corner of the veil of the enormous diversity of possible interpretations of the built environment. In this way, the study offers a challenge to designers, a challenge that can be inspiring in dealing with the profound complexity that the design process implies.

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Modélisation sémiotique et systémique de l'objet design comme signe-action complexe

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Résumé

Les approches sémiotiques et systémiques du design produit sont à la fois peu nombreuses et peu coordonnées. C'est ce que fait apparaitre l'état de la recherche en ce domaine. Les quelques études sémiotiques disponibles ont par ailleurs tendance à isoler l'objet de ses usages, de ses utilisateurs et de la complexité du système d'objets qui constitue son environnement proche ou des modes et styles de vie qui constituent ses univers. En conséquence, l'objet analysé est le plus souvent réduit à une image figée de lui-même. Seules les études qui relèvent de la sémiotique pragmatique veillent à inscrire l'objet dans l'action, les interactions et différents contextes.

C'est dans cette lignée que la recherche ici présentée propose une modélisation sémiotique et systémique de l'objet. Celui-ci est considéré comme un signe-action complexe inscrit dans le temps, dans l'expérience d'interaction et de relation, dans les habitudes et les changements d'habitudes résultant des tensions adaptatives engendrées par les changements technologiques, culturels et socio économiques.

Une telle approche à la fois sémiotique et systémique impose de reformuler les questions de recherche. Les objets communiquent-t-ils dans l'action et comment ? Comment les traiter comme des signes complexes sans les séparer de leurs environnements de conception et d'usage et sans réduire la dynamique des usages aux seuls «bons usages» décrétés par l'analyste ? Comment penser la relation avec l'objet en action (l'expérience) à la fois de l'intérieur (approches internalistes) et de l'extérieur (approches externalistes) ? Comment penser l'objet complexe comme un système de relations et d'intelligences distribuées dans des représentations individuelles et collectives, mais aussi intégré dans des mémoires externes ? Comment distinguer les différentes phases de découverte, d'apprentissage, d'automatisation des usages et de leurs changements qui constituent la vie des humains avec les objets ? Enfin, comment modéliser cette complexité et tester les hypothèses interprétatives produites par la recherche ?

Mots-clefs

Codétermination ; communication ; design ; modélisation ; objet ; sémiotique ; systémique.

Abstract

Semiotic and systemic approaches to product design are both scarce and uncoordinated, as shown by the current state of research in this area. The few semiotic studies available also tend to isolate the object from its uses, its users and the complexity of the system of objects that constitutes its immediate environment or of the patterns and lifestyles that make up its universes. As a result, the analyzed object is often reduced to a frozen image of itself. Only the studies that fall within pragmatic semiotics analyze the object within the action, interaction and the different contexts.

In line with this approach, the research presented here proposes a semiotic and systemic modelization of the object, which is considered as a complex sign-action recorded in time, in the experience of interaction and relationships, in the habits and lifestyle changes resulting from adaptive pressures generated by technological, cultural and socioeconomic change.

Such a semiotic and systemic approach requires reformulating research questions. Do objects communicate within action and how? How to address them as complex signs without separating them from their design and use environments and without only reducing the dynamics of uses to the 'right uses' decreed by the analyst? How to think the relationship with the object in action (the experience) both inside (internalist approaches) and outside (externalist approaches)? How to think the complex object as a system of relationships and intelligences distributed in individual and collective representations but also built on external memories? How to distinguish the different phases of discovery, learning and automation of the uses and their changes that constitute the life of humans with objects? Finally, how to modelize this complexity and test the interpretative hypotheses generated by research?

Keywords
Co-determination ; communication ; design ; modelization ; object ; semiotic ; systemic.

La modélisation dynamique que nous présentons ici concerne les flux de communication générés par et pour l'objet matériel dans le cadre d'une expérience vécue avec et par lui. Ce modèle s'inscrit dans la tradition des modélisations de la communication élaborées jusqu'alors, mais il tente de les dépasser en intégrant les approches dynamiques, constructivistes, situées et, interactionnistes prenant en considération les contextes culturels des protagonistes.

La première interrogation qui a initié cette recherche est théorique : les objets communiquent-ils, et si c'est le cas, comment les choses se passent-elles et comment peut-on les expliquer ? La seconde question a une origine plus méthodologique, après avoir étudié les différentes modélisations de la communication qui ont cours dans les *design studies*, nous avons constaté qu'elles ne permettaient pas de traiter l'objet comme une partie du système complexe et dynamique que nous avions observé lors de nos enquêtes et études de terrain.

La destination de cette modélisation est à la fois théorique car elle tente d'articuler les diverses connaissances produites jusqu'alors au sujet de l'objet, mais aussi pratique car nous souhaitons que ce modèle devienne un outil d'aide à la création, à l'audit et à l'analyse. À ce titre, nous avons veillé à l'inscrire dans le contexte économique hétérogène qui gouverne la conception, la production et la consommation des produits. C'est d'ailleurs par cette mise en perspective générale que nous débuterons cette présentation.

Pour construire ce modèle, nous avons systématiquement combiné des approches inductives, fondées sur des observations de terrain et des enquêtes, à des approches déductives, générales et théoriques. Cette modélisation a été conçue et perfectionnée dans le cadre de recherches empiriques, appliquées et concrètes consacrée à l'étude de bouteilles d'eau, de cendriers, de clef USB, de portes lunettes et de téléphones portables, et même d'interfaces web, etc. Nous ne présenterons pas ici ces études, mais nous développerons la modélisation qui en résulte en la décrivant et en présentant ses arrières plans théoriques.

Cet article plus descriptif que prescriptif explore une à une les grandes composantes de la modélisation que nous avons élaborée. Il débute par une présentation des niveaux sémiotiques de la modélisation, puis il explore les trois pôles du circuit de la communication avant de présenter les cycles d'habitude et de changement d'habitude qui déterminent la nature des relations entre les trois pôles. Il se termine par une présentation des flux qui les relient.

Contexte général de la production du modèle

Modèles économiques et sémioses des objets

Economie des objets biens : Economie linaire

Dans le cadre de l'économie des biens, la communauté des concepteurs et producteurs réalise des produits qui sont des biens de consommation pour des usagers qui en sont souvent les propriétaires uniques. Une fois que les fonctions de ces biens sont épuisées, ils sont massivement jetés. C'est la métaphore du « berceau à la tombe » proposée par Michael Braungart et William MacDonough (2002) qui convient le mieux pour imager cette économie irresponsable. Les produits-biens sont gérés comme toutes les propriétés personnelles et privées, ils sont résolument conçus pour être appropriés individuellement et servir aux fonctions sociales de projection et d'ostentation identitaire. En conséquence, ce sont les sémioses de propriété privée, de cumul des biens, de capitalisation, de distinction, mais aussi de gestion non écologique qui dominent l'utilisation de ces objets-biens.

Economie des objets recyclables : économie circulaire

Dans le cadre de l'économie bouclée, les produits sont conçus par la communauté des concepteurs et producteurs pour être démontables, réutilisables et recyclables. La philosophie « *cradle to cradle* » et sa certification C2C en sont la manifestation. Cette approche réclame un décentrement de la logique de produit « fini » pour tendre vers une logique de seconde vie des composants. Les produits recyclables sont encore des propriétés privées qui peuvent bénéficier des même sémioses que les biens, mais dès la conception et la diffusion le recyclage de fin de vie est programmé. Ils réclament donc des sémioses écologiques et « responsables » adaptées.

Economie des objets et produits de service : économie circulaire

Dans l'économie d'usage et de service, les produits sont avant tout conçus et produits pour être des relais d'usage et de service et c'est ainsi qu'ils sont consommés. Ceux que l'on appelle les *smart products,* des trois classes du *Product Services System* (PSS) (Brissaud, 2009) mais aussi les *Sustainable Service Systems* (3S) ou les produits non matérialisés (PNM) font désormais partie des stratégies de réduction de l'empreinte planétaire des entreprises et des politiques de développement.

Cette troisième forme d'économie éco-durable veille à ce que ses produits relais puissent être régulièrement mis à jour, compatibles avec des utilisateurs divers, multiples, simultanés et/ou successifs et qu'une fois épuisés par ce service commun, ils soient recyclés. Ils entrent le plus souvent dans une économie de « biens » publics ou collectifs en libre-service. Ces produits relais sont encore très souvent traités avec des sémioses issues de la logique de propriété des biens, ce qui provoque divers problèmes tels que les dégradations et les vols.

En ce début du XXIe siècle, l'économie, l'industrie, le design, les sémioses et les croyances dominantes sont encore réductionnistes mais la prise de conscience des bouleversements écologiques en cours tend vers un design de service systémiquement auto éco organisé. Nous sommes progressivement passés d'un design centré sur l'objet à un design centré sur la fonction, puis sur l'usager, à un design systémique centré sur le système intégral.

La culture matérielle, les flux de signification et les niveaux sémiotiques

L'une des thèses centrales de nos recherches (Darras & Belkhamsa 2009a) repose sur l'affirmation que les produits de la culture matérielle ne sont pas des objets passifs mais des relais d'expérience et des médiateurs de croyances, de représentations, d'habitudes et d'agences. Ils sont articulés en vastes systèmes de signes et de fonctions qui contribuent à l'organisation des rapports entre les humains. Dans ce cadre, ces signes deviennent les lieux d'action, de signification et de rapports de pouvoir, ce sont des agences intégrées et matérialisées capables d'être activées et d'activer des humains dont elles modulent les croyances, les habitudes et les identités (Darras, & Belkhamsa, 2009b).

Le design comme processus de conception de produits et de services constitue donc un ensemble de puissants outils d'adaptation et de transformation du monde des objets et c'est à ce titre un acteur majeur dans le modelage des relations sociales et culturelles (Belkhamsa & Darras, 2007). À ce titre, le design, les usages et la culture matérielle sont mutuellement engagés dans des boucles de co-détermination.

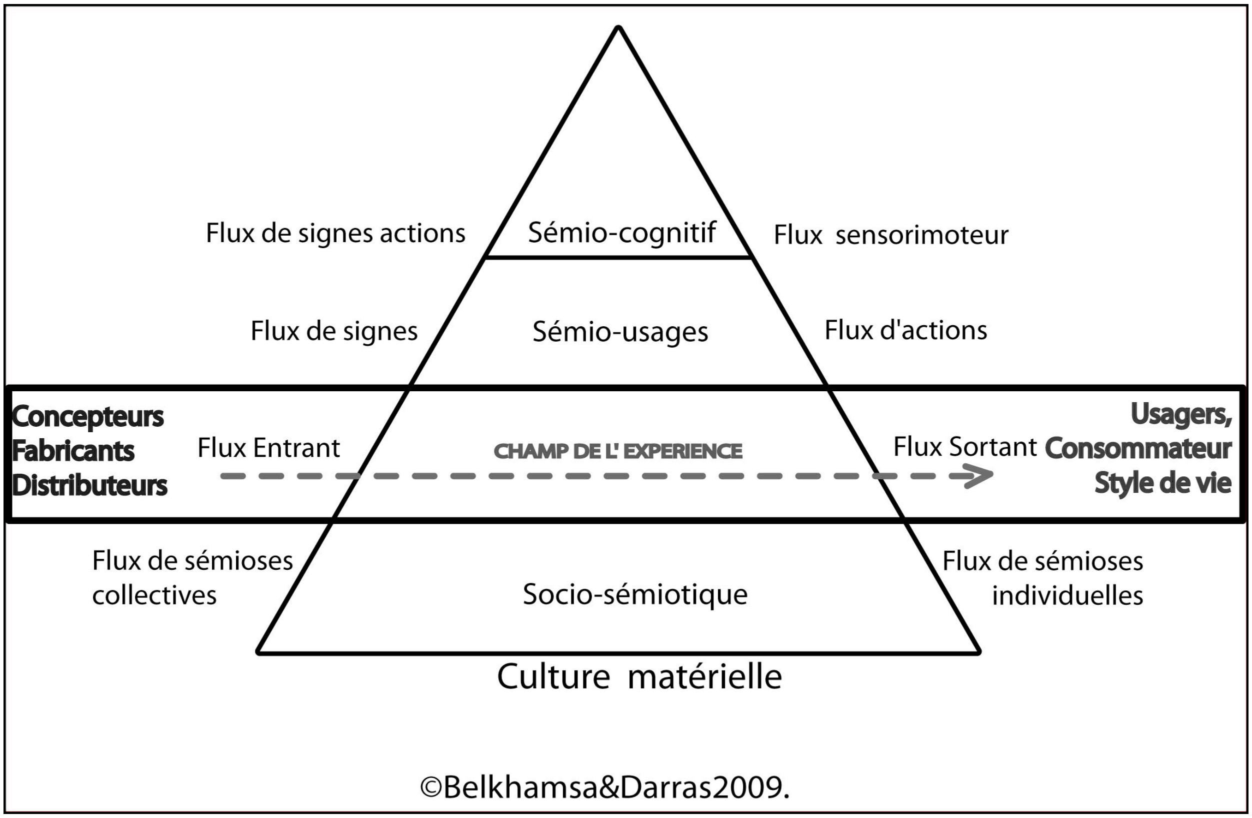

Figure 1 Les niveaux sémiotiques.

Ce diagramme représente les trois niveaux de profondeur auxquels notre modélisation donne accès.

L'expérience est le moment où s'actualisent tous les flux directs, concrets et situés de la relation à l'objet comme représentant d'une culture matérielle. Cette expérience actualise les flux de sémioses individuelles et collectives qui constituent la matière première de l'étude socio-sémiotique. Tel que nous le concevons ce niveau concerne les enjeux identitaires, de classe sociale, de genre et tous les rapports de pouvoir.

Le niveau des *sémio-usages* articule les signes à l'action et aux usages. Il interroge la façon dont un signe produit de l'action et la façon dont un usage produit un signe (Belkhamsa, sous presse).

Le troisième niveau traite du fonctionnement cognitif des processus d'interprétation et d'action et il interroge les processus de fixation et de changement des habitudes.

Ces différents niveaux sollicités par l'expérience avec l'objet en font un artefact chargé de culture réifiée et un signe action très complexe.

Approche en réseau du système de production et de réception des objets et anatomie d'un modèle

Nous avons la conviction qu'une sémiose construite à l'occasion d'une expérience avec l'objet n'est pas seulement le produit d'une personne mais le résultat d'un enchevêtrement de semioses co-construites et co-déterminé par l'individu et sa communauté. Aussi focaliser l'attention sur un seul concepteur ou un seul usager nous semble réducteur de la complexité des instances mobilisées lors de l'expérience avec l'objet.

Le modèle dynamique que nous présentons se compose de trois grands pôles en interrelations qui traitent de l'expérience de la culture matérielle. Afin de représenter les différentes interactions entre l'expérience individuelle contextualisée, située et motivée par un projet et les enjeux individuels et supra-individuels qui sont activés dans le cadre de cette expérience, nous avons choisi d'emboîter deux cercles concentriques, le premier désignant l'individu et le second la communauté dans laquelle il opère.

Les deux pôles des concepteurs-producteurs et de la communauté des usagers sont chacun constitués de deux « horloges » encastrées. Leur rotation permet de situer et de contextualiser les états de sémiose des agents qui sont eux-mêmes en relation avec le système objet. Les « horloges centrales » concernent l'état de ces agents, alors que les « horloges » périphériques permettent de situer tel ou tel état de la communauté interprétative et de la culture matérielle. En conséquence, tout agent[1] est à la fois indépendant et dépendant. Ce sont les interactions et articulations permanentes entre ces niveaux qui constituent selon nous une des originalités de ce modèle. Ce dispositif en horloges encastrées, permet de caractériser soixante-quatre combinaisons représentant les états d'un individu par rapport aux états de sa communauté interprétatives.

Au centre et au sommet du modèle, l'objet possède deux « faces » principales, un côté intègre et matérialise les composantes sélectionnées par le pôle de conception-production : le produit ou le service, l'autre côté est traitée par l'utilisateur comme un bien, une interface d'usage ou un relai de service. En conséquence, à la différence des schémas de communication classiques, qui ont tendance à individualiser ses pôles nous considérons qu'à tous les niveaux de notre modélisation, ce sont des ensembles d'acteurs et d'agents qui sont en interaction avec le monde et ceci vaut autant pour la communauté des concepteurs-producteurs, que pour les communautés d'usager et les communautés interprétatives diverses, mais aussi pour ce que l'on appelle les systèmes d'objets[2]. C'est ce que nous allons étudier plus en détail.

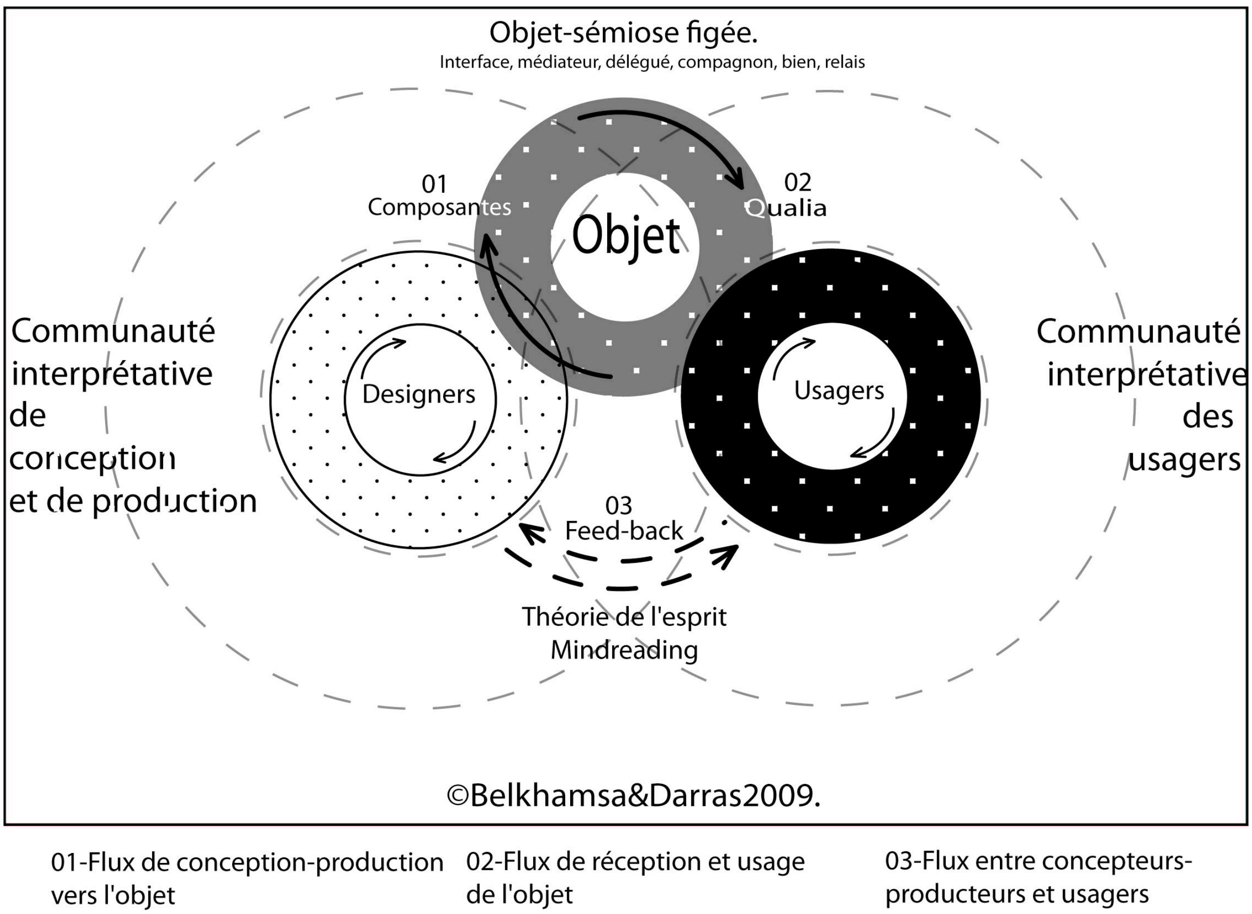

Figure 2 Modélisation simplifiée des flux de sémioses activées par l'objet.

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[1] A l'exception des sujets très autistes.

[2] Conformément à la définition systémique, ce qui fait un système, c'est le réseau plus ou moins dense des interactions, agences et interdépendances que les composantes du système entretiennent entre elles dans l'action.

- La communauté de conception et de production des biens, des produits et des relais de service comprend le commanditaire, les ingénieurs des différents bureaux d'étude, les responsables du marketing, de la direction artistique, du service financier et bien évidemment les designers dont la position et le rôle varient selon l'organisation de l'entreprise, les productions et les produits. Plus ou moins directement et explicitement, tout ce monde contribue à la définition du cahier des charges ainsi qu'aux différentes opérations de conseils, de sélections, de tests, de validation, de fabrication, qu'organise le projet. Finalement, que ce soit revendiqué ou non, toute conception et production est toujours le résultat d'un co-design et d'une co-production.

- De son côté, le concept de communauté des usagers ne renvoie pas qu'aux seules pratiques de groupe. Il concerne aussi tous les usages singuliers et situés qui sont des occurrences d'actions apprises et maîtrisées lors d'échanges directs (imitation ou instruction) ou indirects (médiatisés par un mode d'emploi, etc.) avec d'autres membres d'une communauté. Cette communauté produit et gère des règles et des normes d'usage et d'expérience plus ou moins incorporées par les individus, mais aussi toutes les interactions improvisées plus ou moins déterminées par une cause et tendant vers un but. Les enquêtes sur les conduites individuelles, montrent qu'elles sont bien des occurrences de pratiques partagées notamment sous la forme des croyances et des habitudes qui constituent une partie des représentations communes.

- Le concept de système des objets ne se limite pas aux familles d'objets (Baudrillard, 1968). Il est enrichi par la conception de l'objet comme un dispositif d'intelligences distribuées plus ou moins figées entretenant des relations objet-sujet et objet-objet (Zinna, 2005). Sur ce point, notre modélisation découle de la conception sémiotique relationnelle de C. S. Peirce (1931-1935) et elle adopte le concept de réseau hétérogène ou les agents humains et non-humains sont considérés comme étant des réseaux en interrelations. Elle a aussi de nombreux points communs avec la théorie de l'acteur réseau (*Action-Network Theory*, ANT).

Selon cette perspective les relations entre objets et objets constituent l'écologie des objets. Ces relations peuvent être de dépendance directe (ensemble d'objets fonctionnant en co présence : un service de table, une table et ses chaises, etc.) ou indirecte (ensemble d'objets fonctionnant entre eux à distance : un téléviseur et sa télécommande, etc.) Ces objets peuvent être reliés entre eux à plus ou moins grande distance par divers opérateurs parallèles de point/contre-point mécaniques (la clef et la serrure) ou chimique (un détecteur de fumée et une chaudière) ou thermique (un thermostat et un radiateur) ou par ondes (deux téléphones cellulaires via un réseau), (Uexküll,1956-1965).

Selon le type d'expérience engagée, l'opérateur sélectionne et active certaines relations entre un objet et son environnement et constitue ainsi un système des objets répondant à ses intentions et finalité d'action. En conséquence, chaque expérience définit un système des objets unique et spécifique à chaque opérateur.

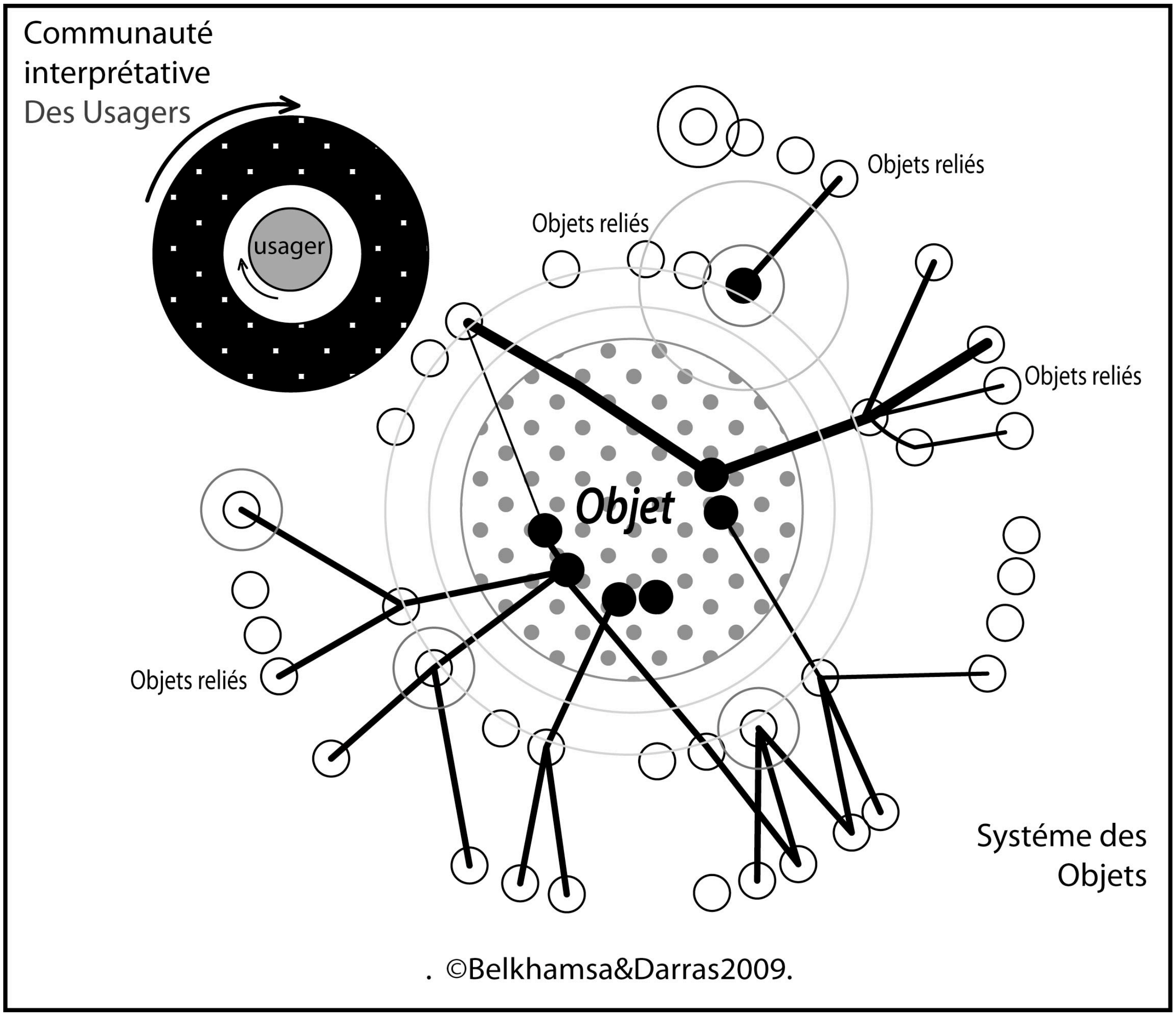

Figure 3 Modélisation simplifiée des systèmes des objets.

Description du modèle

Présentation du cycle des habitudes et changements d'habitude

Cette modélisation dynamique résulte de nos difficultés initiales à modéliser la diversité des actions et expériences avec un objet. Qu'elle soit arbitraire, typique, relative au bon usage ou statistiquement moyenne, aucune des solutions ne nous semblait épistémologiquement acceptable.

Lors de nos différentes observations et enquêtes en réception sur les usages des objets, une évidence s'est imposée, les agents n'avaient pas du tout les mêmes relations aux objets quand ils les découvraient, quand ils apprenaient à s'en servir ou quand ils en usaient régulièrement. Dans les deux premiers cas, ils étaient attentifs à leurs actions et ils pouvaient les décrire, en revanche, ils étaient en difficulté pour en parler dès que leurs relations à l'objet étaient gérées par des automatismes.

Une autre distinction est apparue très tôt, elle concernait toutes les relations avec les objets en crise. La crise apparait notamment quand l'usage d'un objet n'est plus adapté aux besoins. Travaillant à partir de deux territoires et de deux ambiances culturelles sensiblement différentes : la France et la Tunisie, nous rencontrions des objets importés et exportés dont l'identité posait des problèmes, (voir, Belkhamsa et Darras, 2007).

Pour résoudre tous ces problèmes et modéliser la relation systémique, contextualisée et située de la communauté des agents, du système des objets et de l'environnement, nous avons eu recours aux concepts d'habitude et de changement d'habitude développés par C. S. Peirce. Nous les avons ensuite affinés et organisés en un cycle du changement. Ce cycle et ses différentes phases sont représentés dans le diagramme suivant :

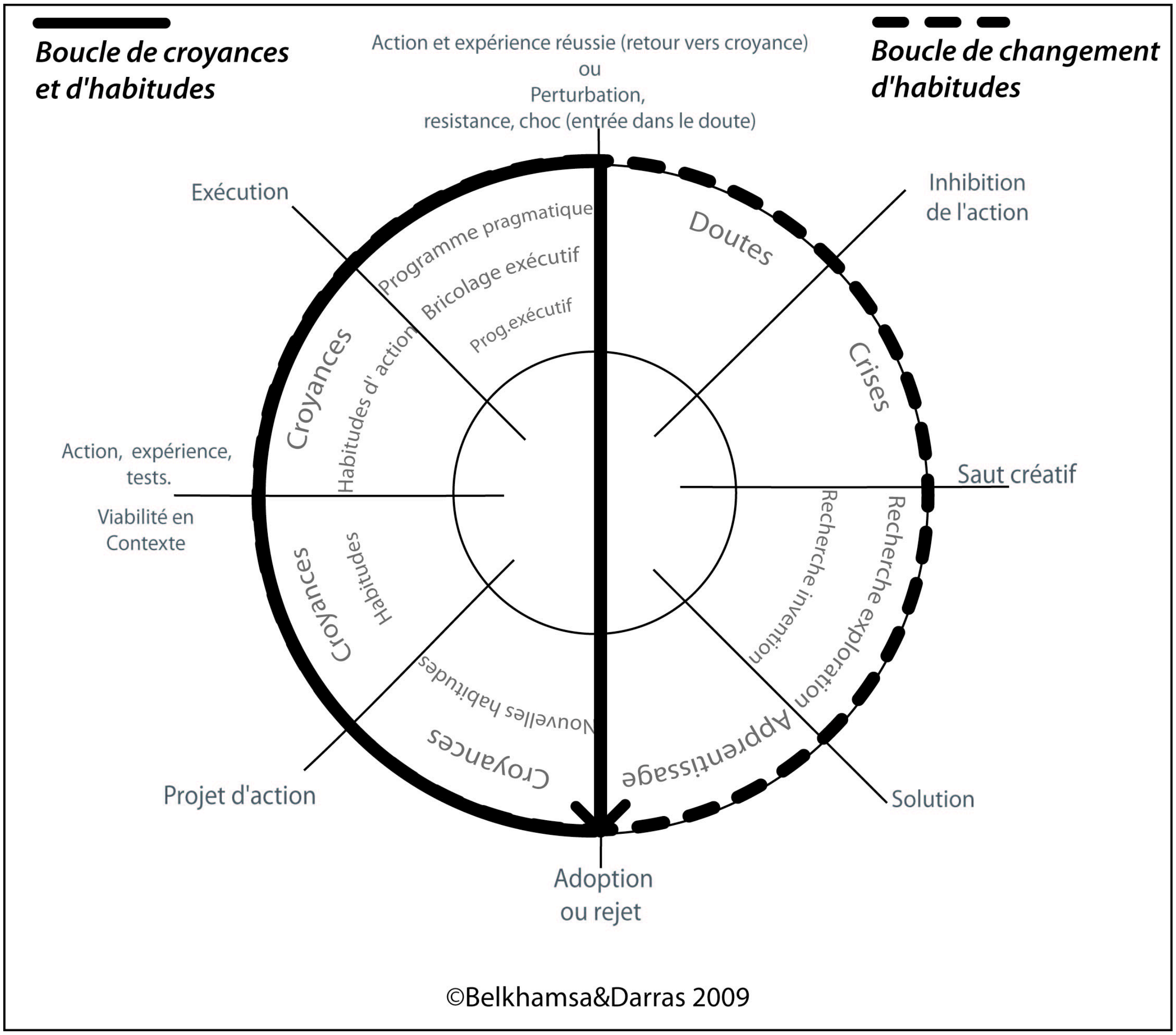

Figure 4 Cycle du Signe-Action dérivé de la théorie de C.S.Peirce.(Auto-eco-organisé)

Tel que nous le présentons ici, la gauche de ce cercle est occupée par les phases en équilibre, c'est le domaine des croyances en phase de stabilité, des habitudes et des habitudes d'action qui en découlent et qui se renforcent et renforcent les croyances quand l'action est concluante (flèche descendante). Cet équilibre est l'état dans lequel se trouve la pensée qui fonctionne dans un environnement prévisible. Nous avons distingué les phases délibératives des phases exécutives. Dans les premiers cas les habitudes sont des prédispositions à agir, dans le second cas les habitudes s'actualisent dans l'action où elles se confrontent aux facilitations et résistances concrètes de l'environnement.

L'hémicercle de droite débute avec le doute qui résulte d'une perturbation de l'habitude d'action, il est généralement suivi d'une crise qui peut se résorber lors d'une phase de recherche de solution. Celle-ci étant trouvée, éprouvée et apprise, une nouvelle habitude est constituée et le cycle adaptatif des habitudes et changement d'habitude peut continuer. Nous allons brièvement présenter chacune de ses phases en notant que le passage de phase en phase est provoqué par des tensions.

Dans la modélisation complète présentée en fin d'article, ces cycles ou « horloges » de base seront, à la fois emboîtés afin de représenter la relation de phase d'un individu avec sa communauté culturelle, et répliqués car ce sont les mêmes phases et tensions qui se produisent en conception-production ou en réception consommation.

Croyances, habitudes, action et signification

Croyances et habitudes

Selon Charles, S. Peirce, a « belief consists mainly in being deliberately prepared to adopt the formula believed in as the guide to action." (Peirce : CP 5.480). La croyance n'est donc qu'une règle d'action et une prédisposition à agir, une formule destinée à servir de guide à l'action. En conséquence, les habitudes qui en découlent sont tendues vers l'action mais elles ne se concrétisent que dans les habitudes d'action. C'est pour Peirce le rôle même de la pensée : « The whole function of thought is to produce habits of action » (CP 5.400, V.13). L'habitude d'action préside à l'accomplissement de la signification qu'est l'action elle-même (CP 5.400). Lors de nos observations, nous avons constaté que les habitudes d'action s'actualisent selon trois process distincts qui peuvent être successifs.

- Les programmes pragmatiques sont des représentations internes ou externes de plan d'action. Une table de multiplication mémorisée ou un système mnémotechnique sont des programmes pragmatiques internes, le mode d'emploi, la recette, une carte routière, un plan de montage, etc. sont des programmes pragmatiques externes.

- Les « bricolages exécutifs », sont activés lors du passage à l'action directe et concrète. Ce sont des actions partiellement « improvisées » lors de l'expérience directe et située. Les agents « bricolent » avec les informations et connaissances distribuées dans leur environnement sous forme de mémoires externes ou excorporées et des habitudes matérialisées et réifiées que sont les artefacts[3]. « Le chemin se construit en marchant » disait A. Machado.

Le programme pragmatique constitue une sorte d'élan initial, d'intention, alors que le « bricolage » exécutif est opportuniste, inventif et adaptatif.

- Les programmes exécutifs sont des bricolages exécutifs optimisés et répétés un grand nombre de fois avant d'être enregistrés dans la mémoire procédurale. Ils deviennent alors à la fois automatiques et cognitivement inconscients. La conduite automobile, ou l'utilisation experte d'un clavier sont des combinaisons d'automatismes et de bricolages exécutifs. Le fait de connaître une action « par corps », dispense de la médiation d'une représentation. Celle-ci devient même gênante quand elle resurgit au milieu d'une action automatisée. Il faut en quelque sorte apprendre à agir sans y penser. Ce qui ne veut pas dire que l'agent ne pense plus, sa pensée n'est plus représentationnelle mais psychomotrice.

Dans tous les cas, passer à l'action c'est savoir fonctionner selon l'un de ces trois modes.

Le doute

L'entrée dans le doute est une situation normale du cycle de la pensée qui tend à la fois vers l'habitude et le confort de la croyance, mais aussi vers l'action qui peut conduire à l'échec et à l'invalidation de l'habitude et de la croyance « Since belief is a rule for action, the application of which involves further doubt and further thought, at the same time that it is a stopping-place, it is also a new starting-place for thought. ». Le plus souvent, le doute n'est pas une phase satisfaisante « Doubt […] is not a habit, but the privation of a habit." Sa résorption inaugure une phase de recherche qui peut s'enliser dans la crise ou se libérer dans un saut créatif. Dans les cas graves la tension se transforme en état de choc qui bloque le processus de la pensée.

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[3]Tels que nous les définissons, ces programmes pragmatique et exécutif sont conformes aux avancées des théories de l'action et de la cognition située (*Situated cognition*), de la connaissance distribuée et des recherches en HMI (*Human Machine Interaction*) telles quelles ont été développées à partir des travaux de Lucy Suchman (1987 et 2007).

La crise

En l'absence de solution viable le sujet et sa communauté entrent dans une phase de crise dominée par le trouble, l'hésitation, l'échec, la souffrance, l'inhibition de l'action, les cercles vicieux et toutes les formes du blocage. En attendant qu'un saut créatif et adaptatif ne survienne et ne soit adopté, on tente souvent de faire du neuf avec du vieux.

La recherche

La recherche de solution peut emprunter différentes voies qui vont de l'imitation, (emprunt ou copie de solutions existantes) à la recherche méthodique et scientifique de solutions inédites fondées sur différentes procédures logiques dont l'abduction, l'induction et la déduction. Entre ces deux extrêmes, l'imagination et la créativité offrent une grande variété de dispositifs de résolution de problèmes qui vont du surgissement intuitif de solutions aux différents recyclages de blocs de pensées. Comme le disait Albert Einstein : « Les problèmes auxquels nous sommes confrontés ne peuvent être résolus au niveau et avec la façon de penser qui les a engendrés »[4]. L'émergence d'une solution peut se faire dans un temps très court ou très long et cette solution peut être plus ou moins viable.

L'apprentissage de nouvelles habitudes

Beaunieux montre que « l'apprentissage d'une procédure se déroule en trois étapes distinctes : une étape cognitive, une étape associative et une étape qualifiée d'autonome. Lors de la première étape, le sujet découvre ce qu'il doit apprendre : il tâtonne et commet de nombreuses erreurs. Puis il passe à l'étape associative, phase transitoire au cours de laquelle il commence à contrôler la tâche à effectuer, sans pour autant l'avoir automatisée. Enfin, pendant la troisième étape les gestes sont automatiques et atteignent un niveau d'efficacité maximale. » (Beaunieux, 2009 : 52). Cette dynamique correspond à trois zones cérébrales distinctes (Hubert et al. 2007).

« Ce basculement (vers la mémoire procédurale) expliquerait pourquoi nos automatismes sont si difficiles à verbaliser. » (Beaunieux, 2009 : 53). Cette économie procédurale permet au sujet de dédier une plus grande part de son activité à d'autres choses. Si dans la compétition entre les habitudes disponibles, la nouvelle habitude apprise parvient à s'imposer et à être validée puis à être adoptée par la communauté interprétative du sujet, elle devient une habitude partagée (consensus) et éventuellement un habitus. Elle est alors incorporée individuellement et socialement jusqu'à la prochaine hésitation, indécision et jusqu'au prochain doute qui engagera une nouvelle recherche.

L'articulation entre les croyances et habitudes individuelles et collectives

Cette étude des phases et tensions du cycle des habitudes et changement d'habitude est applicable aussi bien en conception-production qu'en réception, usage et consommation. Elle l'est aussi tant au niveau singulier du designer que de sa communauté de production, elle est aussi applicable du côté de l'expérience individuelle et du contexte culturel des communautés interprétatives et agissantes dans lesquelles l'usage se déroule. Toute étude d'une expérience consiste donc en un réglage de ces cycles emboîtés en fonction des phases activées.

En général, ce sont les habitudes qui dominent la vie quotidienne des humains. Dans les environnements conçus pour être stables et prévisibles, il n'est donc pas difficile de contrôler très vite les micros changements et de chasser le doute pour retrouver les bonnes vieilles habitudes.

Sur ce plan, tous les individus n'ont pas les mêmes comportements, ainsi les individus créatifs sont plus attirés par les tensions provoquées par le doute que par la stabilité. Ils aiment les professions et les activités plus risquées où les habitudes sont souvent déstabilisées. Ils apprécient de voir leurs certitudes mises en doute, ils adorent avoir des problèmes à résoudre et relever des défis qui stimulent leur imagination, leur créativité et leur esprit d'invention. Bref, ils aiment être confrontés aux changements et ils en sont les principaux acteurs, en conséquence, ils adoptent vite les nouvelles solutions et les nouveaux produits et services. Ils ont donc bouleversé le modèle de la pensée stable où dominent les croyances, les habitudes et la tradition, au profit

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[4] Référence exacte inconnue, ce propos est généralement prêté à Albert Einstein.

d'une valorisation positive du doute et de la recherche de solution. C'est leur façon de gérer le cycle des habitudes et des changements d'habitude, mais surtout c'est leur attitude constructive face à l'incertitude ainsi que leur habileté à transformer positivement les tensions et le doute en recherche et en solution et non pas en crise ou en rigidité qui en font des individus créatifs.

La créativité attirant la créativité et les créatifs attirant les créatifs, une « classe créative » se constitue qui dispose du pouvoir essentiel de définir les styles de vie du présent mais aussi ceux du futur et donc d'orienter en grande partie l'économie et la production de biens et de services (Florida, 2002).

Cycle de vie de l'objet

Les objets eux-mêmes sont soumis a un cycle de vie et de changement régulé par les lois du marché, des marques et des tendances (e.g., Barthes, R., 1967 , Baudrillard, J, 1968, Marty, R. 1994 : Klein, N., 2000). Il est évident que la relation aux objets est différente quand ceux-ci sont des « concepts », des prototypes ou des produits innovants, ou quand ils sont des produits de masse ou génériques usés ou des survivants de la banalisation érigés en sémiophores destinés aux collectionneurs.

C'est parce qu'il est pris dans le réseau de toutes les combinatoires entre : les différents systèmes économiques ; les différents niveaux sémiotiques ; la variabilité des systèmes des objets constitués à l'occasion d'expérience spécifiques : les différentes combinaisons possibles entre les sémioses individuelles et leurs interactions avec l'environnement, etc. que l'objet est un signe complexe difficile à interpréter. Les composantes de cette complexité étant identifiés, il s'agit maintenant de les mettre en relation par une approche systémique des flux qui les relient.

Etude des trois flux de communication entre les pôles

Cette dernière partie est consacrée à l'étude des flux de communication qui circulent entre les pôles dynamiques en constituant le circuit de la communication de l'objet. Pour faciliter la compréhension de cette partie de notre modélisation, nous devons préalablement expliciter certains paradigmes que nous utiliserons régulièrement (Darras, Belkhamsa, 2008).

- Proposées par James Gibson (1950), les affordances sont des propriétés de l'environnement associées par un animal ou un humain à des actions spécifiques dans un système donné. Ces "opportunités écologiques d'interactions" ne sont ni seulement des propriétés de l'environnement ni seulement des dispositions du sujet, ce sont des propriétés systémiques (écologiques) émergentes qui sont à la fois complémentaires et relationnelles

- Le concept d'enaction a été développé par Francisco Varella dans un contexte épistémologique post-darwinien où la relation organisme/environnement se définit par l'évolution de leur co-détermination. La thèse de l'énaction réside dans le concept de couplage structurel. Ainsi que le notent Visetti et Rosenthal (2006), l'approche énactiviste se distingue par sa capacité à considérer que "l'intérieur" et "l'extérieur" se co-constituent à travers l'action et ses médiations.

- Selon Greimas (1983 : 74), la factitivité « est un faire cognitif qui cherche à provoquer le faire somatique. » L'acte factitif qui en résulte a deux modalités contractuelles engageant « deux instances de l'énonciation, dotées d'un faire persuasif et d'un faire interprétatif.» (Greimas, Courtes, 1979 : 144). Michela Deni (2005 : 82) distingue quatre niveaux de la factitivité de l'objet : le niveau où l'objet agit comme un manipulateur sémiotique de l'utilisateur, celui où les objets structurent les processus d'action de l'utilisateur, le niveau où les objets créent le contexte de relation interobjective, finalement le niveau où les objets modifient les relations entre les sujets.

- Réintroduits dans la phénoménologie et la sémiotique pragmatique par Charles S. Peirce pour désigner le sentiment de rougéité d'un rouge, de stridence d'un son, etc., les qualia constituent les toutes premières informations qualitatives de l'expérience consciente d'un objet. Ce sont des blocs de sensation qui ne sont pas réductibles à leurs composantes élémentaires. Ils fonctionnent comme des synthèses et des gestalt de relations. Tout l'art de l'assemblage des formes et des couleurs du designer vise à constituer des *gestalt* capables de s'imposer au destinataire qui les traitera comme des entités globales. Si le contexte, les dispositions et les attentes du destinataire sont compatibles avec les intentions du designer, les assemblages produiront les qualia espérés, mais ce ne sera pas toujours le cas (voir Darras, 2009).

Flux de conception-production vers l'objet

Telle que nous l'avons modélisée, la communauté des concepteurs-producteurs a pour mission d'intégrer de la signification et de la culture dans des matériaux, des formes et des volumes, etc.

En tant qu'intermédiaires culturels, les « Designers have to embody culture in the things they design (...) They play an active role in promoting consumption through attaching to product and services particular meanings and 'lyfestyles' with which consumers will identify. Put simply they can be defined as involved in the provision of *symbolic* goods and services. » (du Gay et al. 1997 : 62).

Toute cette intelligence matérialisée et organisée est destinée à favoriser l'expérience sensible des qualia par le consommateur usager, puis à déclencher la chaîne des affordances, enaction, habitudes d'action, représentations, projections identitaires, etc.

Flux de réception et usage de l'objet

Les recherches sur les relations qui sont activées entre l'utilisateur et l'objet ont produit divers paradigmes concurrents. Selon nous, ils décrivent différents aspects et différents types de relation objets/usagers ainsi que différentes conceptions de la relation aux objets. Mais surtout, ils entrent en action en fonction des phases du cycle de la réception. Les affordances et les enactions sont plutôt du côté des habitudes, alors que les représentations sont plutôt sollicitées dans les phases de changement d'habitude, donc de recherche et d'apprentissage.

Nous avons cherché à décrire systémiquement et sémiotiquement ce double flux d'agence réciproque qui caractérise la relation entre un objet et un utilisateur (qu'il soit en phase d'habitude d'action, de changement d'habitude ou d'apprentissage.) Après avoir exploré différentes propositions, nous avons opté pour le modèle interactionnel et exosémiotique proposé par Jacob von Uexküll (Uexküll, 1940, 1956, 1965).

Ce modèle correspond très bien à notre conception du monde comme système composé d'agents humains et non-humains humanisés. Dans un milieu constitué par la rencontre d'un objet et d'un utilisateur, (*Umwelt*), les composantes de l'objet destinées (designées) à l'usage s'affichent sous la forme de « points » offerts aux « contre-points » de l'agent.

En termes sémiotiques pragmatiques et systémiques, nous dirons que dans un milieu constitué par un agir spécifique (une expérience), l'objet est un « porteur de significations » qui s'actualisent lors d'une interaction avec des compléments incorporés par « l'utilisateur de la signification ». Le plus souvent, porteur de signification et utilisateur de la signification ont une longue histoire de co-détermination et d'énaction.

Selon cette approche couplée, l'objet est composé d'un ensemble d'attracteurs s'offrant aux contre-points complémentaires des agents potentiels et à plus forte raison à l'usage d'utilisateur prédisposés à agir (habitude) et aspirant à le faire. Cette relation est optimale quand le design est particulièrement ergonomique et « interpellant ».

L'un des avantages de cette approche pragmatique de la signification, c'est qu'elle permet de mettre fin à la séparation entretenue en sémiotique entre la fonction et la signification. Selon la perspective que nous adoptons, toute fonction est une activation d'un porteur de signification par un agent qui réalise cette signification dans l'action.

- Quand la perspective est en réception, les objets porteurs de signification sont tout d'abord perçus par leur utilisateur au niveau des qualia, certains de ces qualia sont traités à des niveaux sensori moteurs élémentaires par des relations d'affordance.

D'autres affordances plus affinées par l'expérience et les pratiques de la culture matérielle fonctionnent en boucles d'enactions qui font intervenir des habitudes d'action et des représentations.

- Quand la perspective est du côté des porteurs de significations potentielles que sont les objets, ces significations ont été intégrées par des designers lors d'opérations de matérialisation diverses pour que l'objet soit un acteur « humanisé » et cultivé. Il est alors porteur d'agences performatives, factitives, designées pour interpeler un usager et le faire agir selon le programme d'action qu'il matérialise. Lors de la relation, l'objet sollicite et guide les réponses déjà incorporées par le destinataire qui est en phase d'habitude d'action et il induit des tentatives de réponses lorsque le sujet est en phase de changement d'habitude.

Flux entre concepteurs-producteurs et usagers

Cette partie de la modélisation caractérise les relations qui sont entretenues dans le circuit de la production et de la consommation entre les concepteur-producteurs et les usagers. Nos observations et enquêtes nous ont permis de distinguer les opérations de production de « Théories de l'esprit », de *mindreading* et les opérations de *feed-back*.

- La théorie de l'esprit et le *mindreading* ***:*** Nos nombreuses observations de personnes en train d'utiliser des objets dans des circonstances diverses nous ont convaincus que les usagers prêtent aux concepteurs et producteurs une intention de communication, de signification et d'interpellation au travers des objets et de leurs interfaces. Cette communication indirecte avec le concepteur survient à chaque fois que l'on cherche une logique au fonctionnement ou dysfonctionnement de l'objet. Quelques déclarations relevées lors de nos observations en sont de bons témoignages : « c'est pas mal pensé ! », « ce truc est mal fichu ! », « mais comment ont-ils imaginé ça ? » , etc.

Bien évidemment, de son côté, la communauté des concepteurs-producteurs ne cesse, elle aussi d'imaginer les comportements des futurs usagers. Elle le fait en extrapolant ces comportements à partir de tests divers mais aussi le plus souvent en s'auto projetant dans les usages à venir.

À un titre ou à un autre, en sa présence ou en son absence, nous avons tous été confrontés à ce processus de représentation de la pensée de l'autre. Pour ce faire, nous activons une capacité mentale que l'on appelle la théorie de la « Théorie de l'esprit ». Nous sollicitons une Théorie de l'esprit ou une séquence de *mindreading* à chaque fois que nous attribuons à l'objet lui-même une Théorie de l'esprit. Ce processus de « personnalisation » est en fait une extension de propriétés mentales de l'humain aux artefacts non-humains. L'objet s'y prête d'autant mieux qu'il est effectivement un lieu d'intelligence déléguée, distribuée et matérialisée.

Dans notre modélisation, le flux des « Théories de l'esprit » et les opérations de *mindreading* sont donc à double sens, ils sont imaginés et testés en conception-production et projetés ou activés lors de l'usage ou de l'analyse. Notons à ce sujet que la plupart des analystes se contentent de travailler sur les « théories de l'esprit » qu'ils attribuent aux designers et c'est précisément ce biais que nous tentons d'éviter avec notre modélisation tripolaire.

. Pour nous, ces processus sont un des hauts lieux d'activation des flux de communication entre les humains et le monde non-humain humanisé des objets.

- Feed-back : Autant les projections de « Théorie de l'esprit » se déroulent sans conséquence directe sur la transformation de l'objet, autant les *feed-back* sont destinés à le stabiliser ou à le modifier. Nous considérons donc comme appartenant au feed-back tous les tests d'utilisation et toutes les enquêtes de satisfaction qui sont en général conduits par le service marketing, mais aussi lors de toutes les opérations de co-design qui se réalisent dans le cadre du design participatif.

Conclusion

La conclusion de cette étude est matérialisée dans le schéma global suivant. Il rassemble et articule toutes les composantes décrites et explicitées étape après étape et phase après phase dans cet article.

Pour bien fonctionner, ce diagramme doit être pensé dynamiquement et complété par différents zooms sur les parties complexes de chaque phase et de chaque flux.

Selon nous, toute étude d'une expérience avec un objet doit être conçue comme l'étude d'un signe action complexe. Elle réclame non seulement le réglage des quatre phases engagées dans l'interaction mais aussi l'étude approfondie des différentes interactions qui s'y déroulent, ainsi que l'étude des flux qui relient chaque pôle activé.

Non seulement cette modélisation permet de traiter de la signification d'une expérience lorsqu'elle s'actualise dans une habitude d'action prévisible parce que récurrente, relativement stable et partagée par une communauté, mais elle permet aussi de traiter de la dynamique du changement des sémioses, des crises comme des phases d'apprentissage. Ceci, tant en conception-production qu'en réception-usage, mais aussi lors de leur articulation (Darras & Belkhamsa, 2009c).

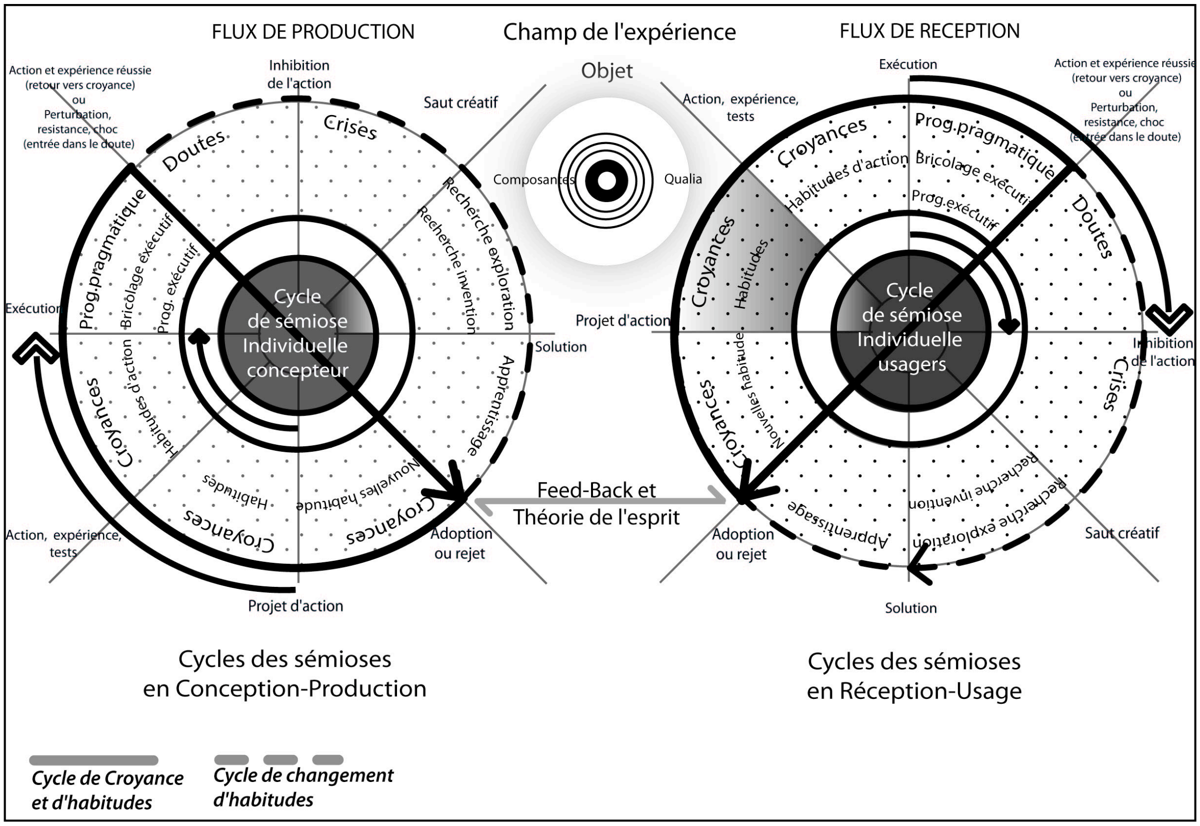

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Figure 5 Carte dynamique de la communication de l'objet

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Dis/Ability teaches Design!

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Abstract

What can Design learn from bodily Impairment or social Disability?
In our paper, we claim that general human and artificial communication systems might be enriched by acknowledging and adding specifics of different ways of communication, perception and locomotion that refer to bodily impairment (Bieling, 2009).

In this regard, we assume, that disability occurs not least through influence by design and culture (e.g. built environment). As Caspers (2006) believes: disability is the lacking ability to “deal with bad design”. Besides the assumption, that design provokes disability, we will furthermore describe how disability can inspire and alter design.

Schillmeier (2009, 79ff) sees disability less as an effect of bodily impairment, but more as a phenomenon of social construction. Oriented towards John Dewey (1929) and Michel Foucault (1963) as well as to Science, Technology and Society Studies (STS) he conceptualizes disability as an event. In this context he asks, who (when, where and how) becomes disabled or not. Schillmeier states ›dis/ability‹ as a “heterogenic, material event”, which connects “social and non-social relations of human and non-human actors, of things, bodies, technologies, sensorical pratices” and becomes able to be experienced in the sense of disabling as well as enabling (›dis/abling‹) scenarios. (Waldschmidt/Schneider, 2009, 17)

„With the multiple objects of ›Disability‹, the parliament of things becomes obvious*:* the assembly of bodies, technologies, and things, as an articulation of reality of natures and cultures“. (Schillmeier, 2009, 79ff) By exploring disability from an *›out-of-center‹* position, we aim to use it as a “knowledge-constituting moment, for the analysis of the (majority of) society”. (Waldschmidt/Schneider, 2009, 15)

In our investigation we consequently focus on integrative processes: An improvement of social integration, as well as an improvement of communication systems and devices through design (research), inspired by and learning from communication patterns of the bodily (and therefore socially) impaired.

We will discuss results and examples of the design research project *Speechless*, an interdisciplinary project run at the *Design Research Lab* of *Deutsche Telekom Laboratories,* Berlin. One main focus of *Speechless* lies primarily on deaf and blind communication and perception, as well as on the transferability of alternative forms of communication to general human (interpersonal) communication and human-computer-interaction (HCI).

During the first project phase, we have been working together with deaf people (in collaboration with *Sinneswandel,* a Society to support deaf and hard of hearing people, as well as with students of Deaf Studies at *Humboldt University Berlin*). The enhanced visual sense, the three-dimensional communication space, as well as linguistic and psychological particularities (Koller, 2008) constitute the main focus of this project phase.

In addition, we developed workshops with sighted and hearing people. By consciously deactivating certain senses or bodily functions (e.g. blindfolding), we aim to gain knowledge for designing multimodal interfaces. How to navigate without seeing? How to communicate without spoken or written language? Etc…

One or more impaired senses sharpen the remaining senses (Montessori, 1952). This can lead to individual skills that differ from common ones. A deaf person for instance, might not hear the music in a discotheque, but in comparison to the hearing people, he or she can to a certain extent easier communicate during the loud music – even over distance.

If we, as e.g. interface designers, understood more about communicative variations caused by bodily impairment, we might be able to create systems that enrich general human communication, by transferring and combining properties of such different variations.

Thus in our research project, we have so far been developing concepts for service- and product-solutions, that might help to overcome some of the limitations caused by bodily impairment on the one hand, and help to enhance the communication and locomotion of “non-disabled” people on the other hand. We aim to open up new perspectives in HCI and add a completely new aspect to design driven inquiries in two respects:

1) By taking bodily impairment as a source of inspiration for the development of Information-Communication-Technology (ICT) in matters of human communication and perception

2) By investigating augmentative and alternative communication (e.g. sign language) from an interfacial point of view. (Bieling, 2009)

Our research project opens up a wide field of new ideas and problems to solve in the learning field about properties of alternative and augmentative communication. It becomes obvious a high potential of knowledge about and systematic use of such systems of communication (Bieling, 2009a), to open up perspectives for designing human-machine-interfaces in particular, as well as for design research in general.

Keywords
Disability inspired Design/Research; Disability Studies; Alternative Communication; HCI; Social Innovation; Participatory Design; Cultural Studies.

This paper introduces an approach to implement an integrated model of disability in design research, a model aiming at merging aspects from the medical and social perspectives of disability.

The paper illustrates a framework for the approximation of two disciplines – Design Research and Disability Studies. By presenting examples of different aspects of design in a disability context and disability in a design context, the paper aims at revealing fundamental perspectives for design research.

We claim that general human and artificial communication systems might be enriched by acknowledging and adding specifics of different ways of communication, perception and locomotion that refer to bodily impairment (Bieling, 2009). The framework can be considered as an experimental stage set for design practice and theory, envisaging an inclusive comprehension of (inter- and trans-) disciplinary development.

By challenging general concepts of disability and ability (›dis/ability‹) our approach may be both contributing to the field of Design Research and the field of Disability Studies.

Background

Against the background of the demographic change of growing life expectancy across the world, we are facing an increasing number of individuals becoming disabled or in need of care (Tervooren, 2002, 1). Thus the phenomenon “disability” is going to become a “universal experience of our society” (Hermes, 2007). Questions about and definitions of disability will have to be reformulated, in order to avoid exclusion of growing parts of society. This also means to analyze societal norms, traditions and values leading to certain perspectives on disability.

Major questions in this context are related to the general assumptions about what disability is about, and about who becomes disabled when and by what or whom. The World Health Organization (W.H.O.) recognizes disability as a “complex interaction between features of a person’s body and features of the environment and society in which he or she lives” (W.H.O. 2001). Against this background “disability” is particularly being viewed as social disability, caused by bodily variations. As Pullin (2009, 2) states: “People are […] disabled by the society they live in, not directly by their impairment”.

Traditionally, for a long period disability has been subject of interest to the applied sciences (medicine, therapeutic-, special needs pedagogic etc), basically focusing on the prevention, deletion or relief of bodily “damage”.

The intention may be honourable however it contains at least two problems: First, the “problem-solving” approach can not cover the complexity of disability, since disability is a very common experience in human life and human beings are no machines, but highly vulnerable and breakable (and actually only “temporarily non-disabled”). Secondly, viewed from a historical and cultural anthropology position, it becomes obvious that disability has neither been a universal cultural category, nor a uniform social practice. (Waldschmidt/Schneider, 2009, 10)

To understand and analyse disability and phenomena of embodied difference as a historical, social and cultural construction, has been the starting point for ‘disability studies’ to develop alternative perspectives which correct or widen the medical/pedagogical approximations to disability.

Confronting the *medical model* with the *social model of disability* allows not least a critical reflection on fundamental concepts of order, which become manifested in antipodes like ‘normality and difference’ or ‘health and illness’.

Different Models: The Social, the Medical, the Integrated.

The *medical model* of disability (also known as the *deficit model*), defines disability as a direct consequence of an impairment. The biological-medical point of view declares disability as a medical condition of the body that is medically diagnosable. Disability activist groups view the medicalisation of disabled peoples’ everyday lives as a form of social oppression (Anderberg, 2005, 2; Johnson/Woll, 2003). Batavia (1999) describes how this point of view considers people with disabilities “paternalistically as dependent patients rather than as self-directed individuals fully capable of autonomy”. Turner (2001) misses in this context a focus on the “actual functions desired by the individual” (Anderberg, 2005, 2). A quantification of disability, by clinical measuring and classifying is being criticized by Anderberg (2005, 2), who claims that it is “alienating rather than supportive to the individual to be faced with a clinical analysis, a professional language of description and a lack of considerate interest for the functions most relevant in her/his own context”.

The *social model* of disability (UPIAS 1975) originally refers to a “rather materialistic view auf the causes of disability” (Anderberg, 2005, 2), but can generally be referred to the social construction of disability. Anderberg (2005a, 2) summarizes its key message as follows: “Societal structures should be changed to accommodate people with disabilities, not individuals that should be changed to fit into a rigid environment and society”. Disability is not seen as a “characteristic of the individual but rather the situated response to an inaccessible, inflexible and un-adapted environment and society” (ibid.).

However, neither the medical nor the social model of disability is exclusively satisfactory for design (Anderberg, 2005, 1). The medical model, as a “problem-oriented” approach, oversimplifies disability as an “individual characteristic and directs attention towards individual adjustments and means” (ibid.). The social model, on the other hand, directs attention towards ideological and political analysis, not towards proposals for “practical everyday solutions for experienced functioning” (ibid.), or suggestions to practically change situations into preferred ones.

Seelman (2003) introduces an *integrated model* as an attempt to merge, or bring closer the medical and social perspectives. Others have been contributing to this attempt, some of them linked to the fields of biocultural anthropology.

According to the social and medical models, Schillmeier counterposes an object-centred, experience- and occurance-logical concept of the nature(s)/culture(s) of disability. He states ›dis/ability‹ (Schillmeier, 2009) as a “heterogenic, material event”, which connects “social and non-social relations of human and non-human actors, of things, bodies, technologies, sensory practices” and becomes able to be experienced in the sense of disabling as well as enabling (›dis/abling‹) scenarios. (Waldschmidt/Schneider, 2009, 17)

Schillmeier describes, how empirical research in STS on disability emphasizes the complex event-character of disabling and enabling realities in everyday practice. Disability, understood as “dis/abling practices” underlines the situational links and connections of human and non-human actors, processes and practices (Waldschmidt/Schneider, 2009, 91, according to: Schillmeier 2005; Law/Moser 1999; Struhlkamp 2004).

Furthermore he points out, that it is an empirical open question, how, where and when disability appears. He claims that ›dis/ability‹ refers to a complex interaction between bodies, senses, feelings, symbols, experiences, technologies and technological infrastructures, of situational constructed space-/time-relations etc. that let appear social practices in an enabling or disabling sense. (Waldschmidt/Schneider, 2009, 91)

According to Gilles Deleuze and Felix Guattari, becoming disabled is not to be understood as an “evolution through origin and heritage”, neither in a sense of individual impairment, nor as a result of societal structures. It rather appears through “alliances of human and non-human, social and non-social acteurs, objects and processes” (Schillmeier, 2009, 91; according to Deleuze/Guattari 1992, 325)

„With the multiple objects of ›Disability‹, the parliament of things becomes obvious*:* the assembly of bodies, technologies, and things, as an articulation of reality of natures and cultures“(Schillmeier 2009, 79). Moser and Law (1999) and also Myriam Winance (2006) have in this context used ANT (Actor-Network-Theory) to elaborate on disability and ability. We propose to implement the ANT point of view into our perspective to re-examine the mentioned models.

How do these different models influence an understanding of and active contributions within or amongst the disciplinary fields surrounding design and disability? How is this linked to certain “properties” of these fields?

Situation and Disciplinary Properties

Whenever it comes to combine the two parameters “Design” and “Disability”, discussions immediately turn to focus on what can generally be summarized under terms like “Universal Design” (Erlandson 2008, Herwig 2008, Mace et al. 1991), “Design for all”, “Design for accessibility”, “Barrier-free Design”, “Transgenerational Design” or “Inclusive Design” (Imrie/Hall, 2001). Despite the terminological and sometimes normative differences of these, Mitrasinovic (2008, 419) finds that “the ethical principles are analogous across countries and regions”.

According to our argumentation we consider these in the broader sense again to be summarized as Design *for* Disability (DfD). Meaning, that projects in such fields primarily focus on design development that is intended to protect people with disabilities from being excluded from “using” certain designed objects, processes, services, systems or environments.

Complementary to DfD we propose an approach that could simply be summarized as Design *by* Disability (DbD), meaning, that (not only) Design could be generally and specifically inspired by Disability, or better: by experiences linked to certain disabilities.

However in this regard we also acknowledge the existence of the opposite, which could be called Disability *by* Design. While Caspers (2006) describes how Design can provoke disability, and Anderberg (2005, 4) claims that “technology and design can […] be seen as mediators of disability”, Jöhnsson (2005) sees “artefacts as being imprinted with the goals, visions, and thoughts of their constructors. […] No neutral carriers of information”. Technology and its artefacts thus influence on the individual. They “affect how we relate to things and people […] and how we perceive the world. […] From a socio-cultural perspective, we learn and develop by using cognitive resources that are incorporated in the artefacts as information, procedures and routines. Our way of thinking is guided and coloured by the intellectual and physical tools we use”. (Säljö, 2000; in: Anderberg 2005)

The complex correspondence of the individual and technology within the world of artefacts is described at Goggin and Newell (2003), who explain the example of how the wheelchair can be “theoretically regarded as an aid to mobility”, but as an effective enabler it can only be regarded in a system where the environment is adapted to wheelchair use: “Without the necessary pavement, curbs, ramps, and funding of so-called access, the wheelchair as a system has different meanings and effects” (ibid.).

The correlation of body and space in this context is described by Freund (2001), who claims that spatial organisation constructs bodies and offers bodily possibilities and constraints: “The body is not simply a culturally constructed representation nor is it physically shaped like clay by social force, but it is experienced and 'lived-in' differently in various socio-material environments and material cultures (e.g. technologies)" (Freund, 2001; in Anderberg 2005).

We can therefore assume, that disability occurs not least through influence by design and culture (e.g. built environment). As Anderberg (2005, 5) states: "The body and the various technical artefacts around us make up a system that enables or disables us to perform desired actions".

As a "manifestation of economical, political, social and cultural concepts and individual wishes and ideas" (Anderberg, 2005, 5), technology (and design), its consequences, its use and meanings become important for disability studies. Anderberg (2005, 5) complains that the Disability Studies Community fails to directly acknowledge the importance of technology and design for the field, which (if so true) would be unfortunate, because "technology and design are too important to be left only to the technicians and designers; it cannot be seen as being separate from other instances of the culture we live in. Technology and functional aids belong in the heart of Disability Studies." (ibid.).

As far as to our knowledge, the acknowledgement of technology (and Design) within parts of the Disability Studies Community has been evolving. Nevertheless we still assume Design as to be very important for the inclusion into Disability Studies. We like to mention two reasons for that: First, the consequences and correlation of Design and Disability, as we described, are very complex and not to deny. That means secondly a high potential of societal interventions and active change of situations, not least through the help of design.

In order to be able to analyze the correlation, the impact and the relevance of demographic and socio-cultural categories, especially concerning aspects of disability, on form and practice of design (process), as well as its effects on usage and practical use of design within these categories, it could be helpful to define and understand the relevance of the scientific approach of disability studies to design research (and vice versa), by taking a closer look to disability studies' fields of interest and 'self definition':

Carol Gill (1998), underlining that Disability Studies are based on the social model, points out, that disability in every society is being defined through a complex interplay of political, economical and cultural values. Thus Disability Studies are interdisciplinary, meaning that the construction of disability needs to be examined not only from a medical or pedagogical point of view, but also from the perspectives of e.g. sociology, law, economics, literature and media studies, historical or cultural sciences.

Disability studies therefore focus on the social/political/economical/cultural context of disability. A major goal is not, to avoid, optimize or heal certain individual impairments, but rather to critically analyze the social processes of disability. The analysis shall be less intended to find solutions to 'correct' disabled people, but rather to generally find ways out of excluding social systems and processes (Gill, 1998).

We argue that our approach of combining the two disciplines Design Research and Disability Studies might not least contribute to the latter intention, by additionally substantiating and clarifying an enhanced and reflected understanding of disability.

Design Research is especially destined to be complementarily involved in the Disability (Studies) debate, since it is not only descriptive (like Disability Studies could be occasionally recognized as), but also projective and proactive. Nevertheless this implies certain requirements to the discipline of Design Research, first of all a methodology that allows dealing with uncertainty, ambiguity and complexity in real-life situations.

However helpful for design's involvement in the disability debate, is the awareness of design's general stance and relation to "problems".

Problem Solving and Problem Making

Pullin describes how Disability can provoke problems in people's lives, either directly or indirectly. However such problems are "either viewed as being inherent in an impairment itself or as being created by the designed environment and other people's behaviors". (Pullin, 2009, 41) This point of view stands in close relation to Schillmeier's (Waldschmidt/Schneider, 2009, 17) characterization of dis/ability as an event which connects “social and non-social relations of human and non-human actors”.

In the different disciplines dealing with disability, we recognize different approaches and understandings of disability. These stand in close relation to their respective educational backgrounds. Medical engineers for instance seem to be attuned to problems. After Pullin, a typical engineering methodology might start with “*Step1: problem definition*, followed by *Step 2: solution generation*, and so on”. The discussion, to what extent design is to be defined in its broadest sense as problem solving, has been going on for a long period (Antonelli 2008; Funke 2003; Heufler 2005; Mayer 2004). Diefenthaler (2008, 307) claims that the problem solving process in design is “seldom linear because evaluation techniques are an essential feature. The varieties of possible solutions originate for the most part as short-term proposals ”which she relates to the fact that a design process is not always and “only influenced by a rational, analytical work method, but also by an emotional, intuitive process” (ibid.). While ongoing discussions seem to seek the role of a designer between the two poles of a designer as a “Problemsolver” or “Sensemaker”, Antonelli adds a third role, which is the “Problemmaker”. (Antonelli, 2009). An interesting alternative to the (long ago insufficient) term “Problemsolver” and the (also not really satisfying term) “Sensemaker”: The concept of “problemmaking” becomes especially interesting, since it contains two meanings: First, the acknowledgment of Rittel’s *wicked problems* (Rittel, 1973) and second, the idea to cause problems on purpose for instance by irritating people (respective users). The latter is described by Bredies (2008), who argues that “Innovative artefacts without established cultural conventions will necessarily irritate the user to a certain extend. […] Designing innovative artefacts therefore provides an area where designers can exploit the irritating moment as an opportunity” (in context of Bredies’ Paper: for co-design in use).

We will argue in our paper, that without completely denying the aspect of “problem solving”, the concept of “problem making” is of high potential for approaching disability in context of design, as well as it is for backing up the societal process of modifying general perspectives on disability.

Because of the “nature” of disability and the “culture” of engineering, Pullin (2009, 41) sees design for disability and inclusive design as “usually approached as an exercise in problem solving […] This also has something in common with the clinical tradition of diagnosis and treatment”.

We therefore agree on the point, that some of the challenges facing design for disability might “not best described as *problems* to be *solved”* and that “issues not easily defined as problems are likely to be overlooked” (Pullin, 2009, 41).

However in our general understanding and in the specific understanding that laid the foundations for our project, we do not (only) focus on *design for disability*, but wish to widen the research area in a sense of *disability by design* – *design by disability*. Now, why doe we propose and how are we going to achieve this?

Convergence – Design Knowledge and Disability Knowledge

Not all design, and especially not design research, is about solving problems. According to Fällman (2008) the process of a design research project can be seen as a triangular model defined by the activity areas of “design practice”, “design studies” and “design exploration”. The latter may still require solving problems that arise along the way, but “frequently as a means to an end rather than as an end in itself” (Pullin, 2009, 43). We may localize here a “subtle yet fundamental inversion of engineering methodologies that will usually include a creative exploration of alternatives, though as a means to the end of solving the core problem” (ibid.).

However a Designer may “revisit an object, a material, or a medium that has already been successfully designed, designed with, or designed within […] before, in which case the value does not lie in solving an unsolved problem” (Pullin, 2009, 41). Especially Design Researchers may as well explore completely new fields, whilst potential questions or problems to be solved might appear not until the research process has been going on for a while already.

Many art and design school disciplines, for instance, involve exploration that can appear playful, vague, experimental and open-ended, but its intent may be no less serious for possible results to gain from it.

We believe that such exploration approach, which seems to be characteristic for design research, could be an enriching input for Disability Studies. On the other hand, the design exploration could receive important input from Disability Studies' social or integrated model perspective, for widening the spectre of possibilities by simulating or experiencing different role perspectives.

The Design-Research-from-a-Disability-Studies-perspective or the Disability-Studies-from-a-Design-Research-perspective might even be imaginable in a sense of an *about/for/through*-model (Fig 1): While Research *about* Disability would represent a rather critically analytical view on disability, possibly but not necessarily based on the social (or integrated) model, Research *for* Disability would represent the medical-engineering-, problem-oriented perspective, possibly but not necessarily based on the medical model. This second point of view might occasionally also apply to what we summarized before under DfD, but we admit that this might not generally be the case and maybe still has to be discussed). The third point of view would be Research *through* Disability, basically analogue to what we described before as Design *by* Disability. It would represent the most explorative part, where Design Research could provide a broad spectre of methods (empathic modelling, capability simulation, visualisation, prototyping, etc) to understand disability in a productive sense. It would be the field, where we could learn from Disability (better: from certain disabilities) in order to transfer knowledge into general or specific other fields (e.g. transfer properties from blind navigation into digital navigation systems).

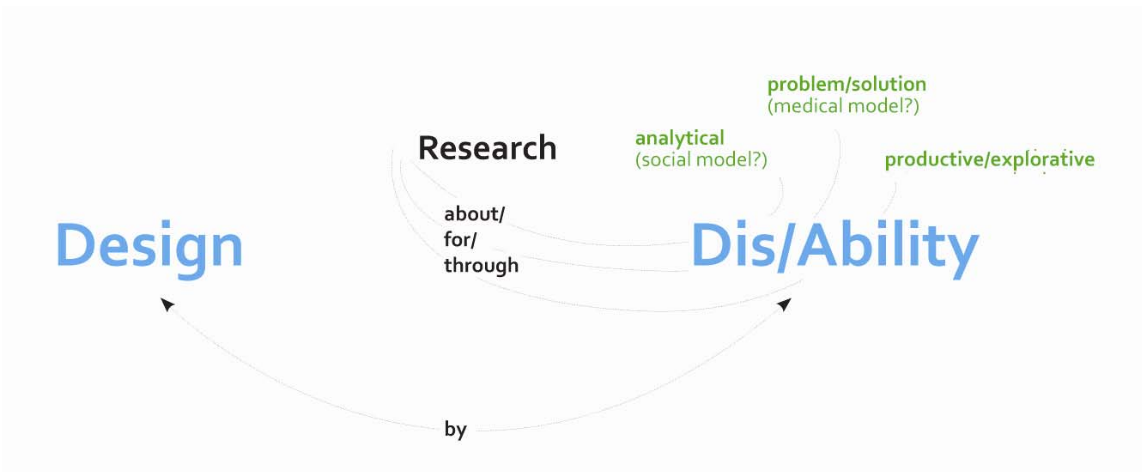

Fig 1 Research about/for/through Design and Dis/Ability

However we must obviously consider disciplinary differences in how we produce knowledge and how we use it.

Thoutenhoofd and Naue (2007) describe how knowledge is socio-culturally and socio-linguistically shared as much as it is empirically demonstrated and peer-validated. They claim that "lived experience is centre-staged as a bottom-up or grass-roots form of knowing that is as often intuitive (or 'native') and phenomenal as it is reflexive and objectified." In their explanation, Thoutenhoofd/Naue (2007) describe deaf and disabled people as subjects of "highly formalised, normative kinds of knowledge practices – in fields as diverse as medicine, economics, biology, education and psychology – which do not speak *with* them, but *about* them (or worse, *for* them). […] Knowledge within these fields is of the body as a site of multiple meanings that fractures any coherent sense of self and identity. In this third scholarly formation knowledge is essentially derivative of professional practice."

Design Research may also offer descriptions and explanations of what naturally or culturally exists, but unlike traditional science, Design aims at producing and conceiving artefacts. As Simon describes it as an "action aimed at changing existing situations into preferred ones".

Design explores different possible solutions for a problematic situation (The definition of "problematic" is certainly a matter of perspective). Unlike traditional social sciences, it is rather about 'what can be' (and how it can be), than about 'what is'. This stance about a future world state does necessarily involve uncertainty. Since knowledge about an existing situation "does not necessarily lead to knowing how to change it, design knowledge […] needs to be useful not only to inform reflection, but also anticipation and projection of those who design (DRLab, 2009).

Thus the knowledge produced in Design Research aims to inform and enable present and future design practice. It is therefore not only descriptive, but also projective. In other words: "it transcends the present to enable projective actions" (ibid.).

Method

In order to disentangle the complex construct of guiding questions within the range of the two parameters "design" and "disability", we fragment it into sub-questions which again shall lead to sub-answers. With this rational method (Descartes), we draw parallels to Choopankareh's (2006) approach: The human subject as part of a society on one hand is being put into relation to the product/artefact as part of the environment on the other hand. In our research project we shall examine disability as a societal phenomenon leading to a complex of problems for (certain) individuals, in order to find out, what role design can play in that context.

In order to face the resulting subdivision into two relations – "Human - Artefact" and "Disability - Design" – we propose to implement these into Findeli's model for design/research questions/answers (Findeli 2008). If we took for example the following as a research question: What can Disability and Design learn from each other? Then, this broad question could be framed into several specific design questions, for example: How can we generally transfer knowledge from Alternative and Augmentative Communication (AAC) into human-computer-interfaces or specifically into ICT-Devices? Or more precisely: What functions (or aesthetics etc.) can an electronic device contain, that is inspired by certain disability related aspects? The possible design answers may here, in turn, be helpful in answering the research question(s).

In our case study, we laid a strong focus on empathic modelling, capability simulation, prototyping, visualisation, interviews or audio- and video-documentaries. In the following we will give an overview about three of our different method approaches (Collaborative workshops with experts and non-experts; Self-Experience; Fictional and non-fictional Input) and describe their application in the respective case. The results show how the methods help designers to structure and organize information about the context and identify productive opportunities of understanding, intervention and transferability for design.

Collaborative Workshops with Experts and Non-Experts

During the first project phase, we have been working together with deaf people (in collaboration with *Sinneswandel* a Society to support deaf and hard of hearing people, as well as with students of Deaf Studies at *Humboldt University* Berlin. The enhanced visual sense, the three-dimensional communication space, as well as linguistic and psychological particularities (Koller, 2009) constitute the main focus of this project phase.

In addition, we developed workshops with sighted and hearing people (Fig 2 + 3). By consciously deactivating certain senses or bodily functions (e.g. blindfolding), our aim was to gain knowledge for designing interactivity. One or more impaired senses sharpen the remaining senses (Montessori, 1952). This can lead to individual skills that differ from common ones. A deaf person for instance, might not hear the music in a discotheque, but in comparison to the hearing people, he or she can to a certain extent easier communicate during the loud music – even over distance.

Some of our guiding questions were: How to navigate without seeing? How to communicate without spoken or written language? These questions were meant to lead us to more general aspects: How can we change or widen the function of an interface? How can we transfer concepts into navigation systems or communication device?

Both types of the workshops were based on a participatory design approach. Whilst the workshops with 'non-disabled' people focused more on explorative aspects, the main focus of the workshops with Deaf people was on actual Co-Creation.

Thus in our workshop approach, we follow a two-poled model of participation, by collaborating with disabled people as experts (e.g. through ethnographic observation), and with non-disabled people as non-experts (e.g. through simulation or empathic modelling).

Figure 2

Figure 3

Fig 2 How to reduce complexity and thereby avoid confusion caused by missing language skills? In this workshop the participants (age: 6-11 yrs) explored the idea of communication without written or spoken language, using visual communication and symbolic language.

Fig 3 In another workshop the participants produced prototypes in context of touchable and sensitive surfaces. How should certain functions or situations become tangible? Therefore they tried out different material and haptics (e.g. hard, soft, cold, rough, clean, even, flat, uneven, flexible etc.).

Self-Experience

In our research project we claim »action« as an important part to actually experience and understand the diverse perspectives that we collect. While we link these to existing knowledge and theory, and then synthesize the assumptions in roughly estimated principles, before we selectively involve external people in collaborative workshops, we try to experience as much on our own as possible. As an example we will present impressions and insights in extracts from our video documentary “One Day blind in Berlin” (Fig 4).

Fig 4 Standing next to a speaker, not being able to see, leads to a different posture of the head

Another example is our experience in Sign Language: One way to deal and to engage with a new communication system is to learn it. Therefore, we have been attending Sign Language classes, which has been a revealing experience physically as well as theoretically. It already gave us the chance to gain insights into the visual and expressive language of deaf communication, the deaf community and culture, as well as, how disability offers new horizons and perspectives to alternative ways of communication.

Fictional and non-fictional Input

As another important tool for our topic exploration, we organize so called *Disability Movie Nights*, where we show and discuss film-related material close to our field of interest. The material we show and watch may range from films, documentaries, short movies, video art to music clips.

We identified these film screenings as a helpful method to dive deeper into a topic and to inspire the design research process, since both the shown material and the involved audience broach the issues of different (external, internal, expert, non-expert, poetic or scientific) positions.

It is generally claimed that movies have an effect on people. Against this background, we see a possibly fruitful connection between science, mainstream and screen fiction. Depending on the platform, it allows different transfers: A documentary e.g. could underline the more analytical part (»What is?«), whilst a fictional movie could represent a rather projective part (»What, if…?«). Thus, we use film screenings for both a deeper understanding and associative thoughts.

Transfer / First Results

The methods we used for exploration and production so far are generally based on a human-centred and participatory design approach perspective, as described in “Collaborative Workshops…”. Nevertheless we maintain a cultural studies perspective in our process, as described in “Fictional and non-fictional Input”.

As Design knowledge has different kinds of representations, the form of our knowledge collection ranges from more theoretical (principles) to more practical parts (specific configurations). Besides our verbal argumentation we therefore argue through visual or multisensual representations, like for example sketches (Fig 5-8), images, videos (Fig 9) or prototypes (Fig 10).

Thus in our research project, we have so far been developing concepts for service- and product-solutions, that might help to overcome some of the limitations caused by bodily impairment on the one hand, and help to enhance the communication and locomotion of “non-disabled” people on the other hand. We aim to open up new perspectives in HCI and add a completely new aspect to design driven inquiries in two respects:

1) By taking bodily impairment as a source of inspiration for the development of Information-Communication-Technology (ICT) in matters of human communication and perception

2) By investigating augmentative and alternative communication (e.g. sign language) from an interfacial point of view. (Bieling, 2009)

After collecting various data, including basic theoretical knowledge, experience based impressions, survey based information and collaborative workshop grounded results, the next step after analysing and interpreting has been to actually find out how to evaluate these data and synthesize them for possible design solutions.

In our investigation for example, we collect different characteristics of deaf communication that seem to be special from a non-deaf perspective. In the following we summarize and classify some of the important characteristics of deaf communication we found (Koller 2008). We claim that it might be interesting, whether these characteristics could be relevant for the communication of hearing people, for the future design of human-machine-interfaces or in design in general.

Relevant for communication of the Hearing:
. Discrete and focused communication, despite variable distance
. Attention control
. No constraints through loudness

Relevant for human-machine-interfaces:
. Referencing objects and persons in signing space
. Definition of pronominal references in signing space
. Concept of time in signing space
. Dividing the signing space into categories of valuation
. Roll change
. Lifting, lowering and projecting the signing space
. Whisper and Scream in Sign Language
. Plural by repetition
. Temporal aspects for the variation of sign language
. Object placeholders (classificators)
. A high amount of the singings can be differentiated by (body) movement
. Non-manual means of expression

Of general interest:
. Advantage in occupational fields with focus on visual work
. High information density through additional visual
support
. Impact on well-being
. Visual Rhythm

After several workshops, the project resulted in various physical, visual and audiovisual prototypes that contributed to visualising the findings and theories explored.

Using the examples mentioned above as a basis for concepts, transfers and solutions, we will present in the following some results from our ideation sessions. An appropriate feasibility check needs to be done as next step. However it is rather important is to imagine concept and solutions, even though some of them might lie ahead. Subsequent, in apparent cases, we will analyse technical methods for solutions.

In the following, we collect some illustrations, resulting from our ideation.

Fig 5: Potential for deaf/non-deaf: high/high

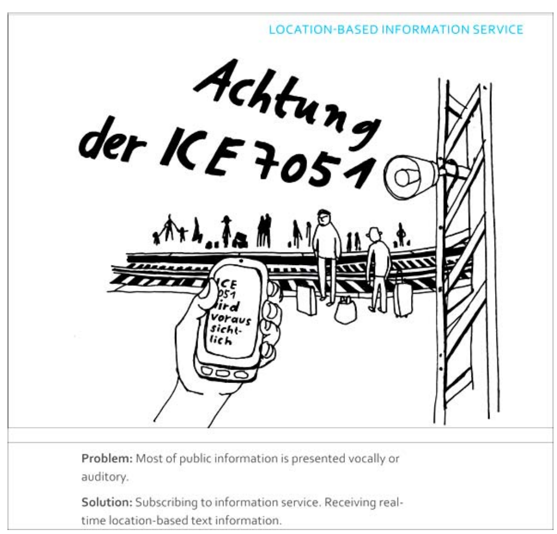

Fig 6: Potential for deaf/non-deaf: very high/very high

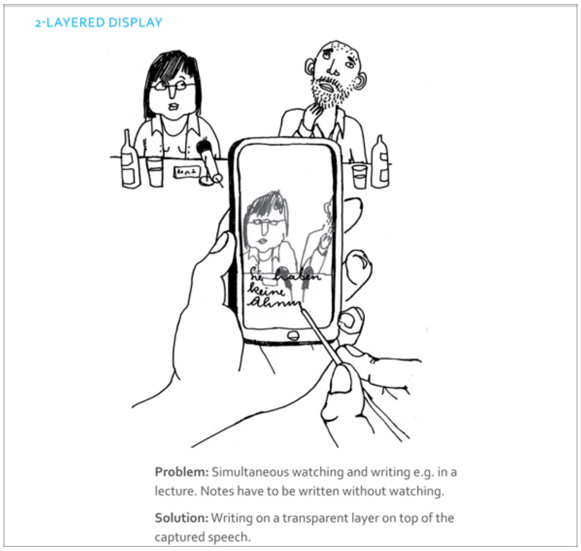

Fig 7: Potential for deaf/non-deaf: med./medium

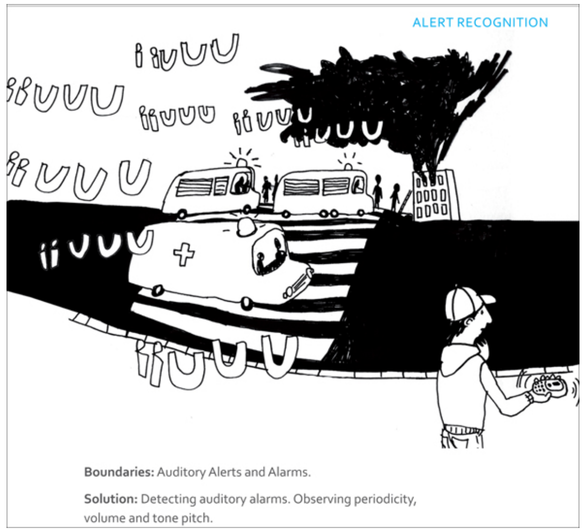

Fig 8: Potential for deaf/non-deaf: very high/medium

Figure 9

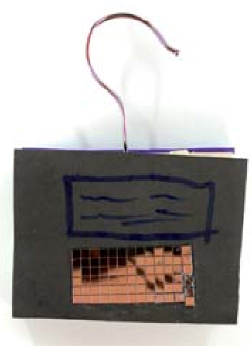

Figure 10

Fig 9 Video Prototype "Virtual Placeholders". The concept of referencing objects in 3D signing space is conceivable for applications in HCI.

Fig 10 Prototype "HangUp" helps to support deaf communication. But also non-deaf people could use such device, for example while cooking driving or working.

Conclusion

Our research project opens up a wide field in the learning field about properties of alternative and augmentative communication. It becomes obvious a high potential of knowledge about and systematic use of such systems of communication (Bieling, 2009a), to open up perspectives for designing human-machine-interfaces in particular, as well as for design research in general.

The transfer of such concepts from augmentative and alternative communication, not least to HCI, can serve designers, engineers, pedagogues in various ways. First of all it can help to overcome communication barriers (by a technique of mediation or translation). Moreover, it opens up new perspectives in learning (language, dialog, cultural/behavioural differences etc.). Furthermore, it widens the spectre of interactivity with the help of human interaction patterns, that are (if not intuitive) at least easy to learn and that have already been proven to function in certain contexts of human (e.g. deaf) communication systems.

For example Sign Language can be an input to human and human-machine-interaction, since it contains transferable rules for syntax and semantics and therefore alternative possibilities to collect, impress and present thoughts. It also enables to use different organs and parts of the body.

Not least in this project, our aim is to find out to what extent we can provide and use a confrontation with and through design within such processes, to evolve innovative methods, products/services and communicative models.

Based on these insights, our research project shall sensitise the design profession as well as related disciplines to realise the various perspectives for HCI, ICT and general human communication as well as for social inclusion through design research, inspired by observations on so called disability.

If we, as e.g. interface designers, understood more about communicative variations caused by bodily impairment, we might be able to create systems that enrich general human communication, by transferring and combining properties of such different variations.

By recognizing disabilities as expertise (e.g. a blind person as an expert in navigation through the dark; a Deaf person as an expert in communication in very loud environments), Design Research in collaboration with Disability Studies might contribute towards an advanced, reflective understanding of disability.

By exploring disability from an ›out-of-center‹ position, we aim to use it as a “knowledge-constituting moment, for the analysis of the (majority of) society”. (Waldschmidt/Schneider, 2009, 15). Siebers (2006, 64) points out the importance to “establish disability as a significant value in itself worthy of future development”. Especially in view of the future challenges of genetic engineering, reproduction and bio-ethics, we might have to reformulate questions concerning disability in modern, medicine-technically dominated societies. What characterizes disability in times of re-inventing the human body? And how do we have to evaluate societal meanings of ›embodied difference‹?

Linking Design Research and Disability Studies to explore ›embodied difference‹ leads towards knowledge, that is relevant not only for the so called ›persons concerned‹, but for the whole society. “Knowledge about disability and the relation between difference and normality […] gives fundamental information about the relation of the individual, society and culture” (Waldschmidt/Schneider, 2009, 13; loosely translated). Thus it leads towards knowledge about im-/possible (use of) things, interactions or configuration of processes and artefacts.

Appendix

As already mentioned above, some of the arguments concerning the fields of design and disability have been discussed in the context of “Universal Design”, “Design for All”, etc. These design approaches shall not be seen as oppositional but rather complementary to what we propose in our paper. However in our research project our aim is to emphasize on certain aspects that are not totally covered by the mentioned approaches. For instance one major focus in our topic is to determine how design can influence (and therefore maybe change) e.g. scientific, political or societal definitions and attitudes. We strongly believe in hybrid research settings and shall furthermore analyze how to use knowledge from other fields such as disability studies in design research. And vice versa: how to transfer design knowledge into other fields.

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Dynamique forme-lumière:

Un processus de création et d'analyse de l'espace architectural par modèles maquettes/images

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Demers, Claude M.H., Université Laval, Canada

Résumé

La recherche propose un regard sur l'objet et la lumière à travers l'élaboration d'une méthode de design et d'analyse spatiale aidant architectes, designers et artistes dans leur exploration créative. Elle tente de réinitialiser le processus de création par des manipulations simples et directes avec la matière, et une expérimentation en maquettes et en images photographiques, deux médiums familiers des architectes et designers. Ces interventions minimales recèlent à la fois une grande richesse de relations spatiales et de nombreuses informations sur le phénomène lumière. Une collecte de plus de 200 compositions spatiales est soumise à l'analyse. Un lexique de paramètres est formulé à partir de notions théoriques relatives à l'espace, l'objet, la lumière et la perception, sous forme de grilles d'interprétation. Celles-ci servent de cadre d'analyse permettant d'identifier les éléments les plus actifs en interaction dans l'espace visuel. Elles orientent la lecture de la complexité spatiale et agissent comme balises dans le processus de décision/création. Le vocabulaire élaboré aide à préciser la nature des interventions et sert de plate-forme d'échange entre les collaborateurs. Ce processus vise également à stimuler l'imagination et la créativité en architecture et en design.

Mots clés

Espace architectural; Méthode de design; Créativité, Perception visuelle; Analyse spatiale; Ambiance lumineuse; Forme; Analyse d'images; Photographie digitale

Dynamic between objects and light

A process of creation and analysis of the architectural space by models and photographs

Summary

The research proposes a look at the object and the light through the elaboration of a design method and spatial analysis helping architects, designers and artists in their creative exploration. It tries to re-initialized the creative process by simple and direct manipulations with matter, and an experimentation with models and photographic images, two familiar mediums of architects and designers. These minimal interventions simultaneously present richness in spatial relations as well as information on luminous patterns. A collection over 200 spatial compositions are submitted to analyses. A lexicon of parameters is formulated from theoretical notions related to space, objets, light and perception, in grids of interpretation. These serve as frame of analysis allowing to identify the most active elements in interaction the visual field. They direct the reading of the spatial complexity and act as beacons in the process of decision / creation. The elaborated vocabulary helps to specify the nature of the interventions and serves as a platform of exchange between the collaborators. This process also aims at stimulating the imagination and the creativity in architecture and in design.

En tant qu'initiateurs d'espaces, les architectes et designers sont confrontés à une multitude de facteurs qui doivent être pris en considération lors de l'élaboration des projets. La recherche s'intéresse particulièrement à la partie créative, en tant qu'exploration, invention et requalification dans le processus de design. Cette étape importante dans la formulation d'une œuvre entière permet d'élaborer des solutions esthétiques aux besoins des usagers.

Les balises et outils d'analyses d'aspects qualitatifs liés à l'approche créative étant peu développés, la recherche vise à offrir de tels outils comme support au processus de création, à travers un cadre structuré organisant la lecture de l'espace visuel par étapes. Face à la complexité liée aux nombreux paramètres de spatialité et de perception visuelle en interaction, cette recherche propose de circonscrire plusieurs d'entre eux pour en définir les actions (tableau 1). Peut-on isoler certains paramètres plus significatifs pour qualifier l'espace? Il est reconnu que la vue constitue actuellement le sens dominant notre perception du monde (Pallasmaa, 2005). Architectes, designers et artistes sont particulièrement sensibles à la relation spatiale et perceptuelle entre la lumière et l'objet. Ces deux éléments se complètent et se modifient de multiples façons, et leur potentiel esthétique est reconnu. Comment lumière et objets sont-ils en interaction et se révèlent-ils l'un l'autre? Quels caractères apportent-ils à l'espace? Comment est-il possible d'analyser ces interactions? La recherche propose deux moyens d'approfondir cet univers. Une expérimentation en maquette avec images photographiques numériques sert de matériel d'analyse. Des grilles d'évaluation et des traitements d'images servent de guides à l'interprétation visuelle et spatiale. La méthode permet de caractériser les ambiances lumineuses, de mieux les cibler et d'élaborer des solutions esthétiques pour mieux les articuler. Elle permet également d'appréhender la relation objets/lumière comme un moyen de créer des espaces plus stimulants.

Contexte de recherche

La séquence temporelle et spatiale sert entre autres à construire des images mentales pour comprendre et définir le monde physique qui nous entoure. Lors de la perception de l'espace architectural, la formation d'une image globale dérive de l'intégration d'une multitude d'images fixes (Arnheim, 1986; Bell, 2001; Gibson, 1950). Pendant le parcours ou la séquence spatiale, certains espaces manifestent cependant une plus grande intensité émotionnelle que d'autres. Par leur géométrie, leur lumière, leurs formes et leurs matériaux particuliers, ces espaces deviennent « primaires », tandis que d'autres sont « secondaires », créant une certaine hiérarchie. Dans ces espaces dominants, le champ de vision d'un occupant est stimulé par des configurations spatiales attractives et uniques. Un design bien conçu de ces points de vue « stratégiques », comme point de repère, a donc une portée très significative sur l'impression d'ensemble du bâtiment et sur le comportement de l'occupant. Le travail de la création de points de vue architecturaux particuliers oblige à s'intéresser à ce qui, dans l'espace, représente le plus d'intérêt visuel. Pour ce faire, l'utilisation de maquettes permet de concevoir certaines configurations spatiales et l'emploi d'images photographiques devient une sélection de points de vue fixes représentant l'espace architectural.

Lors de la conception, bien que la modélisation informatique a l'avantage de réduire le nombre de manipulations matérielles et d'être précise, le temps de modélisation est parfois long en situation complexe. Le résultat donne un aperçu général de la réalité, mais n'introduit pas tout le côté sensible et tactile de la matière. La subtilité des phénomènes et leurs interactions ne peuvent être intégrées, puisqu'ils ne peuvent être programmés, étant trop complexes (Demers, 1997). Parallèlement au monde virtuel, la manipulation par maquettes demande moins d'expertise et de précision et condense en un seul temps, une large part de la complexité de l'interaction matière/phénomènes physiques (Zevi, 1959; Holl, 2000). Le phénomène lumineux n’étant pas physiquement influencé par la différence d’échelle, les maquettes sont d’autant plus pertinentes à ce niveau. Le point de vue unique de la photographie permet, quant à lui, de porter une attention particulière à certains détails et d’évaluer l’assemblage de la composition de l’espace architectural (Michel, 1996). La photographie comme mécanisme, se rapproche en partie du fonctionnement de l’œil humain, entre autres par une sensibilité à la lumière, un système de diaphragme, de lentilles, une zone de précision centrale, une vision de la profondeur (Michel, 1996; Frisby, 1981). Par contre, la sensibilité à certaines longueurs d’ondes, aux couleurs, au seuil de faible intensité lumineuse et la capacité d’adaptation, sont des mécanismes qui peuvent différer (Michel, 1996). Malgré cela, la photographie demeure tout de même un excellent moyen de traduire la vision humaine (Demers, 1997). La version numérique de la photographie, quant à elle, offre la possibilité d’ajout de traitements numériques pour mettre en valeur ou révéler certaines structures de composition en action dans l’image. L’acte photographique peut donc constituer à la fois une prise de données et un premier filtre du regard.

La méthode partiellement informatisée avec maquette et images numériques est donc simple et accessible. Elle se rapproche à plusieurs niveaux de l’expérience spatiale et visuelle réelle et rassemble plusieurs phénomènes complexes.

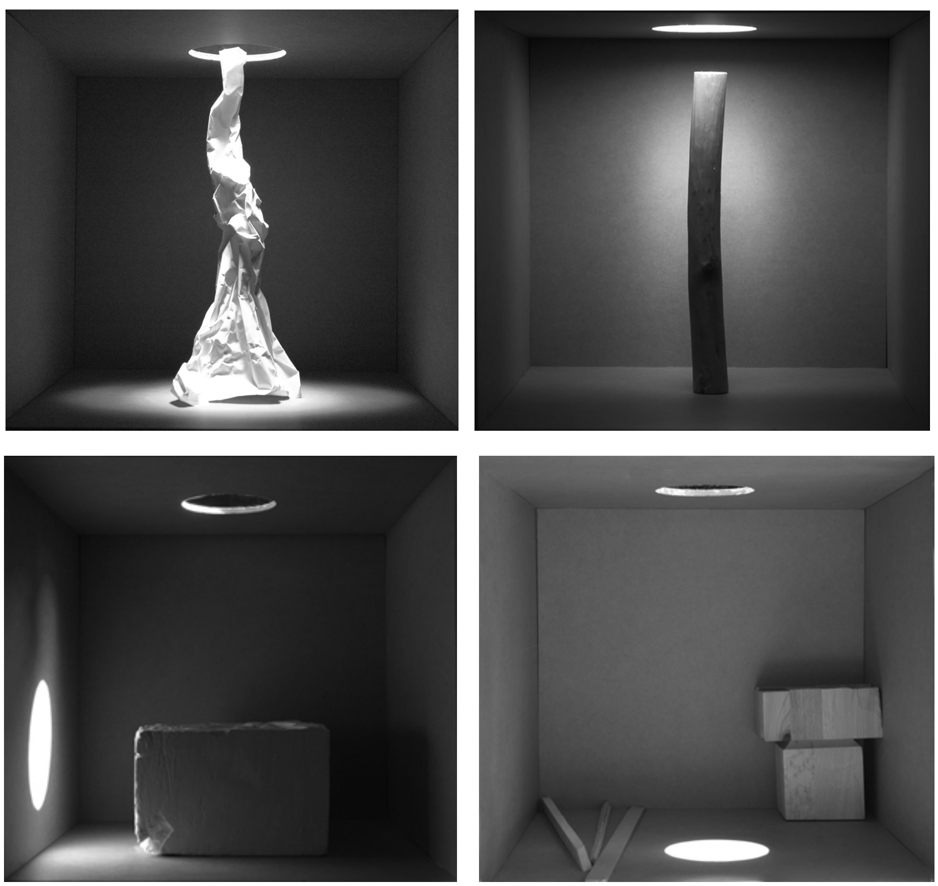


Figure 1. Points de vue de maquettes de l’expérimentation. Matériaux : papier, bois, plâtre. Lumière directe. Ouvertures zénithales.

Théorie-Méthodologie

Thèmes de création

La recherche propose une schématisation d'acquis théoriques et de qualificatifs liés à la perception visuelle, l'espace, l'objet et la lumière. Cette schématisation condense et structure une complexité d'informations. Ainsi, quatre thèmes de création interdépendants émergent : les éléments spatiaux, d'attention visuelle, de composition et d'ambiance. Sans être réducteurs, ils peuvent guider la construction, la description ou l'analyse d'un espace ou d'une image.

Éléments spatiaux :
Le concept d'espace est à l'opposé du vide. Au cœur de l'idée d'interrelation entre les éléments physiques en architecture, il est un lieu de relations entre objets perceptibles se définissant par leur référence les uns avec les autres. Selon Arnheim (1986), une partie de ces interactions est créée par un rayonnement spatial des objets, selon leurs formes, leurs dimensions et leurs distances. Ce concept de champs de forces, bien que peu exploité dans les analyses spatiales, influence pourtant la perception (Arnheim, 1986; Meiss, 1993; Cousin, 1980). Arnheim donne en exemple : un objet courbe peut avoir une extension spatiale interne centripète et une extension spatiale externe centrifuge, chaque rayonnement influençant les objets environnants. Une rencontre de plusieurs rayonnements crée une certaine densité spatiale. Les actions des objets représentées généralement par des extensions linéaires dans la typologie d'Arnheim, sont transposées graphiquement dans cette recherche (Biron, 2009).

Éléments d'attention visuelle:
Le concept d'attention visuelle est fondamental. Plusieurs études démontrent que le processus de compréhension de l'espace est influencé par la sélection d'éléments dans le champ visuel (Lam, 1992; Weber 2002; Livingstone 2002; Michel 1996). Ces centres visuels ou éléments d'attention nous permettent de faire rapidement le tour d'un environnement en le décomposant en points de repère pour amorcer la compréhension, le classement et la catégorisation. Ce sont entre autres, les contrastes et luminosités élevés, les masses proéminentes, les objets tridimensionnels, les formes simples, isolées, les couleurs vives. Le concept d'attention visuelle est au cœur de la recherche et de l'analyse des éléments dominants et structurants l'espace physique et visuel.

Éléments de composition:
Les éléments de composition, sous les dénominateurs communs tels la verticalité, l'horizontalité, la symétrie, la forme concentrique ou excentrique, par exemple (tableau 1), sont reliés à différents états physiques de notre corps (gravité, axes corporels, état passif horizontal, état actif vertical) qui en est la référence. Ils structurent et orientent notre compréhension et notre perception de l'environnement, par la gradation des hauteurs, du poids et des déplacements. Ainsi, les éléments de composition visuelle expriment soit un mouvement, une direction, un axe, une orientation, soit un arrêt, une zone, une surface, un point fixe (Arnheim, 1986; Cousin, 1980; Meiss, 1993). Ces deux états opposés accompagnent continuellement la perception de l'espace architectural. Dans cette recherche, directions et zones sont aussi appliquées à l'analyse qualitative du comportement de la lumière, afin d'estimer son action dynamique.

Éléments d'ambiance :
Les éléments d'ambiance visuelle concernent différents états et qualité de la lumière en rapport à l'espace qui la délimite. Ainsi, les facteurs d'intensité, de contraste, de distribution ou de qualité par exemple ont une grande influence sur la sensation globale de l'espace et sur la perception des objets présents. Ces états de la lumière sont intimement liés aux ombres qui sont en soi visuellement inséparables.

Le dynamisme spatial concerne donc plusieurs facteurs: l'extension spatiale des objets s'influençant mutuellement, le mouvement de l'œil dans la recherche d'informations entre les points de repère importants, la direction et la position des formes objets et lumière, structurant l'espace et le champ visuel par rapport à nos axes corporels et la qualité des stimuli dans l'environnement observé.

Grilles d'interprétation

Ces grands thèmes de création découlent de concepts théoriques identifiés selon une revue littérature et une analyse théorique de Biron (2008). À ces thèmes correspondent des paramètres spécifiques élaborés entre autres par des auteurs tels que Arnheim, 1986 (champs d'influence et rapports de force entre les objets), Lassance, 1998 (familles lumino-spatiales), Louis, 2003 (natures dynamiques des formes architecturales), Lecas, 1992 (modes de perception et d'attention visuelle), Michel, 1996 (design des espaces par la lumière) et Demers, 1997 (méthodes d'analyses digitales). Leur énumération favorise l'analyse en détail et constitue la première grille d'interprétation qualitative de cette recherche. Ainsi, **la grille des paramètres** rassemble une majorité de paramètres regroupés en cinq sections ou cinq dénominateurs communs à la fois à l'objet, la lumière et l'espace. Ce sont : le type de forme, l'orientation, la localisation, l'étalement et la qualité (tableau 1). Certains de ces concepts ont été sélectionnés dans la présente recherche pour leur potentiel d'analyse digitale à procurer une interprétation visuelle préliminaire à un concept de relation espace-lumière-objet (Biron, 2009).

Dans le tableau, l'objet se distingue comme objet libre (indépendant des parois), contenant (limite matérielle et spatiale) ou ouverture (découpe dans une paroi). La forme géométrique, organique, articulée ou unique, l'orientation principale, le nombre et la position des objets dans l'espace, sont des exemples de paramètres, utiles pour caractériser l'action perceptuelle et spatiale des objets (tableau 1).

La lumière et l'ombre sont étudiées simultanément, puisqu'ils se tissent l'un l'autre. La lumière se distingue en lumière-ouverture (forme lumineuse produite par la forme de l'ouverture) et lumière-projetée (*pattern* obtenu par la réflexion de la lumière sur une surface, créant quelques fois des motifs ou dessins (figue 2). L'ombre peut être attachée (à la surface d'un objet ou corps), projetée (portée sur une surface ou un plan) ou fausse (absence de lumière) (Cassati dans Binet, 2002; Demers, 1997). Lumière et ombre acquièrent ces qualificatifs lorsque leur forme est bien définie et visuellement incontournable dans le champ visuel. On distingue aussi l'orientation linéaire, verticale, oblique, la position et le nombre d'éléments dans le champ visuel, la délimitation, la distribution ou la qualité directe, diffuse, naturelle, artificielle, comme exemples de paramètres actifs visuellement et spatialement.

La grille comporte également plusieurs paramètres relatifs à l'espace global. Retracés dans la littérature ou résultants d'effets de la lumière ou des objets, ils sont parfois abstraits et plus difficiles à évaluer, mais demeurent des indicateurs du caractère potentiel de l'espace.

Tableau 1 : Grille de paramètres et qualificatifs relatifs à l'objet, la lumière et l'espace.

	Type de forme	Orientation	Localisation	Étalement	Qualité
Objets	• objets libre objet contenant objet ouverture • géométrique/ organique • forme ou volume articulé/unique	• orientation(s) principale(s): horizontale/verticale/ diagonale linéaire/courbe/circulaire concave/convexe régulière/irrégulière symétrique/asymétrique sans orientation	• position(s): centrale/périphérique gauche/droite avant/arrière haut/ bas zénithale/latérale • gravité visuelle: forte/faible (haute/basse) • nombre d'objets: unique/multiple	• dimension grande/moyenne/ petite • proportion objet/contenant/ ouverture	• texture • matériaux • couleur • réflectance/ spécularité surfaces
	Type de forme	**Orientation**	**Localisation**	**Étalement**	**Qualité**
Lumières/ombres	• lumière ouverture/ lumière projetée/ • ombre attachée/ ombre projetée/ fausse ombre	• orientation(s) principale(s): horizontale/verticale/ oblique linéaire/circulaire rasante sans orientation	• position(s): latérale/zénithale centrale/périphérique gauche/droite avant/arrière haut/ bas • nombre d'éléments lumière et ombre: unique/multiple	• proportion lumière/ombre • motif: simple/complexe • dominance du pattern: dispersion/ concentration • délimitation: bien délimitée/ mal délimitée • distribution: uniforme/ non uniforme	• naturelle/ artificielle • directe/ diffuse • intensité lumineuse • couleur
	Type de forme	**Orientation**	**Localisation**	**Étalement**	**Qualité**
Espace	• positif/négatif • contenant/dialogue (sous-espace) • interne/externe	• excentriques/concentriques • linéaire/courbe	• positions : objet/lumière/ombre • nombre d'éléments: objet/lumière/ombre	• unité/ fragmentation • proportion formes/fond	• densité : forte/faible • Contraste élevé/faible

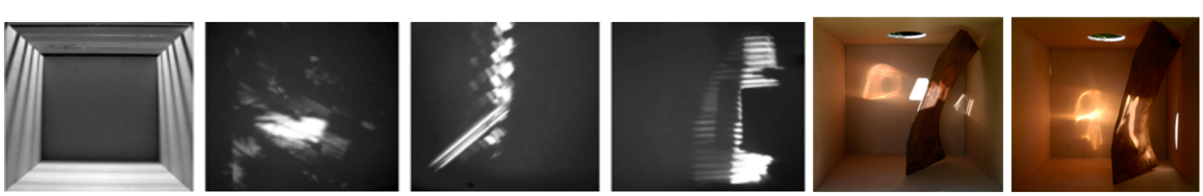


Figure 2 La production des motifs est attribuable la projection de la lumière, la forme de l'ouverture, l'intensité lumineuse et la réflectance des matériaux.

La seconde grille distribue les paramètres du tableau 1 qui peuvent être classés, en **deux types d'interprétations : les directions et les zones** (tableau 2). La recherche démontre que les éléments constituant une image peuvent être analysés sous forme de lignes (directions) et de surfaces (zones), jouant un rôle majeur dans la perception visuelle et indiquant des actions intrinsèques des formes. La direction est le sens d'action ou axe des objets et de la lumière. Elle est traduite par des flèches. La zone implique l'idée d'une région d'occupation dans l'image et l'espace. Elle est identifiée par une surface uniforme et bien délimitée.

Tableau 2 Types d'interprétation des paramètres : par direction et par zones, indiqués respectivement par des flèches et des surfaces lors de l'interprétation des espaces-maquettes.

	A- Directions	B- Zones
Objet libre/contenant/ ouverture	1 • orientation: *horizontale* *verticale* *diagonale* *concave/convexe* *linéaire/courbe/circulaire* *régulière/irrégulière* *symétrique/asymétrique* *sans orientation* 2 • gravité visuelle: *hauteur/poids*	1 • type de forme: *géométrique/organique* *à volume ou forme articulé/unique* 2 • position: *centrale/ périphérique* *gauche/droite* *avant/arrière* *haut/ bas* zénithale/latérale 3 • nombre d'objets: *unique/multiple* 4 • dimension *petite /moyenne/ grande* 5 • proportion objet/contenant/ouverture 6 • qualité de réflexions de surface: *importantes/moyennes/petites/absence*
Lumière/ombre	3 • orientation: *horizontale* *verticale* *oblique* *linéaire/circulaire* *rasante* *sans orientation*	7 • type de forme: *lumière ouverture/ projetée* *ombre attachée/projetée/fausse* 8 • position: *latérale/zénithale,* *centrale/périphérique* *gauche/droite* *avant/ arrière* *haut/ bas* 9 • nombre d'éléments: *unique/ multiple* 10 • proportion lumière/ombre: *petite/grande* 11 • motif: *simple/complexe* 12 • dominance du pattern: *dispersion/concentration* 13 • délimitation : *bien délimitée/mal délimitée* 14 • distribution: *uniforme/non uniforme* 15 • qualité d'intensité lumineuse : forte/faible

Ces directions (axes principaux) et zones (surfaces) acquièrent plus particulièrement la qualité d'être dynamique ou statique, si on les observe à travers la troisième grille d'interprétation : le **tableau des catégories dynamiques et statiques**. Les éléments statiques favorisent l'arrêt physique et perceptuel et les éléments dynamiques favorisent le mouvement. Les directions et les zones se trouvent alors investies de couleurs (rouge et bleue), les rendant facilement interprétables dans l'analyse. Ensemble, ces trois grilles sont des guides qui permettent de décortiquer les éléments les plus actifs d'un espace ou d'une image.

Tableau 3 : Classement de plusieurs paramètres en catégories dynamique et statique

Type d'interprétation		Paramètres	Catégories	
			Dynamique	**Statique**
Directions	**Objets**	1 • orientation objet	verticale, diagonale linéaire selon orientation convexe irrégulière asymétrique	horizontale courbe ouverte, circulaire concave régulière symétrique sans orientation
		2 • gravité visuelle	forte (haute)	faible (basse)
	Lumière/ ombre	3 • orientation lumière/ombre	verticale, oblique linéaire rasante	horizontale circulaire sans orientation
Zones	Objets	1 • type de forme objet	articulée	unique
		2 • position objet	périphérique haut zénithale	centrale bas latérale
		3 • nombre d'éléments:	multiple	unique
		4 • dimension objet	grande	moyenne/petite
	Lumière/ombre	6 • réflexions de surface	importantes	moyennes/petites
		7 • type de forme lumière/ombre	lumière projetée ombre projetée bien délimitée	lumière ouverture ombre attachée mal délimitée
		8 • position lumière et ombre	périphérique zénithale haute	centrale latérale basse
		9 • nombre d'éléments lumière et ombre	multiple	unique
		10 • proportion lumière/ombre	petite proportion ex. : 1/5 contraste élevé	grande proportion ex. : 1/2 contraste faible
		11 • motif	complexe	simple
		12 • dominance du pattern	concentration: contraste élevé	dispersion : contraste faible
		13 • délimitation	bien délimitée	mal délimitée
		14 • distribution	non uniforme	uniforme
		15 • intensité lumineuse	forte: contraste élevé	faible : contraste faible

Expérimentation-Analyse

La partie appliquée de la recherche, sous forme d'expérimentation en maquettes, met en relation des objets (matériaux d'ateliers), des ouvertures et des qualités de lumière. Les angles d'éclairement, c'est-à-dire l'angle de projection de la lumière source à travers l'ouverture, varient également, afin d'éclairer différentes régions de l'espace. La forme et le matériau du contenant demeurent fixes. Leur couleur se traduit par un gris moyen sur les images noir & blanc. Chaque maquette est photographiée de face, à une distance fixe, uniformisant l'échantillonnage. Elles sont traduites en images numériques, traitées par divers filtres et modes afin d'en extraire des informations (Biron, 2008). La figue 3 montre certains espaces maquettes dont les éléments varient selon deux types d'objets de forme géométrique et organique, deux formes d'ouvertures (linéaire et circulaire), quatre qualités de lumière (naturelle, artificielle, diffuse, directe) et trois angles d'éclairement. Elles sont accompagnées d'images traitées numériquement. Le mode *isohélie* décompose l'image en cinq tonalités de luminosité, aidant à mieux visualiser la répartition de la lumière et des ombres importantes. Le filtre *courbes de niveaux* cible des niveaux de luminosité relative (figure 3c,g,k,o), dessinant le contour de zones d'intensités lumineuses. Il est utile pour dégager une orientation et une organisation épurée des formes dans l'espace. Le filtre *tracé des contours* trace la frontière entre les écarts de luminosité, c'est-à-dire les contrastes d'intensité. Les traits obtenus ont une intensité plus ou moins prononcée, selon le contraste qu'ils délimitent (figure 3d,h,l,p). Ces filtres diminuent les détails moins importants de l'espace visuel. Ainsi, certaines régions disparaissent, par insuffisance de détails et de lumière. C'est le cas de l'objet des figures 3f, g et h.

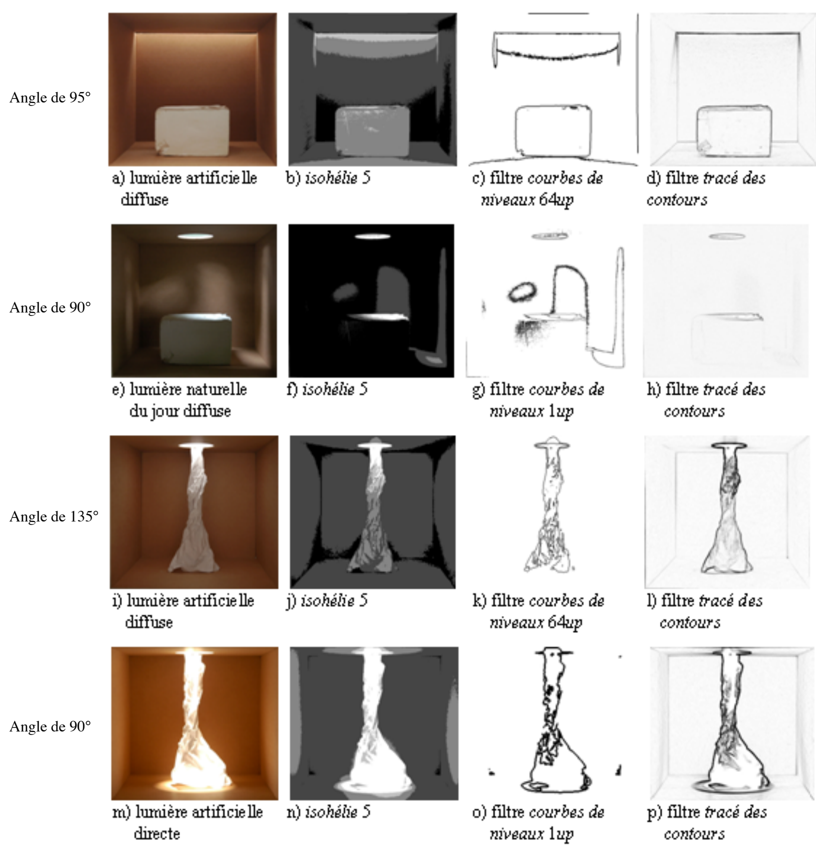
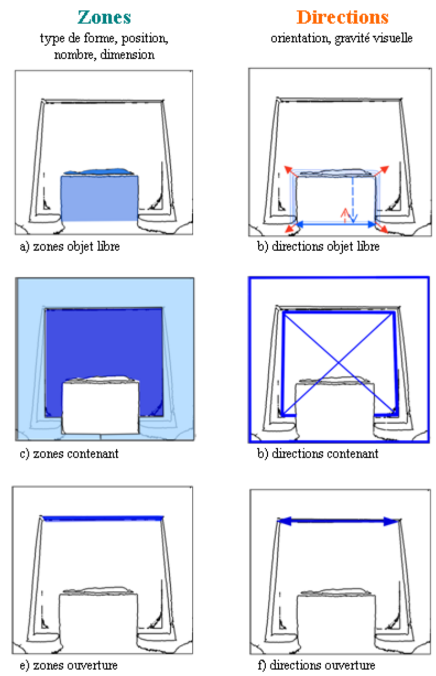


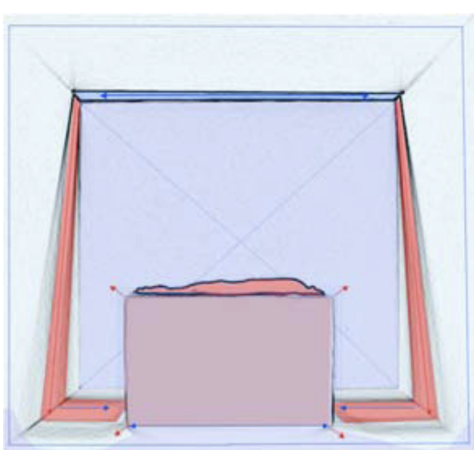
Figure 3 Images digitales avec ouvertures linéaires ou circulaires, différents angles et qualités de lumière naturelle ou artificielle, directe ou diffuse. Les images sont traitées par mode *isohélie*, mode noir&blanc et filtres de courbes.

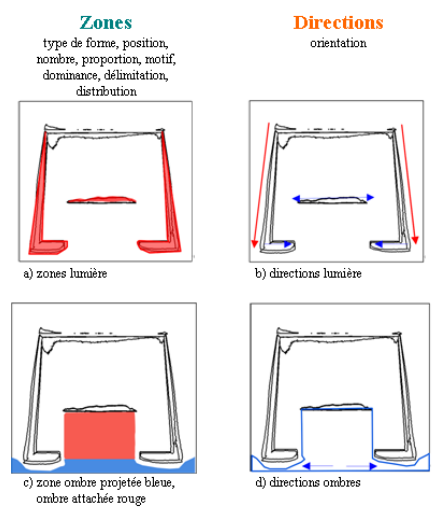
La figure 4a est un exemple d'image de maquette soumise aux interprétations des grilles. Les paramètres de la grille #1 (tableau 1) sont d'abord énumérés et évalués. La grille demeure une référence tout au long du processus. À l'aide des filtres, objets, lumière et ombre sont ensuite examinés de façon distincte, en interprétation par directions et par zones, grille #2 (tableau 2). Les éléments considérés comme statiques (bleu) et les éléments dynamiques (rouge) sont alors clairement identifiés, selon la grille #3 (tableau 3). Une mise en commun est reproduite à la figure 4d.


a) image maquette



b) Objets


d) Mise en commun



c) Lumière/Ombre

Figure 4 Représentation graphique d'une analyse des directions et zones d'un espace maquette. a) image originale (bloc de plâtre, ouverture linéaire zénithale, lumière artificielle directe, b) interprétation des objets, c) interprétation de la lumière et des ombres, d) mise en commun des interprétations des objets et de la lumière/ombre.

Dans cet espace, l'objet libre est plutôt statique. Bien ancré au sol, sa gravité visuelle est presque nulle (Arnheim, 1986, 1988). Il présente une légère direction horizontale, sans grande expansion, ce qui lui donne une impression de stabilité. Bien que sa dimension soit assez importante, il perd une grande partie de sa tridimensionnalité due à l'effet dissociateur de l'ombre attachée (avant du bloc) et du dessus fortement illuminé. Ainsi, en accentuant ou diminuant les détails et les contours des objets, l'intensité de la lumière peut produire une impression de matérialisation ou de dématérialisation des surfaces (Demers, 1997; Lecas, 1992; Weber, 2002). Ceci agit sur l'attention visuelle et la définition des objets environnants. L'ouverture linéaire, horizontale et zénithale occupe peu d'espace dans le champ visuel. Elle est donc peu active. Dû à l'angle d'éclairement et de prise de vue, il n'y a pas de lumière-ouverture. Par contre, la lumière directe produit une *lumière-projetée* très bien définie qui encadre l'objet par sa forme presque carrée, prenant expansion au sol. L'ombre attachée au bloc s'attribue une forme géométrique remarquée, dont la visibilité est accentuée par le contraste avec l'arrière-plan. L'évaluation de la couleur n'est pas abordée puisqu'elle demande une considération psychologique approfondie.

Une des forces de cette configuration est sa simplicité. Le peu d'éléments présents et leur forme captent l'attention. Les principales directions et zones y sont bien distinctes. L'analyse des objets démontre des directions et des zones principalement statiques. La lumière a cependant une double action. Elle encadre le bloc et le contenant, renforçant la symétrie et la stabilité de leurs formes ainsi que la centralité de l'ensemble. En contrepartie, sa nette délimitation, son *pattern* lumineux concentré en deux formes géométriques triangulaires définies, sa verticalité et son intensité lumineuse élevée, deviennent des éléments dynamiques importants. L'analyse permet d'affirmer que c'est la forme et l'intensité de la lumière qui donnent la plus grande force à cet espace, surpassant en importance les éléments statiques, malgré leur nombre. La figure 5 montre comment le caractère de l'espace diffère par la modification de la relation objet-lumière, simplement en changeant l'angle d'éclairement de la lumière.

Figure 5 Modifications de l'effet d'encadrement lumineux des objets, par modification de l'angle d'éclairement.

Plusieurs centres d'attention (plan d'ombre, forme géométrique de la lumière, intensité élevée, etc.) sont présents dans la figure 5a et effacés dans la figure 5c. Il faut cependant faire une distinction entre centres d'attention et niveaux d'attention. En effet, nos yeux sont attirés vers les zones rapidement identifiables comme les objets simples, proéminents, les contrastes, les luminosités élevées qui sont des centres d'attention. Nos yeux devront s'attarder plus longtemps pour comprendre les formes complexes, les zones floues, avec peu ou trop de détails ou sans grande direction de lecture, comme parfois en lumière tamisée et diffuse, demandant un niveau d'attention élevé. Les centres d'attention nous intéressent particulièrement, étant des repères dans la lecture et le design de l'espace lors de la création. Ces zones d'intérêt ou d'attention agissent en grande partie comme déterminant du caractère de l'espace et sont intégrées (perçus) rapidement.

La mise en commun de quelques analyses spatiales souligne les principaux éléments révélés par la méthode (figure 6a-e). Les flèches dessinées (figure 6f-j) représentent graphiquement le sens de lecture potentiel ou estimé entre les éléments visuels dominants. Le mouvement ou le sens de lecture est certes minimal et limité, mais il résume simplement les actions concertées ou non des éléments présents. Le parcours du regard est représenté par un va-et-vient (flèches) entre les formes. Bien que subjectifs, ils se basent tout de même sur les éléments visuellement et formellement actifs révélés dans les analyses. Dans la figure 6C, l'œil cible les deux zones de forte luminosité et l'orientation verticale de la forme centrale. Lumière et objet sont reliés ensemble par une symétrie et une forte présence commune des certains de leurs paramètres telles la position, l'orientation, l'intensité et la dominance du *pattern* (tableau 1), orientant le regard en un va-et-vient le long du cône de lumière et de la forme de papier. Dans la figure 6E, plusieurs éléments se partage l'attention. L'ouverture et les deux zones de lumière projetées possèdent une intensité assez élevée pour attirer l'œil, tandis que les tiges de bois, bien qu'occupant un faible pourcentage de l'espace visuel, ont une orientation verticale et diagonale marquée. Les masses du coin droit de l'image, bien qu'assez proéminentes, sont fixées au sol. Elles s'effacent dans l'ombre qui n'est pas assez intense pour en faire ressortir la présence par contraste. Les nombreux éléments ne s'appuient pas les uns les autres, orientant le regard dans plusieurs directions différentes.

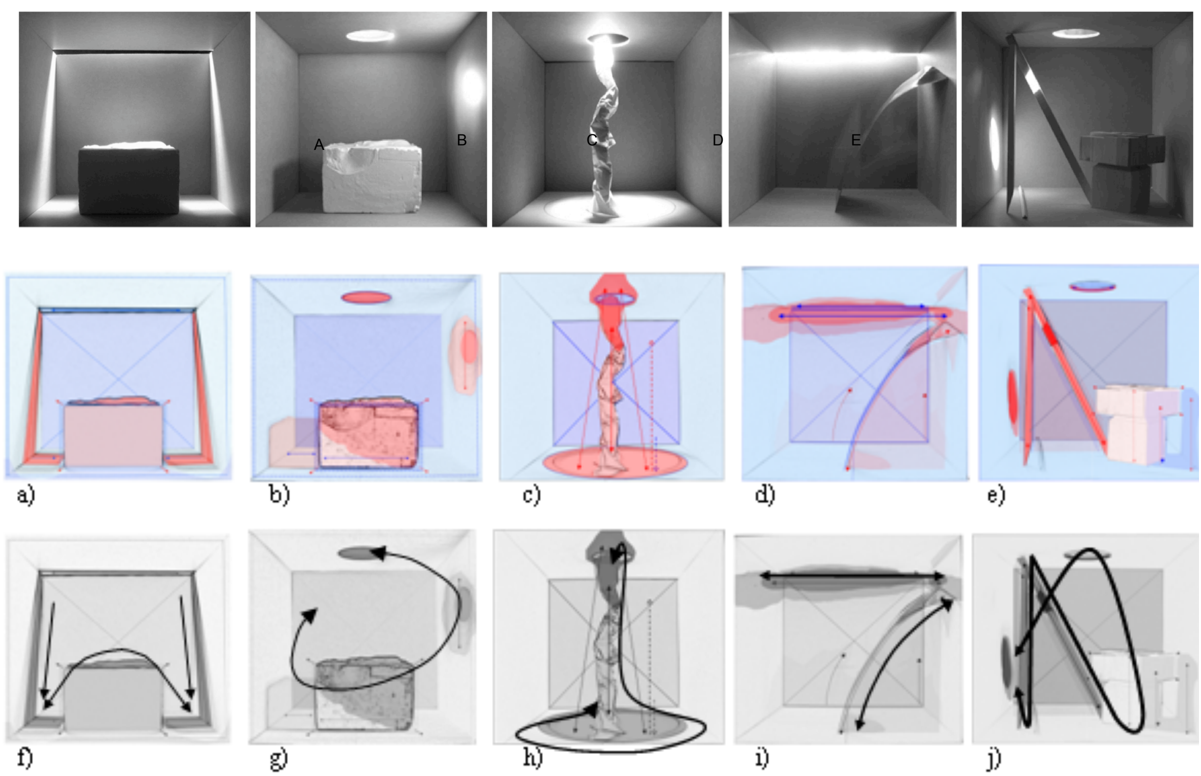


Figure 6 Interprétation de cinq espaces-maquettes, par directions et zones a-e), ainsi qu'une évaluation du sens de lecture potentiel entre éléments visuellement dominants f-j).

Conclusion

En design architectural, l'analyse et le regard esthétique font tous deux parties de l'élaboration de l'œuvre. La recherche tente de tisser ces deux approches parallèles. Elle s'intéresse à l'espace en tant que lieu de relation où objets et lumière dialoguent et se transforment mutuellement. Elle propose un éventail de qualificatifs et de notions théoriques concernant objets et lumière. Ceux-ci sont répertoriés sous forme de grilles d'interprétation. Le vocabulaire développé se compose de paramètres fournissant une compréhension claire et détaillée et une vision globale de l'environnement visuel. Il faut cependant se rappeler que bien que nous compartimentons les phénomènes pour mieux les comprendre, la perception globale de l'espace est complexe et les phénomènes sont inter reliés. Le travail propose également une expérimentation par des manipulations d'objets et de matière, sous forme de maquettes et d'images photographiques. Par la grande accessibilité et la visualisation rapide des interventions, ces deux médiums permettent d'observer plusieurs phénomènes simultanément et révèlent une multitude d'informations. Cette démarche réitère la richesse de ces manipulations comme source d'imagination, plutôt que simple représentation. Cette méthode favorise l'analyse et le design de points de vue « stratégiques ». Ceux-ci ont une portée significative sur la première impression d'un bâtiment. Lors de l'analyse, les grilles d'interprétation et les traitements numériques appliqués aux photographies génèrent des représentations graphiques, devenant des outils pour le design. La recherche présente certaines limites inhérentes à la représentation en maquette, mais situe tout de même un discours permettant de qualifier une relation spatiale intégrant la lumière et l'objet, qu'il serait intéressant de valider en milieu réel. Cette méthode, bien que conçue pour stimuler l'étape de la création, pourrait être confrontée avec l'analyse d'espaces réels, pour en étendre la portée.

La recherche révèle la nécessité de considérer à la fois les **directions** et les **zones** d'une image et d'un espace. Ces deux éléments de composition et d'attention influencent grandement la perception spatiale et visuelle. Elle témoigne aussi de l'importance d'attribuer les catégories **dynamiques et statiques** aux éléments, car ils agissent également sur notre perception et sur le caractère de l'espace. Deux concepts émergent de la discussion : la **compétition** et le **renforcement**. La compétition est définie comme une division de l'attention visuelle entre plusieurs éléments dominants, dont leurs actions perceptuelles ne sont pas spatialement ou formellement liées. Cela crée un effet de **dispersion** et une lecture multiple de l'espace. Elle demande un niveau d'attention plus élevé, car les éléments rivalisent entre eux pour le partage de l'attention. Le renforcement est une **concentration** de l'attention visuelle due à la complicité spatiale et formelle existant entre les éléments ou les centres d'attention. Les éléments travaillent en complicité. Leur position, leurs formes, leurs directions et leurs zones se renforcent les unes et les autres. Lors de la conception, l'espace souhaité (particulièrement les points de vue stratégiques) peut donc comporter un partage de l'attention entre plusieurs points différents ou la lumière et les objets peuvent travailler conjointement dans un but d'unité.

En somme, cette approche détaillée jette les bases d'un travail de création, dont la méthode offre beaucoup de souplesse. Elle élabore une vision globale de l'espace où les éléments visuellement importants sont identifiés et qualifiés. Cette démarche fait de l'interprétation de la relation objets/lumière, un moment privilégié permettant de comprendre leur dynamisme et d'anticiper leurs effets dans la production d'oeuvres artistiques et architecturales. Elle peut également guider les créateurs dans l'univers de l'interaction objets-lumière et donner des balises lors de l'enseignement. Cette évaluation en détail à l'aide de grilles d'interprétation de l'espace physique et visuel est une approche qualitative servant d'outils de réflexion et de schématisation, face au phénomène de complexité lors de la création. Elle doit être considérée comme l'apport d'un vocabulaire servant à développer parallèlement la rigueur de l'analyse, l'imagination et « l'acuité créative », enrichissant les interventions.

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Complexity in Home Medical Equipment Design

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Abstract

Home medical devices are developing into a major industry worldwide that covers monitoring, diagnostic, disease prevention, treatment, alleviation of disease and rehabilitation equipment. Services are being moved out to the community and into the home; self management is replacing hospitalization and visits to the doctor's clinic; and custom-tailored medicine is making inroads into normative treatment. These developments have great implications for the scope and design of home medical equipment.

The paper will discuss the unique and complex nature of home medical devices, from a human–environment–machine perspective focusing on the changeable unpredictable nature of users, the unknown, amorphous home environment and the level of intricacy of tasks performed by patients having various diseases and disabilities.

The design of home/personal medical equipment should be guided by the need to make it compatible with the needs of different users and diverse residences. The selection of medical equipment should not be determined by passing trends, technological fashions, or search for innovative and hi-tech applications and gadgets.

We call for increased awareness and active, ongoing research by multidisciplinary teams of healthcare personnel, end user patients, caregivers, psychologists, social workers, and especially, the architects and designers who will be involved from the first stages of concept development through to the final stages of medical device marketing. Design of home/personal medical equipment should follow principles of inclusive design (design for all, universal design) criteria, following user-centered design methodologies. It should accommodate the dynamic, uncertain and complex profile of the widest range of users and environments.

Keywords

home care; medical devices; healthcare design; medical equipment; inclusive design; design for all; user-centered design

Medical device design, manufacture and use constitute a growing industry worldwide, having great economic impact and spilling over into various fields, and serving as a driving force for innovation (Klatzky, Kober & Mavor, 1996; The World Health Report 2008). The traditional way medicine as a whole is packaged and delivered is changing enormously. Services are being moved out to the community and into the home; E-health services, remote monitoring technology and self management are replacing hospitalization and visits to the doctors' clinics; custom-tailored medicine is making inroads into normative treatment (Bogner, 1999; Grundersen, 1999). These developments have great implications for the scope and design of home medical equipment.

In parallel, our society is graying as a result of increased life expectancy and a decrease in birth rates. Aging is being accompanied by a rise in chronic diseases such as diabetes, heart diseases, hypertension, COPD (Chronic Obstructive Pulmonary Disease), arthritis, osteoporosis, etc. (Lathan et al., 1999; The World Health Report, 2008). Chronic diseases can be controlled and prevented by patients who care for themselves via self care and monitoring, thus making the care process a more continuous collaborative relationship between patients and doctors. The assertion that "Health is a state of complete physical, psychological and social well being; not only the absence of illness" (WHO), combined with improved technology, primarily in the field of Information Communication Technology (ICT), is further spurring the expansion of the medical device market. This phenomenon is in line with the concept of "Social Design ", proclaimed by Papanek in "Design for the Real World" (1984). It is not surprising, therefore, that the investments made in the hi-tech medical device industry have been among the most successful commercial ventures, even during these dark days of today's global economic crisis.

Nevertheless, design of medical equipment is a unique field, with its own specific design demands. The design of for-home-use devices is an even more complicated issue for planners and designers.

This paper will discuss the unique nature of for-home-use medical devices, and focuses on evaluating the issues of their complexity that are related to the nature of users, the environment and the task performed.

Home Medical Equipment

Medical devices are "any instrument, apparatus, appliance, material or other article, whether used alone or in combination, including the software necessary for its proper application intended by the manufacture to be used for human beings for the purposes of diagnosis, prevention, monitoring, treatment or alleviation of disease" (European Medical Device Directive (93/42/EEC) (Martin et al., 2008). While hospital equipment is becoming more sophisticated and specific, significant numbers of medical devices are moving out of hospitals into community and residential settings for use by the public. This new situation raises problems and dilemmas not faced in the hospital setting.

Monitoring and diagnostic devices are present in every home, from simple universal devices such as thermometers and weight scales (e.g., routine weight watching, pregnancy follow-up) to specific devices such as blood pressure meters, glucometers, "Holter" type devices, INR meters (for patients under anticoagulant therapy), pulse oximeters, peak flow meters (e.g., asthma), macular degeneration detection systems and portable EKG/pulse meters. These devices enable remote and frequent monitoring of patients' clinical status and help in maintaining peoples' well being. Diagnostic self-test kits such as pregnancy tests or urinary tract inflammation tests are a fast developing sector of homecare products, thanks to innovative technologies.

Documentation of clinical and personal data (e.g., personal electronic medical records), linkage to information sources, on-line connection and consultation with physicians and medical/social staff, together with the use of ICT, empower patients and help close the loop among patients, devices, laboratories, data bases and physicians (Rollins &Rayburn, 2003). Taken altogether, these form a "disease management team".

Disease prevention, treatment and disease alleviation devices extend the responsibility for preventing illness, impeding further deterioration and hospitalization from hospitals and clinics to the home and work place. This category includes a range of devices, from simple machines such as inhalators and wound healing equipment to advanced equipment such as CPAP masks (e.g., for sleep apnea), liquid oxygen tanks, oxygen generators, catheters, infusion pumps, pain relief and analgesia devices, and even home dialysis machines.

Rehabilitation home equipment may enable frequent, around the clock treatment in a private and comfortable environment, but requires redesigning of rehabilitation gear. Rehabilitation home devices are in line with the concept of 'well being' and part of the trend of gym and fitness equipment that has also moved to the house setting.

Medical device are subject to complex regulations that vary considerably across the world, making compliance a complex and difficult process (Martin et al., 2008).

The use of home medical equipment and services empower patients, shifting them from passive recipients of care services to active participants. Several studies have suggested that interactive health services in which patients continuously take care of their own clinical data will improve management and control of chronic diseases, promote earlier discharge from acute care settings (replaced with continuous home services), improve clinical outcome, reduce the number of clinic visits, increase patient satisfaction, and shift care process towards more continuous collaborative relationships between patients and providers (Barlow et al., 2007; Garcia-Lizana & Sarria-Santamera, 2007; Rollins, & Rayburn (2003). Nonetheless, a new approach to the equipment is needed, given that most medical devices for at-home use are miniaturized, simplified, portable and some times colourful versions of the original professional hospital apparatus (Bogner, 1999; Wilcox 2005).

Users of Home Medical Equipment

Patients are not the users of medical equipment in hospitals and clinics (they are forbidden to operate the equipment by themselves). Professional staff—the nurse, technician or physician—operate the equipment. They are all experienced, dedicated, and trained users who are physically fit and healthy. They receive guidance and technical assistance during equipment operation (or have professionals on standby to call upon). Those who benefit from the use of healthcare devices neither order nor purchase the devices. Healthcare administrations, insurance companies and regulatory bodies such as the FDA decide what medical devices and technology will be accepted and purchased for the healthcare facility, based on economic, social and institutional factors (Wilcox, 2003).

On, the other hands, the users of home medical devices are heterogeneous groups of the patients themselves (self-care) or family members and care givers supporting the patient. The diverse profile of users includes experienced and untrained/occasional patients, family members ranging from spouses to grandchildren and caregivers of different levels of professionalism who may have conflicting interests and needs (Klatzky, Kober & Mavor, 1996; Lathanet al., 1999).

Common diseases and disabilities such as motor dysfunction (e.g., Parkinson disease, essential tremor, arthritis), visual impairment (e.g., diabetes retinopathy, cataract), loss of tactile sensation (e.g., diabetes neuropathy), cognitive impairment (e.g., dementia), auditory decay (phonal trauma, Presbycusis, deafness), speech disabilities (e.g. stroke) and equilibrium and balance disorders may impair a person's ability to operate the equipment. Motor restriction may disrupt the ability to perform simple functions on the device interface such as turning a knob, moving a slider, or pushing a bottom, or to complete procedures such as puncturing the finger for blood sample and wearing the blood pressure cuff. Visual decline will prevent reading the check-up results or following the color indicator and auditory dysfunction will prevent following the sound indicator (e.g., signaling the start and end of measurement). Cognitive deterioration will disturb various stages from the initial steps of the decision whether to perform the procedure or remembering how to perform it, to final steps of remembering the results of the checkup and reporting them correctly (Bogner, 1999; Wilcox, 2005).

Side effects of medications may further impair the user's ability to operate the equipment. This includes changes in visual sensation (e.g., anti-cholinergic drugs), auditory abilities (streptomycin), alertness (anti-allergic drugs), tactile sensation (chemotherapy), perception, cognition and information processing abilities (psychiatric drugs) and more. Anxiety, fatigue, loss of sleep and depression contribute to decreased attention and performance on the part of both the patients and family members (Klatzky, Kober & Mavor, 1996).

In contrast to the professional personnel at hospitals or clinics, patients may be by and large 'unstable'—going through unpredictable and/or frequent changes in clinical status and performance during the period they use the equipment (Bogner, 1999). Chronic patients and elderly people may have multiple disabilities and disorders that complicate the situation, mandating a tradeoff between modes of actions and display configurations of the medical equipment (Mclaughlin, Rogers & Fisk, 2004).

This diversity, unpredictability and fluctuation in users' profiles and abilities further complicates the design of domestic medical devices, their modes of operation and display options in comparison to the stable, known professional profile of hospital equipment operators (Bogner, 1999; Klatzky, Kober & Mavor, 1996; Lathan et al., 1999; Mykityshyn, Fisk & Rogers , 2002; Wilcox, 2005).

The Home Environment

The hospital environment is a constantly regulated setting, under supervision, with strict regulations and inspection protocols. Environmental variables that are controlled in healthcare facilities include sterility (with separation between isolated sterile and non-sterile zones), illumination levels and glare, electromagnetic disturbances, temperature regulation, moisture and vapor control, background noise (alarms, equipment operation, paging), furniture congestion and more.

As opposed to the controlled healthcare facility milieu, household and community settings are heterogeneous, unpredictable and uncontrolled environments, which introduce elements of complexity and uncertainty into the equation of location, performance and design of medical devices. Each user's home is unique, as opposed to the controlled and standard environment of hospitals. The positioning of medical devices at home, the possibility of electrical disturbances, interaction with other home devices, a non-sterile environment, unpredictable levels of illumination and glare, background noise, crowding of family members, specific maintenance constraints related to varied temperature, moisture, vapors and sunlight, and the need for transportation are some of the factors complicating the design of medical home devices. These factors are less relevant for the design of hospital medical equipment.

In addition to technological and ergonomic issues (Klatzky, Kober & Mavor, 1999), healthcare equipment used at home is also charged with issues of esthetics, design trends, styles and fashion, to the same degree that any consumer product is. For-home-use equipment design considerations are also compounded by the need to avoid images of sickness or disability (Wilcox, 2005).

Conclusion:

This paper presented some of the complex issues involved in designing home healthcare equipment resulting from by the special nature of users and their diverse and dynamic abilities (and especially disabilities) and the mismatch between the atmosphere and design of the house and the image and outlook of the medical equipment. In order to cope with the complexity, and overcome some of the dilemmas in the field of home medical devices, we need the active and continuous involvement of multidisciplinary teams of healthcare personnel, end user patients and caregivers, psychologists, social workers, and primarily architects and designers. The latter group especially will be most involved with concept development through to marketing the medical device(s) as life style articles.

It is necessary to define the objectives of healthcare devices and services at home in terms of life style and “all family" use. Design of home/personal medical equipment should follow principles of inclusive design (design for all, universal design) criteria, so that devices will be usable by the widest possible array of users operating in the widest range of conditions, following user-centered design methodologies (Arsand & Demiris, 2008; Klatzky, Kober, Mavor, 1996; Lathan et al., 1999; Wilcox, 2005).

The selection of medical equipment *should not* be determined by passing trends and technological fashions, or by a search for innovative and hi-tech appliances merely for their own sake. Moreover, design should not be transferred from the medical milieu to the homecare setting (with slight changes) or directly moved from one medical domain to another without first testing the compatibility with the heterogeneous profile of users and the residential environment.

It is expected that in the near future innovative technologies, computing, ICT and virtual reality will enable a holistic approach to medical equipment as an integrated part of the overall surrounding (Lathan et al., 1999). Aware houses (smart homes) and wearable computers will enable optimal personalized performance for each user and improved compliance with maximal integration with the environment whether this is the home, office or a mobile environment (Chan, Estève, Escriba & Campo, 2008).

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Barrier analysis as a design tool in complex safety critical systems

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Abstract

When constructing or improving large complex systems, design activities help establish the needs and goals of users, deepen the understanding of the system and facilitate ideation of new solutions. When service systems are large, dynamic and complex, the need for thorough design work is especially evident. However, design methods usually strive to describe and design best case scenarios and we argue they lack the perspective of safety needed when working in safety critical systems. In order to gain knowledge on how a perspective of risk and safety can benefit design in a safety critical domain, two different perspectives were adopted through the use of two different methods. The methods were service blueprinting and barrier analysis, adopted from service design and cognitive systems engineering respectively. The methods were implemented during the research phase of a service design project in a home healthcare system in Sweden. Service blueprinting is a method used by service designers to visualise services. Barrier analysis is aimed at identifying and categorizing artefacts and functions that prevent unwanted events from taking place, or that lessen the impact of their consequences. A comparative analysis of the two methods was performed, concluding that barrier analysis has the potential to benefit design work performed in complex and safety critical systems. The potential for barrier analysis to be more tightly integrated into current service design methods is discussed, but more research is needed in order to clarify this matter.

Keywords

Service blueprint; barrier analysis; Cognitive systems engineering; healthcare; design perspectives; service design

Large and complex human-machine systems (e.g. process industry, power stations, transport systems, healthcare institutions, etc) present great challenges in organizing, developing and maintaining the successful operation of whatever activity is being performed. In developing these kinds of complex systems we think that adopting a design approach and using design thinking is valuable. It helps establish the needs and goals of users, deepen the understanding of the system and facilitate ideation of good solutions. A design approach helps to put people in focus instead of technology or system architecture (Cooper, 1999).

However, when working with complex human-machine systems the aspect of safety often comes into play. Many of these systems are not only complex but also safety critical, i.e. the risk of serious accidents, injury or death is present. While designers generally have a well equipped toolbox of methods and techniques for user research, ideation and valuation we argue that most designers lack tools to help them consider safety aspects of their design suggestions. Safety consideration is something not generally addressed in the standard set of design tools. We suggest that designers need to turn to other disciplines for methods that can add the perspective of safety and risk when working in safety critical environments. In this paper we will present a case study where such an approach was adopted.

The different perspectives of design and CSE

Formalized methods and techniques used in design work help designers structure their approach to a design case and provide guidelines and step-by-step formulas to best practice work. However, by directing the designer's attention and actions to certain aspects of the design problem a method can also be said to reinforce a perspective or a focus in the design process. Different methods bring different aspects of the situation to the designer's attention, thus making them prioritized in the design work. It has been shown that actively adopting different perspectives in design processes affects the outcome of design work (Hult, Irestig, & Lundberg, 2006). The use of formalized methods can be a way of directing the focus of design work and can add perspectives not otherwise considered by the designer, thus affecting the outcome of his or her work.

The design disciplines, we argue, carry with them a certain kind of perspective that is reflected in the methods and techniques used in design work. Design is about exploring and unfolding a design space, thus finding the best possible solution to a specific situation. The focus in design work is naturally turned to the positive aspects of potential design solutions. It is often about creating beautiful, functional and pleasant objects and experiences. Methods for visualizing and communicating design solutions therefore focus on best case scenarios, which turns the design focus to the aspects that create these best cases. Design methods may address failure and safety, but few have an explicit focus on worst cases. The traditional design communication techniques such as storyboards and scenarios also focus on specific events, putting focus on a small number of all the possible interactions, activities, and events within a system.

Another discipline concerned with complex human-machine systems is Cognitive Systems Engineering (CSE). CSE has its roots in cognitive science and is devoted to studying phenomena that emerge when people use technological artefacts in their work (Hollnagel & Woods, 2005). CSE is a systemic approach used for analyzing, evaluating and designing complex systems, much like systems design, but with a separate set of methods and assumptions. The CSE approach can be broken down into three main concerns (ibid.); (1) how cognitive systems cope with complexity, (2) how to engineer joint cognitive (human and machine) systems and, (3) how the use of artefacts can affect specific work functions. Within CSE a systems approach is adopted. The basic premise of a systems approach is that humans are fallible and errors are to be expected and caused by an "upstream" of systemic factor, a view initially proposed in Perrow's *Normal accident theory* (Perrow, 1984; Reason, 1990). The main assumption is that it is not possible to change human conditions, but it is possible to change the conditions under which humans work (Reason, 2000). Since CSE is devoted to the understanding of how to maintain control in complex environments, the focus of interest is on the prevention of accidents rather than on finding the best solution for situations when everything is working as it should.

There is a significant difference in perspectives between design disciplines and CSE. While design focuses on best-case scenarios, CSE looks at worst-case scenarios and how to prevent them from occurring. We argue that when designers work in complex and safety critical environments, there is a need for a perspective of safety not normally adopted by designers. We also argue that this perspective could be added to design work by the use of methods from CSE. In order to explore this idea further a research project applying methods from both service design and CSE was carried out in a home healthcare setting.

Methods

In this section we will begin by describing the methods used to model the home healthcare system. Two methods were used, a *service blueprint*, representing the service design perspective, and *barrier analysis*, commonly used within the CSE domain. The case is described in the following section which leads to a review of the results produced by the two methods. This is followed by a discussion of each individual analysis and concluding remarks concerning benefits and limitations of merging the two methods.

Service blueprint

Service blueprinting is an approach for service innovation and improvement (for a detailed description see Bitner, Ostrom, & Morgan (2008)). Together with customer journeys, it is commonly used by service designers as a way to visualize services, in order to make them more tangible and susceptible to design activities (Segelström, 2009). A service blueprint provides a description of the service process, customer points of contact and physical evidence as well as the underlying support processes that support and drive the service. Bitner et al. (2008) has described services as “co-created with customers” with examples like; professional services, retail, financial, telecommunication, healthcare, and many others. The original blueprint method was developed in a service management context, and has been adjusted by the service design research community to better fit design activities and goals (Polaine, 2009; Wreiner et al., 2009; Sparagen & Chan, 2008). In this study, the method described by Bitner et al. (2008), has primarily been used, but some changes had to be made to fit the context.

The first step in service blueprinting is to identify and map the process (Bitner et al., 2008; Shostack, 1984). Viewing a service as a process allows the unfolding events to be visualized over time, connected by a number of touchpoints where customers interact with the service. Each touchpoint is subsequently described using five layers; (1) customer actions, (2) onstage, (3) backstage, (4) support processes and (5) physical evidence. When visualizing the blueprint these layers are separated by lines, which allow an illustration of the different interactions over time (see Figure 1). Vertical lines between the components show inter-functional connections between components.

Customer actions include all steps taken by a customer throughout the service delivery process, and are depicted chronologically. Onstage refers to the visible contact made between a customer and an employee, this point is also commonly referred to as a moment of truth. Backstage refers to actions performed by the employee not visible to the customer, for example a telephone call or some other preparation. The fourth layer in the service blueprint is the support processes, which includes all activities executed by individuals who do not have direct contact with the customer but that need to occur in order for the service to be delivered. The last layer, physical evidence, is described at the top of the blueprint and represents all the tangibles that customers come in contact with. The physical evidences are identified for each customer action and every moment of truth. (Bitner et al., 2008)

Barrier analysis

The second method applied to the collected data was a barrier analysis. Identifying barriers is common within risk and safety assessments in CSE. A barrier is an obstruction or hindrance (or defence) that may prevent or lessen the impact of an unwanted consequence (Hollnagel, 1999). This may include stopping, slowing down, restricting, limiting or in some other way weakening an uncontrollable process. The concept of barriers is used to understand and prevent accidents. If an accident has taken place this means that one or several barriers have failed, i.e. did not serve their purpose or were missing (Hollnagel, 1999). Barrier analysis is frequently used to describe accidents in terms of conditions that lead to failed barriers (Hollnagel, 2004).

Often barriers are identified together with other risk analysis methods in order to provide a context to better understand the barriers’ function and how they are related to each other (e.g. Guldenmund et al., 2005; Harms-Ringdahl, 2003; Svenson, 1991). However, in this analysis, barriers were identified directly after the participatory observations and later in the light of the blueprint. To verify that the barriers usage had been correctly interpreted and that no major barriers had been unidentified, several workgroup representatives within the home care service systems participated in a workshop where these barriers were discussed.

Barrier systems and barrier functions

The barrier identification performed on the data collected from observations at healthcare centers included four different types of barrier systems described by Hollnagel (1999, 2004): material, functional, symbolic and incorporeal (immaterial).

- *Material barriers* are physical hindrances, for example buildings, walls, fences, railings, cages or gates. A material barrier does not need to be perceived or interpreted to serve its purpose.
- *Functional barriers* prevent or hinder actions by setting up a number of pre-conditions that need to be met in order for an action to be carried out. This may for example be locks, passwords, distances or delays. The pre-conditions do not necessarily need to be seen or interpreted by a human; they can also be sensed by the system itself.
- *Symbolic barriers* require an act of interpretation by an intelligent agent that responds or reacts to it. Examples are for instance coding (color, shape, spatial layout), instructions, procedures, signs or an approval of some sort. A symbolic barrier indicates a certain limitation but does not in itself hinder an event from taking place, if it is neglected or ignored by the user.
- *Incorporeal barriers* are not physically present in the current situation; they depend on the knowledge of the user. Common incorporeal barriers are rules, guidelines, restrictions and laws.

Barriers can also be categorized according to their function within the system, defined as a specific manner by which the barrier achieves its purpose, the most basic distinction being preventative or protective (see Table 1). As the name implies the function of a preventative barrier is to prevent an unwanted event from taking place. The role of the protective barrier is to lessen the impact of an unwanted effect or action when it has taken place (Hollnagel, 2004).

Case study

We applied the two methods on a case which covered the early research phase of a design process, and the goal was to use the findings from this research phase to create a model of the complex service system of home healthcare. This model, or description, is the foundation for further design work to find new solutions and improvements. The research group consisted persons with experience in design research, as well as persons with experience of adopting a CSE-perspective in safety critical environments.

Data collection

Initially a literature study of the home healthcare domain was performed (Hägglund & Lind, 2006; Orre, 2009; Wallqvist, 2003; Winge, 2007). Then a total of 25 hours of participatory observations with different care giving organizations was performed by the four researchers. Observations were not only performed in the patient’s homes but also at district care centers and at the main hospital in order to gain insight into the workflow of the major organizations participating in the home healthcare system. During the observations, special attention was given to the handling and distribution of medication.

Personnel working within the healthcare system in Sweden are required to report incidents deviating from normal procedure or events that have led to or could lead to injury for the patient. In order to gain insight into issues regarding patient safety within the home healthcare system an initial study of reported adverse events from 2003 to 2009 from several care giving organizations was performed. One of the most common occurrences reported was incorrect handling of medication. This included patients receiving the wrong type of medication, patients receiving medication at the wrong time or medication not given at all.

Within the home healthcare system individual accommodation is necessary in order to meet the patients’ varying needs. To preserve our impressions from the observations and to turn our data into a more living individual, we created a persona (Pruitt & Adlin, 2006).

Persona

Anja, 85 years of age, has lived alone in her apartment since her husband passed away a few years earlier. Anja is treated for age related diabetes, pain in her hip and occasional depression. She has previously had thrombosis and heart related problems which she takes medication for. Her condition requires the involvement and coordination of a number of care givers, including relatives, home care service, food delivery service, the district care center and the hospital. This means that she gets home visits at least twice a day but often more. Anja was used as a representative of our main user group in the subsequent analysis.

Results

The results are presented individually for the two methods. A suggestion for how to combine the results is provided in the discussion, followed by the conclusions of this work.

Blueprint result

The service process described in the blueprint analysis was "a typical day in the life of Anja" and included a 24 hour time period. During this day Anja got five visits; three from the home healthcare service, one food delivery and a visit from the hospital. Anja also has an alarm if she needs any help during the evening or night. Figure 1 presents an excerpt from the blueprint. The excerpt shows a period in the middle of Anja's day when a person from the home healthcare service visits to administer medication. The excerpt ends before the caregiver leaves.

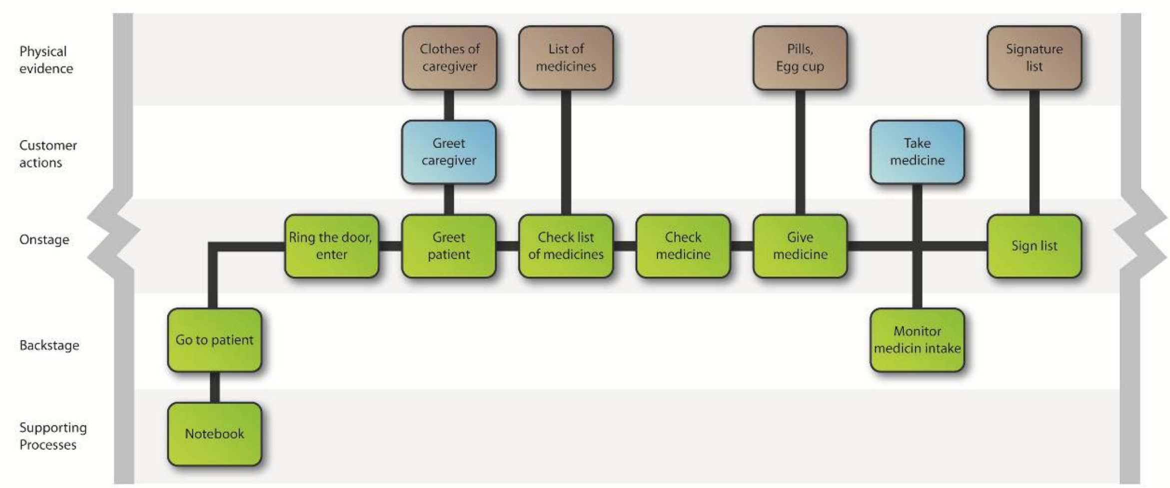


Fig 1. Excerpt from blueprint for home healthcare visit with Anja

Barrier analysis result

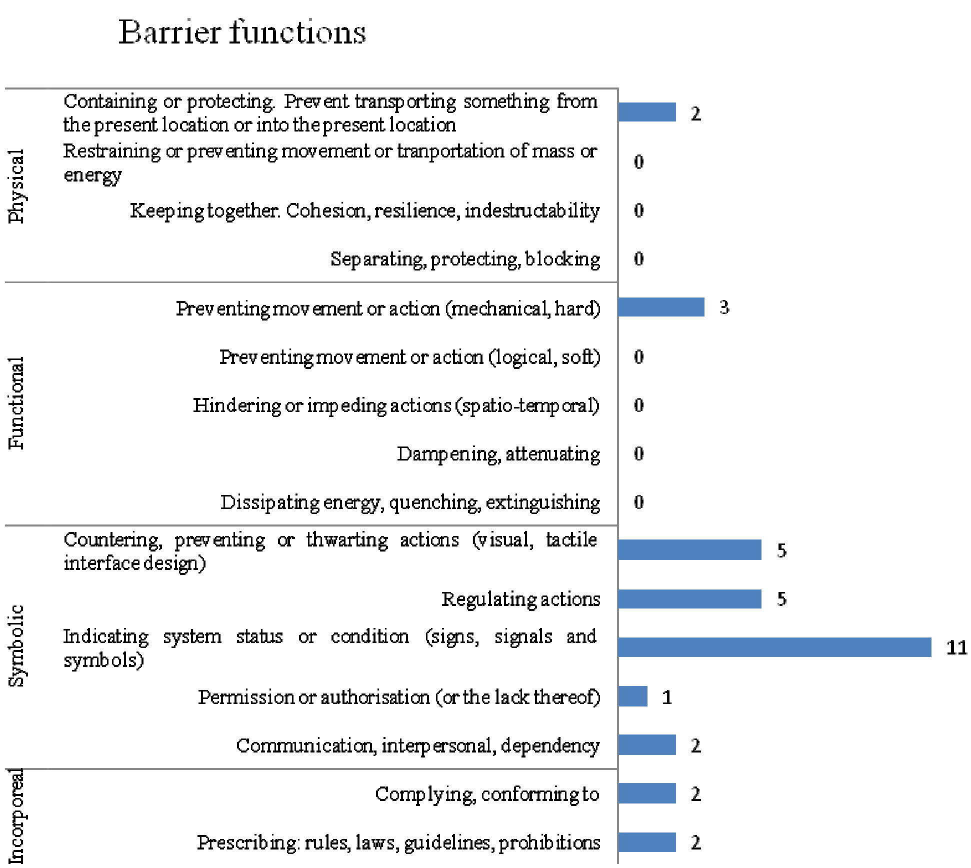
Table 1 and Table 2 show the results of the barrier analysis, note that only barriers relating to medication have been identified in the system. In Figure 1 the barriers are identified as well as the barrier system they belong to and if their function is preventative (Pre) or protective (Pro). Table 2 presents a more detailed description of the barrier functions and their distribution; the numbers in Table 1 correspond to the functions in Table 2. For example "egg-cup" and "medicine cabinet" are physical barrier systems, classified as category 1 in Table 1. This corresponds to "Containing or protecting, prevent transporting something from the present location or into the present location" in Table 2.

Table 1. Barrier systems and barrier functions in a home healthcare system in Linköping, Sweden.

Barriers / Functions	Physical 1	Physical 2	Physical 3	Physical 4	Functional 1	Functional 2	Functional 3	Functional 4	Functional 5	Symbolic 1	Symbolic 2	Symbolic 3	Symbolic 4	Symbolic 5	Incorporeal 1	Incorporeal 2
Signature list												Pre/Pro			Pre	
Medical dispenser					Pre					Pre		Pro				
ApoDos*					Pre					Pre		Pro				
Egg-cup or alike	Pre															
Delegation of medication													Pre			Pre
Laws																Pre
Supervision														Pre/Pro	Pre	
Medicin cabinet	Pre				Pre											
Place for storing medicin (cabinet)										Pre						
Remainder (note)										Pre						
Color-coded schedule for care-givers**										Pre	Pre	Pre				
Incident reports											Pro					
Medicin list											Pre	Pre				
Cosmic/Safedoc***											Pre	Pre				
Alarm												Pro/Pro				
Routine for medicine distribution											Pre					
Patients medical diary												Pre				
Binder containing patients medical information												Pre				

*medical dispenser from pharmacy, **schedule shared by all caregivers in one area, covers an entire wall, ***electronic health records.

Table 2. A classification of barrier functions and the number of barriers from the home health care system.



Discussion

The aim of this research is to identify what kind of information, and what image the two different methods convey of a service system. We are interested in clarifying whether or not they can complement each other and whether barrier analysis can be used as a design tool that emphasizes safety issues. The two methods described in this paper are very different and we do not attempt to directly compare them or recommend one over the other.

Blueprint

The blueprint, as expected from a service design tool, was more effective in increasing the understanding of the patient's point of view and the understanding of processes in the home healthcare domain. It also served to visualize the service encounters and thus made them available for design valuations and suggestions of redesign.

Each service encounter is mediated, either by situated instruments (service evidence) or socially (people, rules, and roles) (Sangiorgi, 2009). The blueprint primarily shows the socially mediated actions, and the instruments chosen as part of the blueprint scenario. The instruments and interactions included are the ones most commonly used, or considered to be of greater importance. Since only one of many possible scenarios is considered, a lot of possible outcomes and incidents are not covered. When designers create a blueprint, a choice is made on what to include, which normally leads to a representation of the most common activities.

Barrier analysis

Identifying all the barriers (in the care takers home environment) involved in the medication process was done fairly quickly since we had observations and documentation to rely on. The subsequent workshop verified that the relevant barriers had been included. The most challenging part was to categorize the identified barriers into the predefined classes. The ambiguous nature of many barriers, and overlapping barrier categories, sometimes made them hard to classify.

Many interactions within a system as complex and people-intensive as home healthcare depend largely on the social interactions (e.g. conversations) between individuals. Such interactions are informal and proved hard to categorize in the barrier framework, as well as in the blueprint. Also as a consequence of the social nature of the healthcare system, our analysis showed that most barriers are either symbolic or incorporeal. This is probably the case with most similar systems where service providers' actions are controlled by laws, authority, permissions, and so on. We could also see a large majority of the barriers dedicated to preventing accidents from happening, as opposed to very few that actually protected the system by dampening the effects of incidents. This was also an interesting finding from the barrier analysis that would otherwise have been hard to identify with the standard design tools.

Worth noting is that the barrier analysis identified mechanisms and artifacts that were not mentioned in the blueprint. Some mechanisms and artifacts were simply not used in the blueprint scenario and some were not covered by the levels of the blueprint. For instance, delegation of medicine, laws, supervision, incident reports and routines, are not exposed by the blueprint. These barriers can be seen as somewhat "hidden" in the system and therefore not visualized by the snapshot picture of the system the blueprint provides. However, these mechanisms are important for the system to function and critical for patient safety and would therefore be necessary to consider when creating service design in such an environment.

Combining the results

Currently, barriers exist as context free entities in the barrier analysis. As a way of extending the analysis, the identified barriers was mapped onto the existing levels in the blueprint format, see Figure 2. When the list of barriers was placed into the layers of the blueprint, some interesting things happened. For instance, it was obvious that the barriers could be placed on different levels depending on who were using the barrier at the moment, who could perceive it, where it was currently placed, and so on.

Placing the barriers in the blueprint format provided a context for the barriers, by adding information about interdependencies and relations. Most barriers pertaining to physical evidence in the blueprint framework also have associated available actions. Besides being a physical evidence, an alarm can potentially be used both by the patient (customer action), onstage, or by the visiting care provider, either onstage or backstage (i.e. without the patient noticing). Some barriers also have different manifestations, for instance a manifestation in the real, physical world and a copy in the digital world. Many lists and notes for instance, are kept both in the binder at the patients home and in the medical health records. In Figure 2, the barriers were included on the blueprint layers, with some appearing at multiple layers. This is partly because the function of the barrier depends on where the barrier is, and what action is being performed, and partly because the same barrier can have an artifact, a process, or event associated, thus appearing at multiple layers in the blueprint. This makes the placement of the barriers on the blueprint somewhat difficult. It might have been possible to place the barriers in a slightly different way than in Figure 2.

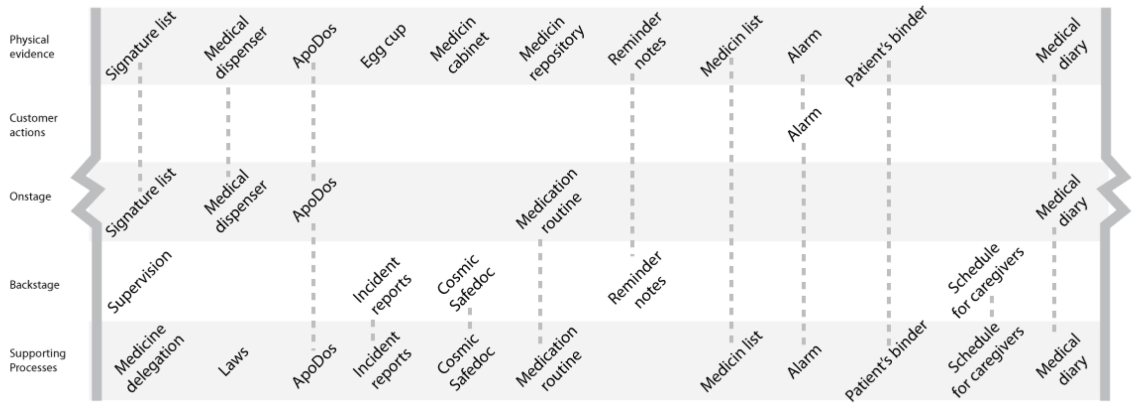


Fig 2. The list of identified barriers translated into blueprint objects.

Conclusion

One goal of the research was to evaluate the potential of barrier analysis as a complementary design tool. The barrier analysis provided a more complete view of the objects and possible events in the system and was not dependent on a specific scenario that arbitrarily included events. The blueprint did mention most of the identified physical and functional barriers, whereas only a few of the symbolic and incorporeal barriers were included. The complete list of barriers offers ways to think about 1) where new barriers could fit in 2) what types of barriers could fit in and 3) implications of taking away existing barriers. The barriers themselves also serve as opportunities for redesign and triggers creativeness.

To be an effective design tool though, barrier analysis needs to be better described (i.e. defined) and customized to meet the requirements of design – quick, easy, and practical. The current form does however create a good floor for reflection and discussions, and the process of categorizing barriers provided insights about the domain. We have seen that actively adopting a safety perspective is important for the design of safety critical systems. The barrier analysis used in conjunction with a more traditional design method provided a richer picture that pointed out safety issues. The safety perspective also underscored that the nature of humans in such systems must be understood and that incidents should be seen as natural occurrences in any safety critical system.

It is also important to note that the barrier analysis per se does not insure that safety issues are regarded. Equally as important was the perspective itself, and using approaches and knowledge from CSE greatly affected the study. For instance, an activity associated with the CSE approach is looking at available documentation from accidents and incidents. The choice to look at the reported adverse events was a direct consequence of adopting this perspective, and lead to our focus on medication. This focus later prompted a more thorough description of our persona's medical condition, which in turn had implications for what was included in the blueprint.

Future research

In an attempt to see how the two methods might work together, a simple mapping of the barriers onto the blueprint framework provided added contextual information, but to make sure that barriers are considered in design for complex systems, a complete merge of the methods could prove fruitful. Any such approach must however consider the different manifestations, uses and temporal aspects of barriers that must somehow be accounted for by the merging method. The blueprint could also be adjusted to account for episodes in the system where barriers are in effect, thus eliminating some of the problems with temporal scope that was encountered.

Furthermore we believe that service blueprinting would be useful as a complement to existing CSE methods. Service blueprinting provides a basis for better understanding complex systems from a user perspective and facilitate the process of finding better design solutions. The merits of such an approach need to be further explored.

Acknowledgements

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Author Biography

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After about ten years working with care for the elderly and people with dementia, Johan got interested in human behaviour and took a bachelor in cognitive science. From there he went on to a master in design, eager to apply his newly acquired knowledge about humans as social, communicative, and embodied beings situated in cultural and evolutionary contexts. During this time, Johan also started working with user innovation and managing projects where design students collaborated with organisations and companies. His current research, as a PhD student at Linköping University, aims to expand our knowledge about prototyping services.

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Daniel Anundi

As a graduate student in design at Linköping University with a background in cognitive science his studies have focused on interaction design and service design. His research interests includes among other things interaction aesthetics, health care and service innovation. Currently he is employed by the Swedish Meteorological and Hydrological Institute as an interaction designer and writing his master's thesis on the subject of service recovery.

Stefan Holmlid

Stefan Holmlid is assistant professor in interaction and service design at Linköping University, with 15 years of experience of design research in academic as well as industrial settings. He pioneered studio teaching of interaction design and service design in Sweden, and continues to teach user-driven innovation, interaction design and service design.

Currently his research interests are the expressive powers of and the involvement of stakeholders through design methods and techniques in service development and service innovation. The idea that design objects and design materials can be both dynamic, active and that the design is co-created "in use", drive his research of relevant theoretical grounding for design. His research is founded on a critical stance towards institutionalization of user-centered design.

Complexities of teaching and learning collaborations with international partners: the Global Studio

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Abstract

During the past four years, academics from the School of Design at Northumbria University have developed and implemented an innovative international collaborative teaching and research model named 'the Global Studio'. The Global Studio provides a response within Higher Education to shifting trends taking place in manufacturing and the related emergence of globally networked organisations. This paper examines the challenges of establishing and maintaining teaching and learning relationships with international partners.

During the past four years seven international collaborative research projects involving high profile overseas universities and multinational industry partners have been undertaken within the Global Studio. A focus of the Global Studio is developing a better understanding of product development processes that are conducted by globally distributed and cross-cultural design teams. The Global Studio is enabling staff and students at a university located in the UK to work in a cross-disciplinary and cross-institutional context with staff and students from the participating partners based in countries such as Australia, the USA, the Netherlands and Korea. The cross-institutional collaboration is enabling the intersection of various disciplinary approaches which are facilitating the development of innovative practices.

In this paper we explore some of the complexities associated with conducting the Global Studio. We also provide an example of one of the projects undertaken in 2008. This particular Global Studio was conducted in collaboration with a multinational mobile products manufacturer and two universities based in Korea and the UK. The paper draws attention to complexities of teaching and learning collaborations with international partners.

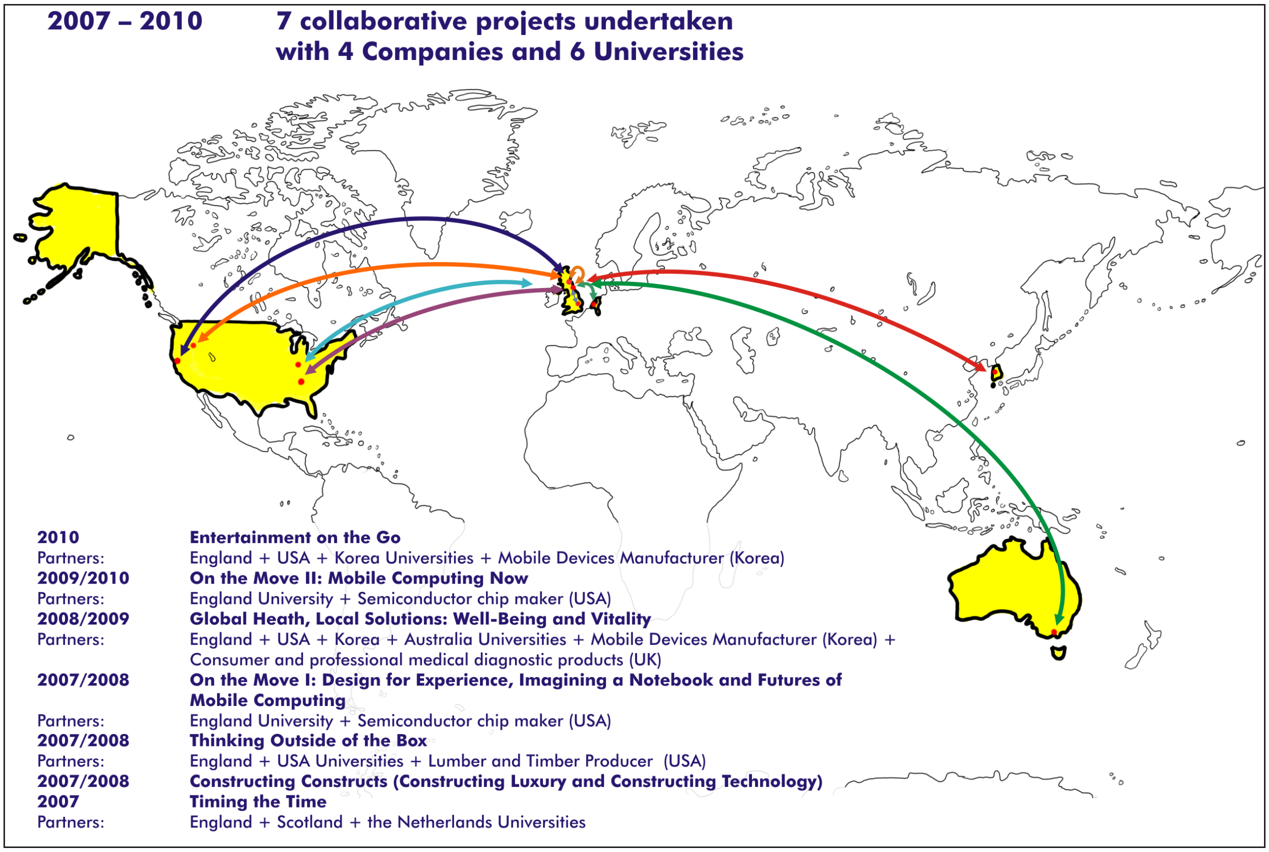
Keywords

distributed design teams; e-learning; design studio; industry based projects; international learning collaboration

Over the past four years the School of Design at Northumbria University has been experimenting with an innovative curriculum design and delivery model named 'the Global Studio'. The Global Studio is a cross-institutional research informed teaching and learning collaboration conducted between Northumbria University and international universities and industry partners. Participating institutions based in the UK, USA, Netherlands, Australia and Korea.

The aims of the Global Studio are linked with current and future industry needs associated with contemporary changes in the organisation of products and services development (e.g. Bohemia & Harman, 2008; Clough, 2002; Cox, 2005; Engardio & Einhorn, 2005; The Design Skills Advisory Panel, 2006) including the shift to the use of distributed terms in the product development process. These changes highlight the importance of equipping design students with skills for working in globally networked organisations particularly the development of skills in intercultural communication and collaboration (Bohemia & Harman, 2008).

Following in the tradition of the design studio, with its emphasis on project-based learning and learning in and through 'doing' (Schön, 1985), students in the Global Studio design a product and/or service using a design process methodology (Cooper, 2001; Pahl & Beitz, 1996; Roozenburg & Eekels, 1995). The emphasis on project-based learning in the Global Studio is underpinned by the assumption that this pedagogical technique contributes to embedding established design practices into the student's own repertoire. However, additional layers have been woven into the course to facilitate the development of skills in cross-organisational and cross-cultural communication and collaboration. Thus, the Global Studio integrates elements from a design studio model of education with elements that equip students with specific knowledge and skills required to work in globally networked organisations and in distributed design teams.



The design of the 'Global Studio(s)'

The initial Global Studio was conceived as a course conducted annually between participating universities located in different countries. There have been a number of initiatives aimed at fostering cross-institutional international collaboration (e.g. Adams, 2002; Akar, Öztürk, and, & Wiethoff, 2004; Coxon, Allen, & de Bono, 2007; Elspass & Hollinger, 2004; Grierson, Ion, & Juster, 2006; Hildre & Fyhn, 2002; Horváth, Duhovnik, & Xirouchakis, 2003; Karjalainen & Repokari, 2007; Novoa, 2007; van Boejen & Babke-Schaub, 2007). However, global projects are often very expensive. For example, a recent collaboration between a European university and an American university cost approximately US$200,000.[1] Another collaboration between a group of European universities cost approximately €50,000.

Thus, one of the major aims of the Global Studio was to provide a learning environment where students could develop skills in intercultural communication and collaboration but in a way that was economically sustainable and that would enable an entire cohort of students to participate.

Another aim was to develop a structure that would enable teaching and assessment to be organised independently at each of the partner universities, thereby overcoming some of the difficulties associated with cross-institutional collaborations (Bohemia, 2004).

In the initial course, student roles and associated activities were structured throughout the project to encourage students to engage in cross-institutional communication and interaction. This was predominantly achieved through having students act in the dual roles of 'client' and 'designer' (see Figure 1). A detailed description of the organisation of the client and designer roles has been reported elsewhere (Bohemia, Harman, & Lauche, 2009).

[1] From a seminar presented at the 9th International Conference on Engineering & Product Design Education, 13-14 September 2007, Northumbria University, Newcastle upon Tyne, UK

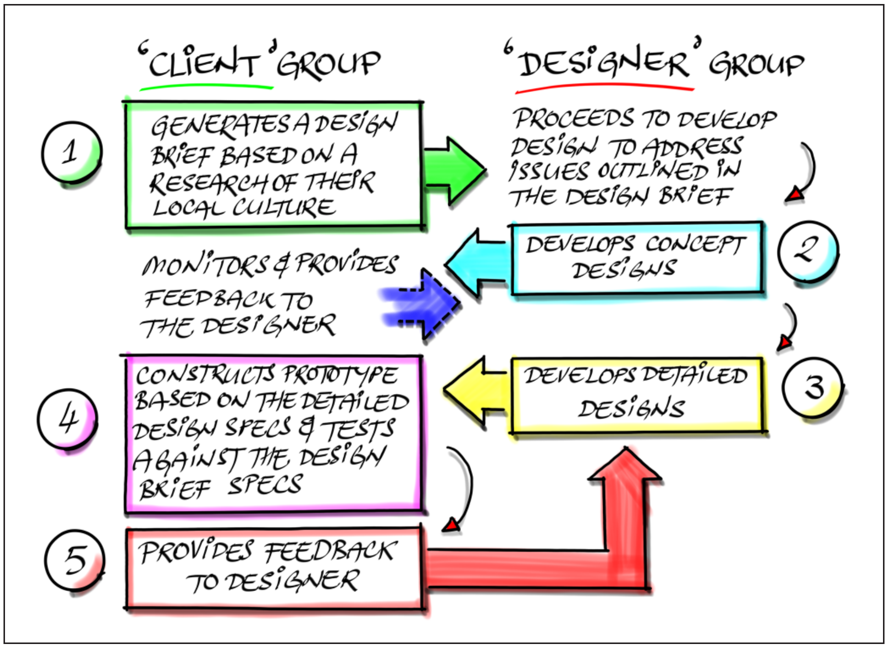


Figure 1 Key stages in the Global Studio

Note: Each group takes up both the designer and client roles

A year later the Global Studio was incorporated into a different programme in the School of Design. This resulted in changes to the design of the Global Studio as the capacity to collaborate with industry partners based in different geographic locations needed to be incorporated into the Global Studio design delivery. This provided additional challenges to those experienced in the previous Global Studio. For example, the inclusion of industry partners increased the complexity of interaction and communication amongst the students, lecturers and industry partners, see Figure 2 and Figure 3 (Bohemia et al., 2009).

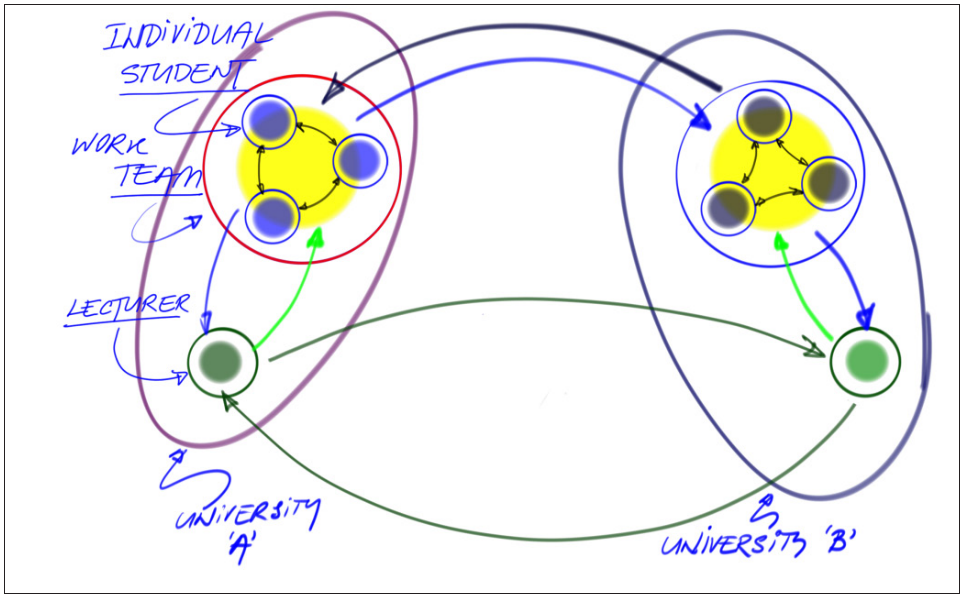


Figure 2 Interactions between student teams and lecturers in the Global Studio conducted in 2007

Note: there were multiple work teams located at each of the partner universities

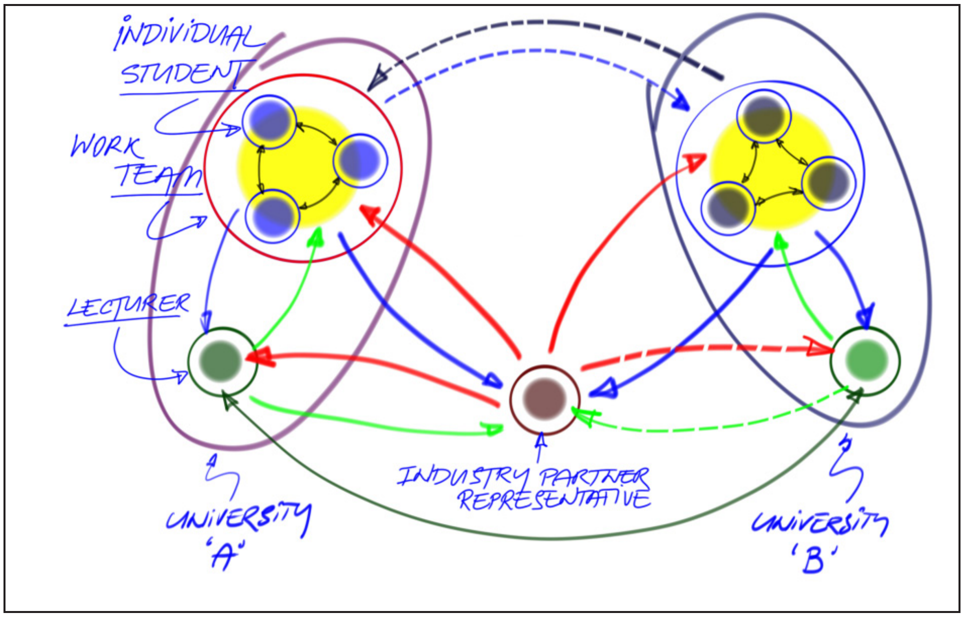


Figure 3 Increased complexity of interactions between student teams, industry partners and lecturers in the Global Studio conducted since 2008

Note: there were multiple work teams located at each of the partner universities

The inclusion of the industry partners also impacted on how projects were structured as well as student roles and interactions. For example, since 2007/2008 it was the industry partners who took-up the role of clients within the Global Studio (see Table 1). This meant that students from the participating universities no longer acted for each other as 'clients' and 'designers' as they had done in the initial Global Studio. This significantly changed the way students from the different participating universities interacted and communicated with each other. For example, having the industry partners acting as the clients shifted the focus of interactions between students from different universities as illustrated in Figure 1 to interaction between students and the industry partner as illustrated in Figure 4.

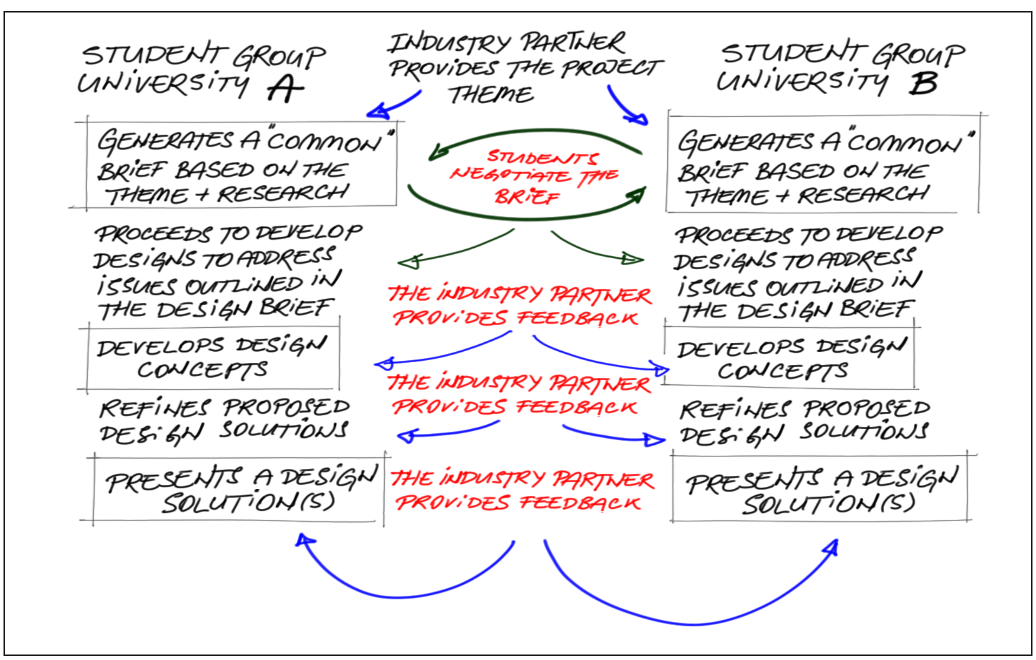


Figure 4 Key stages in the Global Studio incorporating an industry partner's input

This has reduced the reliance of students based at one university from having input from students based at another university. A subsequent outcome was a significant reduction of interaction and need to communicate between students based at the different participating universities. For example, there was less content uploaded on each of the individual group project web pages compared to the previous Global Studio. In addition, data from the student surveys indicated that a lower percentage of students in the 2007/2008 cohort felt that the Global Studio had provided them with the opportunity to explore cultural (53% 2006/06, 40% 2007/08).

Over the four years nearly 450 students have participated on the Global Studio, thus demonstrating that this mode of international studio delivery is possible to be undertaken on a large scale (see Table 1).

Collaborative Partners	**Academic Year**			
	2006/2007	2007/2008	2008/2009	2009/2010
Higher Education Partners based in	• The Netherlands • Scotland • England	• Korea • England • USA (partner A)	• Korea • England • Australia • USA (partner B)	• England • USA (partner B) • Korea
Number of participating individual students	63	60	147	179
Industry Partners		• Semiconductor chip maker (USA) • Mobile Devices Manufacturer (UK + Korea) • Lumber and Timber Producer (USA)	• Consumer and professional medical diagnostic products (UK) • Mobile Devices Manufacturer (Korea)	• Semiconductor chip maker (USA) • Mobile Devices Manufacturer (Korea)

Table 1 University and Industry partners participating within the Global Studio

Key organisational issues

An important question that needs to be asked by prospective partners before proceeding with the design of a Global Studio is: *'Is a cross-institutional collaboration actually feasible?'* Issues that need to be considered include (Bohemia, Harman, & Lauche, 2009, p. 28):

- Timing: Start of academic year, semester length and public holidays differ from country to country. In addition, suitable days and times for synchronous interactions need to be established.
- Level: At what level should the programme be introduced? What prior skills are necessary in order for students to participate in the Global Studio? Do students at different participating institutions all need to be at the same level of study?
- Co-ordination and project leadership: Who is responsible for overall co-ordination of the Global Studio? Is a co-ordinator or project leader required?
- Assessment: What type of assessment would enhance learning in this course? For example, what proportion should be team-based? Should each project milestone be assessed? Can assessment be organised to take into account institutional differences? In addition, a question needs to be asked what should be assessed and who should be assessing?
- Resources: What resources would be needed to run this programme? In particular, are technological resources compatible? Would a potential difference in the level of available resources at one institution disadvantage its students?
- Language: What will be the lingua franca? Do staff and students have adequate skills in the lingua franca? Is this necessary?

- Academic staff skills: What skills should academics have to participate in and manage this type of programme?

In addition to the above issue the following points should be also considered:

- Length of the project: What should be length of the overall project? How much time should be allocated to each of project stages? How might students be provided with low stakes confidence building opportunities to practice various stages of the design process and embed these practices into their repertoire?
- Level of the industry partner support: What level of involvement should the industry partner provide? How do you ensure that students from each participating universities have appropriate access to the industry partner?
- Level of interaction between students: What level of interaction is expected to take between the students from different universities? How should this interaction be encouraged?
- Supporting students: What support should academics provide to students? Should they provide any support/feedback to students based at other universities?
- Research issues: What data should be collected? How should this data be collected? Who has access to the data? University specific ethical procedures/policy.

The above issues and associated questions foreground the complex negotiations required with internal and external stakeholders in order to establish successful cross-institutional teaching and learning collaborations (see Figure 5).

The complex negotiations required to organise the Global Studio, both internally and externally lead us to recommend that the Global Studio be embedded in a core Design Studio module in the programme. This would contribute to making this innovative model of curriculum delivery more sustainable as once the critical negotiations have been worked through they are in place for ongoing delivery.

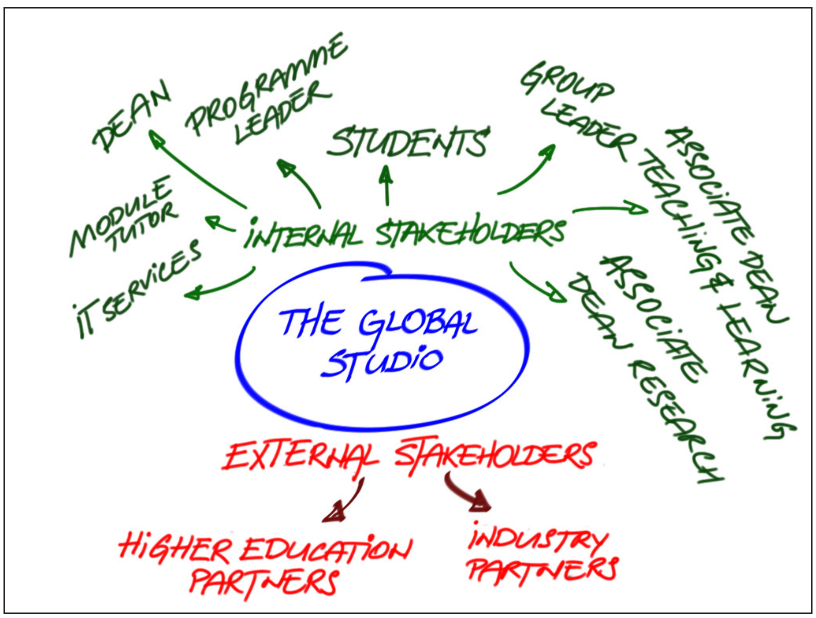


Figure 5 Internal and external stakeholders

Furthermore, generally project-based learning undertaken in collaboration with industry partners requires specific disciplinary skills in order to tackle given project themes. Therefore, these industry based design projects are ‘tied’ to specific disciplinary programmes such as industrial design or fashion design.

Delivering the Global Studio

The Global Studio is delivered using a blended learning approach with a combination of online learning and face-to-face teaching. An important aspect of the Global Studio is the incorporation of Web 2.0 technologies. The focus is on developing skills in distance communication and collaboration by means of these technologies.

There are various models for delivering the Global Studio. For example, the Global Studio can be conducted with other universities, as was the Global Studio in 2006/2007 or with industry partners, as is in the current Global Studio (see Table 1), or with both.

	University	University
University	University + University	University + Industry Partner + University
Industry Partner	Industry Partner + University	

Figure 6 Possible collaborative intersections for delivering the Global Studio

A case study

The 2007/2008 project titled *Constructing Constructs* was conducted between Northumbria University and Korean university in collaboration with a Mobile Devices Manufacturer (UK and Korea design studios). This project explored themes of *Constructing Luxury* and *Constructing Technology*. The contact between the Northumbria University and design studio manager was established at an international conference. This was then followed up by further discussions to establish the project scope, timing and how the project teams were organised.

At the commencement of the *Constructing Constructs* project, students were organised into 3 work teams at each of the universities. Then, the project teams were asked to complete a short design task with the aim of creating a team 'identity'. At the end of this team building exercise each group had agreed on their team name and produced their team logo. The following project teams were briefed by the industry partner via teleconference on the two broad project themes which were New Luxury: *Constructing Luxury* and *New Digital Lifestyle: Constructing Technology*. The next task was for the work teams to develop a design brief addressing one of the two themes. These design briefs were then discussed and fine-tuned with the industry partner. After the design briefs were agreed on the work teams undertook tasks such as brainstorming, mind mapping, market research and user research. At each of the key stages of the project students uploaded their work onto a shared secured space for review by their industry partners. All students, industry partners and academic staff had access to this space. Based on these exercises they then started to develop initial concepts which were presented to the industry partner for evaluation. Based on this feedback they further developed a specific concept to illustrate their design solutions. Again these were reviewed by the industry partner. Final presentations of design proposals were communicated to the industry partner via posters, a movie and design process diaries (see Figure 7).

Figure 7   Constructing Constructs project design process (2008)

Encouraging collaboration

One of the strategies used in the Global Studio to encourage online collaboration is to schedule regular project progress reviews with the industry partners. As industry partners are physically located at another city/country these reviews needed to be conducted at a distance. Therefore, online technologies such as Wiki pages and tele/videoconferencing were used to facilitate distributed communication between the university and industry partners. For example, the *Constructing the Construct* work teams from the Korean and Northumbria universities conducted seven virtual meetings with the industry partner during 10 weeks while the project was running using both Wiki pages and teleconferences (Bohemia, Smith, et al., 2009).

Involving international partners

Regular contacts with representatives from the other universities and industry partners help to sustain these relationships. These contacts can be used to evaluate projects, writing collaborative papers and funding applications and planning for future collaborative projects. In addition, industry partners' ongoing feedback provided to students also facilitates regular contacts.

Attracting funding also helps with sustaining these relationships. For example, funding enables academics to visit their industry and/or university partners as well as disseminating research outcomes at international conferences. It also provides resources to facilitate the development of research networks, support staff sabbatical exchange visits and provide the means for student exchanges.

Managing multiple relationships

There are at least four types of collaborative partnerships that need to be developed. The first is the development of partnerships with other universities. The second are partnerships with external industry partners. The third partnership is with university service support sections such as IT and eLearning and the fourth is with internal and external funding bodies.

Managing and sustaining the above relationships requires the allocation of resources such as time. Therefore, those involved in conducting programmes such as Global Studio need to be supported by their institutions to allow them to engage in cross-institutional collaboration activities.

A model for forging and sustaining successful cross-institutional collaborations

An initial conceptualisation of the Global Studio was that it would enable a research network to be established among the participating institutions in order to gain a better understanding of the ways cross-disciplinary, cross-institutional and cross-cultural design projects are undertaken. This links with an ongoing aim of the Global Studio for the development of collaborative partnerships with industry and the exploration of practice led research on distributed design, see Figure 8. In better understanding how design work is undertaken in distributed work settings, for example the ways particular technologies enable and constrain the design process, innovative solutions might be developed for organising distributed design teams and collaboration across distance. In addition to providing a site for examining product development in geographically distributed work groups, the Global Studio also provides a site for undertaking research with a focus on teaching and learning.

Figure 8 Linking Research, Education and Practice

Contribution of Global Studio

The Global Studio has contributed to a number of key strategic university goals at Northumbria University such as delivering an outstanding student experience; developing excellence in research informed teaching; generating high quality research outputs; increasing research income by engaging with business and funding bodies; and creating a collaborative culture (internally and externally) which actively encourages teamwork, development of staff expertise, and interaction with strategic partners regionally, nationally and internationally. In addition, the Global Studio has enabled participating academic staff to develop research and scholarly activities and it facilitated the development and implementation of research informed curriculum and innovative pedagogic practices. For example, the Global Studio generated close to £100,000 of research income, it enabled the production of more than 20 research outputs including a book (Bohemia, Harman, & Lauche, 2009), journal articles (Bohemia & Harman, 2008; Bohemia, Harman, & McDowell, 2009; Lauche, Bohemia, Connor, & Badke-Schaub, 2008), international conference papers (e.g. Bohemia & Harman, 2009; Bohemia et al., 2007; Bohemia, Lauche, & Harman, 2008; Bohemia, Lauche, Langeveld, & Badke-Schaub, 2006; Bohemia, Smith, & Harman, 2008; Lauche et al., 2007) and it led to numerous invited workshops and guest lectures at leading international universities. During the past four years, seven international collaborative research projects involving high profile overseas universities and multinational industry partners in collaborative research activities have been undertaken within the Global Studio.

Conclusion

Issues associated with initiating and running the Global Studio in some respects are similar to those associated with initiating and running other project-based courses. However, within the Global Studio these issues are amplified as additional factors, such as external stake holders' needs and wishes, need to be taken into consideration. This means that setting-up and conducting the Global Studio is beyond just one person. From our experience, we propose that setting-up and conducting the Global Studio requires substantial backing and support from senior managers within the Schools/Faculties as well as institutional IT support. This is in addition to the commitment that is needed from those who are and/or will be directly involved in conducting it.

However, as outlined above, the Global Studio could provide benefits which potentially address a number issues Higher Education is currently facing. For example, the Global Studio provides an opportunity for internationalising the design curriculum where students are able to practice intercultural communication in collaboration with their international peers. It could also provide students with a novel way to engage with international industry mentors. In addition it has the potential for academics to forge strong international relationships with their academic peers and industry partners thus potentially providing a fruitful ground for developing research projects involving industry and universities.

In addition, the Global Studio provides a platform for teaching staff to continue their professional development in areas such as e-Learning and practice-based Teaching and Learning. The Global Studio could also be used to promote the sharing of resources such as teaching strategies and techniques and collaboration in relation to curriculum development across participating Higher Education institutions.

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Intensive studio experience in a non-studio masters program: Student activities and thinking across levels of design

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Abstract

In conjunction with an emerging view of instructional as a design field versus its traditional identification as a science, the authors have designed, established and studied from 2005—2009 a masters level course using studio-based pedagogy. This paper examines the design tensions involved in that effort from the perspective of the designer/instructors and the design activities and thinking of the students in the most recent iteration of the course. The research is based on analysis of field notes, student work, and syllabi across these five years, as well as on reflections of the designer/instructors. Design tensions center on the difficulties of adapting a pervasive pedagogy into an environment not conceived to support it and on the evolution of the course as it became more studio-oriented. Examination of the student's activities and design thinking was made through the lens of Lawson and Dorst's (2009) models of design, and include analysis of design activities as represented in our field notes together with discussion of sample work from students that illustrate their design thinking. The design models offered a useful vocabulary for discussing student's design behaviors, both with respect to their unique approaches to design and to the observations of the instructors regarding the effect of revisions in the course. We also discuss two categories of design activity used as extensions to the model (using external input and using tools) to describe activities in this class.

Keywords

design pedagogy; studio; instructional design; case study

Although instructional design is a field that has viewed itself for decades as a scientific enterprise, and to a large extent still does (Smith, 2008), questions have been raised about our basic "scientific" identity as early as 1981 (Davies). Recently those questions have been given a clarifying context by the broader discussion of design as an intellectual tradition in its own right (Nelson and Stolterman, 2003), and the recognition that instructional design shares broad characteristics with every other design enterprise, as argued persuasively by Geol and Pirolli (1992) and Goel (1995). This has resulted in the emergence of divergent conceptual tools and broad models of designing within the field of educational technology and instructional design (Boling and Smith, in press).

Questions regarding the way we train instructional designers have also been explored for some time (Boling, 2003; Ertmer and Cennamo, 1995; Rieber, 1998; Rowland, 1994; Sugar and Martindale, 2004; Tripp, 1994). Rowland demonstrated in 1992 that expert professional practice of ISD in the field is not as model-centric as our teaching; it is more in line with the "designerly ways of knowing" described by Cross (2006) and of acting

(Schön, 1983). However, if we examine the standards currently gaining support in the field of instructional design as the basis for masters level curriculum (Richey, Fields and Foxon, 2001) we see that the prevailing view of competent performance is still centered on definable and consistent processes for design (Boling & Smith, 2009). Processes, expressed most often as process models, are useful for designers, but as Lawson (1997) points out in his treatise on architectural design process and its short-lived phase in which process models were popular, the broad scope of design knowledge is in no way addressed by design education centered on process models. Recently, Lawson and Dorst (2009) extend the scope of this argument to claim that the development of design expertise is actually prevented by the use of such models.

The Study

Having considered for some time the various ways in which students in the instructional design program were not developing designerly ways of knowing (Cross, 2006) and behaving (Bichelmeyer, Boling & Gibbons, 2006), the authors undertook in 2005 the adaptation of an existing course in general visual skills for instructional designers into a studio-type course in instructional illustration using a studio model, which is the signature pedagogy (Schulman, 1995) for design education in most traditional fields of design.

This course has been taught, and re-revised, five times since that first revision. We first adapted the ways in which we had ourselves been taught during our respective educations in fine arts and architecture (Boling, 2008) and blended them with the lecture-and-project format prevalent in college-level instructional design programs. Our vision was that we would offer our students an immersive studio experience, which we hoped would compliment and amplify the hands-on project-based curriculum our students already go through. We have used a design tensions framework (Tatar, 2007) to explore the issues involved in making this kind of adaptation of pedagogy, and Lawson and Dorst's models of design (2009) to examine the activities and work of students in the fifth summer class.

The design tensions framework

We make the assumption that designing a course is an act of design and is subject to the tensions inherent in that act. We discriminate between design tensions and "trade-offs," as they are commonly discussed in design. Trade-off implies that one dimension or aspect of a design must be sacrificed or compromised for another, whereas the notion of a design tension requires that multiple valid requirements in a design situation must be reconciled without sacrificing one for the other or compromising either unduly (Alexander, 1979). These tensions have been classified by Tatar (2007) into four types: vision (goals); approach; project tensions; and "as created" situations. During the process of designing and offering a course, particularly when the course is redesigned and implemented multiple times, these tensions tend to arise in a disorderly fashion rather than in neat categories.

Vision

Tatar discusses the tension related to vision for a project as "a tension between what is and what ought to be ... the project vision or potential" (p. 417). While this sounds much like the result of a traditional needs analysis in instructional design, and might very well be, it does not describe the desired outcome so much as the open-ended “problem of active choice” and “interrelationship between the sociological and technological” in design (p. 417). That is, the designers do not attempt to identify a gap between what is known (someone’s knowledge or performance) and what can be quantified as an outcome, so much as to work with the tensions set up by envisioning change.

Approach

Design tensions at the level of approach arise when designers consciously select methods of reconciling what ought to be with pre-existing reality (Tatar, 2007; p. 418). These realities may be anything from limited resources to conflicts in values, and the approach taken toward action by designers is flexible in light of the realities. In other words, there is no single, approach determined by pre-existing realities. Using existing terms from instructional design, this would mean that context, content and audience analyses only tell the designers what the tensions are likely to be for a given approach; they do not bound the choice for an approach absolutely. Designers must choose, or create, that approach in light of the foreseeable tensions present. This is not to say that designers always make up an approach from whole cloth; they may reach for known patterns or “standard configurations” (Vincenti, 1993) with which to reconcile vision with reality. However, this choice will both “narrow the focus,” an outcome well recognized in traditional ISD, and “introduce complex systems” (Tatar, 2007, p. 418), an outcome less often addressed in the basic process models.

Project tensions

The next level in the framework, these are “places in the project that (a) directly or indirectly fall within the designers’ scope of influence but (b) where means, ways, and values come into conflict” (Tatar, 2007; p. 418). Here the designers are moving from a general approach to the specifics of how that approach is supposed to play out in the enacted design. Tensions arising here require designers to attend to specific and concrete realities, versus broader or more conceptual ones.

“ ‘As created’ ” situations” (Tatar, 2007; p. 418).

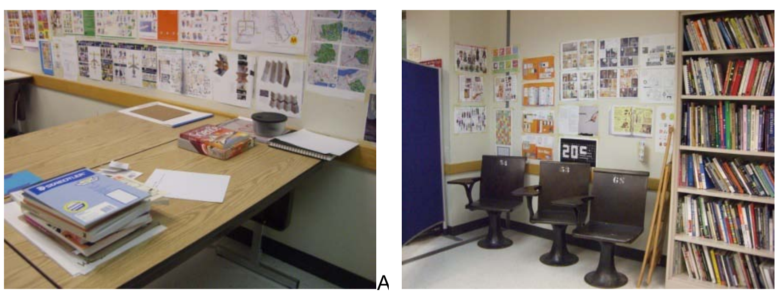
These tensions arise during the implementation of a design as a result of the design having changed the situation into which it is introduced, or of the design having been changed by that situation. “As created” situations give rise to the last level of design tensions in the framework because some of the resulting outcomes of the design as enacted may be in conflict with the original vision. Resolving these tensions may involve reconsideration of the moves that were made to resolve tensions throughout the framework.

The Design Expertise Framework

In their recent extensive exploration of design expertise, Lawson and Dorst (2009) identify three inter-related descriptive models that describe designing; one model covers the nature of design activities, one the levels at which those activities occur, and one the types of thinking in play during design. Design activities are envisioned as affecting one another constantly and in every relationship. The primary activities are: formulate, move, represent, evaluate and manage (p. 51). The levels at which these activities occur begin at the bottom of a pyramid and comprise project, process, practice and profession (p. 61). The third model addresses the types of thinking that may be employed while designing. These are shown as circles within circles, the innermost being convention-based thinking, then situation-based thinking and then the outermost being strategy-based thinking (p.69).

Methods

This repeated single case study extended over five iterations, with revisions, of a course in instructional graphics design in a masters level instructional design program. The authors designed the course collaboratively; it has been taught both cooperatively by both authors and individually by one author. The course is eight weeks long, held in a dedicated studio space with a flat table workspace assigned to each student. Six hours a week are designated as class meeting time; the studio is available to students 24 hours all week. Assignments have varied but always include the conception and production of visuals for specific instructional situations (conceptual or procedural learning, job aids, informational resources, and so on) together with collecting some kind of visual samples from lived experience and completing “Draw 100 Things,” for which students may use any production path they can manage to produce an integrated set of 1”x1” depictions of 100 common man-made objects. It may be worth noting that, in all but the second iteration of the course students and except for Draw 100 Things, project briefs are not the same for each student; students choose their context, audience and subject matter. Participants have included 39 students over the five iterations of the course; these students have been drawn primarily from graduate programs in instructional systems technology and human-computer interaction design.



A

Figure 1 Two views of the studio; A) work-space for two students, B) design books and reading area. Both views show precedent images on the classroom walls.

The data sources for the study include student work and course evaluations for four of the five iterations (2005, 2006, 2008 and 2009), and syllabi and handwritten field notes for all iterations (2005 – 2009). The field notes were most detailed for the latest two iteration of the course when one researcher wrote them immediately following each class session and focused specifically on design tensions (2008; 63 pages) and on student design activities and decision-making (2009; 85 pages). These notes were intentionally as comprehensive as possible, subject to the sometimes overwhelming detail involved in classroom interactions. The unit of analysis for these notes was a statement, portion of a statement, or group of statements representing a distinct idea. After the initial coding, both researchers reviewed, discussed and refined the resulting themes. The researchers used both manifest and latent coding (Holsti, 1969); that is, both explicit and implicit meanings were sought.

For the first phase of the study (Boling & Smith, 2009), explicit statements regarding design tensions (e.g., “Going to the lab … is so far positive. At the same time, opportunistic teaching is less available to all …”) were noted. Implicit meanings that pointed to design tensions (e.g., “I replaced the hard pencils people were using with soft ones – immediate new energy in their sketching;” which may imply a tension between offering an open choice of tools and directing tool use for desired experiences) were also considered. All statements were reviewed and re-reviewed for emergent themes, which were then agreed upon between the researchers as expressions of the tensions consciously felt during the experience of design and redesign and, often somewhat less consciously, captured or revealed in the field notes. We also compared the course schedules and assignments from each summer, and discussed all factors that we considered to have been at play in the course.

For the second, and current, phase of the study, analysis of the field notes began with a close re-reading of them. The notes were then color-coded the notes according to Lawson and Dorst’s (2009) model of design activities. Each notation describing a student framing or re-framing a design problem was marked in pink; each description of a student engaging in evaluation was marked in purple; and so on. During this analysis, the authors conferred on notations describing other activities that took place in class which did not seem to be covered by the model being used and chose to mark up two additional categories of design activity; 1) use of tools and 2) external input. We reviewed these again for themes, but also calculated means and standard deviations for the activities captured in the notes by student to build a quantitative picture of those activities. This phase of analysis also included review of students’ sketches, iterative design products and written papers from 2009, all in light of the field notes and our previous analysis of them.

Findings: Design tensions

Our vision for this course contrasted the “what is” of instructional design—students who struggle with development of designerly judgment (Nelson & Stolterman, 2003), studio thinking (Hetland, Winner, Veenema & Sheridan, 2007), and designerly habits of thought (Cross, 2006)—and what ought to be, specifically, students who do develop these ways of thinking and acting. Tensions at this level included the desire across the faculty for productive change versus the anxiety that experiments in pedagogical format might erode what have long been seen as program strengths, which include strong grounding in systematic processes for design and adherence to reductionist instructional theories rather than design judgment as the basis for rigor in design. This anxiety was most evident in colleagues without prior experience of their own in studio settings, but turned out to be more influential on the researchers than we realized as evidenced by the number of iterations we went through before implementing a well-integrated studio design. n additional tension at this level was that between the resources needed for studio pedagogy and the traditional resources available in the organization. One concrete example involves the use of dedicated space across the duration of a course; this is difficult to do in an environment where classes are expected to move in and out of classrooms every 60-90 minutes, bringing what they need and leaving nothing behind them.

Project tensions included the difficulty of addressing the skills and principles students felt a need to have versus the authentic situated project-based work upon which the course was based. This was related to a tension between offering presentation of principles and techniques versus introducing material opportunistically. For both these tensions the course design needed to provide sufficient support that students were confident to act. However, since the best support was only possible during and after action on the part of the students, we learned that the support could not be front-loaded and that managing “anxiety in action” was more important than creating calculated sequences of prepared instruction. Since this course was not embedded in a full studio environment (where the culture promotes “living in the studio”), we also faced a tension in support of the energy and engagement in the studio through lively discussion/critique versus the time and space individuals need to work and rework tangible products.

“As created” situation tensions involved our concerns over the amount of direct guidance being given to individual students versus their control over decisions and process. In an eight week experience some of them floundered too long without direct guidance, but they seemed to relinquish control quickly in the face of that guidance. Iterations of the course were largely driven by efforts to strike a balance in this situation of tension. Studio pedagogy versus established expectations of instruction, for students and instructors both, was also a major tension once the course was underway. For example, the design briefs we offered were experienced almost as evidence of inadequate instruction by students used to traditional classroom assignments with their full explanations of parameters and detailed rubrics for assessment. In turn, we wondered if we dared to mention to colleagues that the fourth iteration of the course incorporated no prepared presentations whatsoever lest we be seen as shirking the expected baseline responsibilities of an instructor.

Our presentation of design tensions in this paper represents, by and large, the fourth iteration of the course. The fifth iteration incorporated some project refinements, but repeated the basic structure of the fourth. Naturally, the tensions have shifted over time and we have presented those that stand out most clearly across the multiple iterations. Across five summers the course syllabi show a clear shift from more closely specified assignments to less, and from less open classroom format to more open—from 66% structured time in 2005 to 0% in 2009. Critique takes on a different character each class period and is therefore classified as unstructured time. This is particularly true since the “every class” critique plan in the fourth year allowed us to engage in critique without having to dictate the actual structure of critique.

summer	#assignments/ #unique types	minutes of structured time out of 180 total: percent
2005	8/8	120: 66%
2006	8/5	90: 50%
2007	6/5	75: 40%
2008	6/3	0: 0%
2009	6/3	0: 0%

Table 1 Assignments by summer with number of unique types and minutes of structured time out of 180 total per session compared to the total by year

In our efforts to resolve tensions iteratively over the four years, we see the class as having shifted progressively toward a design that resembles studio pedagogy more and more, and looks less and less like an adaptation of that pedagogy. Providing a rich environment and conducting critiques of student work were not course features that could stand alone without sustained periods of time in which students are working and instructors are engaging in dialogue with them about that work *in the moment*. Presentations of principles and techniques, while ensuring that certain topics are covered and that all students are introduced to them, lose their force in a situation where the students' immediate design problems are highly contextual and highly absorbing.

In the most recent summer class we observed them several positive outcomes. Students made active and independent use of the precedent materials in the classroom (primarily a library of about 200 design books and another 150 or so samples of illustration covering the walls), something that had not happened previously. They made more frequent and more complete revisions to their projects than had ever happened before. They began to use critique as a sounding board and an opportunity to benefit vicariously from the design moves of others, rather than showing only their refined work and making minimal revisions in response to input. They experimented more freely with materials than previous classes have done, and several of them made extensive use of precedent models to explore approaches used by previous designers and applicable to their own self-defined design goals. On the whole, they made a stronger shift toward expressing themselves in terms of design principles than most members of previous groups. They grew comfortable in the studio space and were purposeful about spending their work time to solve particular technical and design problems rather than fiddling with tools until someone came around to direct their efforts. In the second phase of our study we focused on this aspect of the course in order to make these observations more purposeful and systematic.

Even so, while the current course does create an intensive "studio bubble" experience for students that seems to exert a strong effect on them, that experience does not last nearly long enough to ingrain the long term changes in thinking and character that we desire for these students. The course is sustainable, and in demand, but it does not do more than give students a start, or a recognition that such dimensions exist within design. This leads us back to the top level of the design tensions framework. We never wanted to leave behind the genuine benefits of a systematic orientation to design—only to address dimensions we saw as lacking; specifically, development of design judgment and designerly ways of thinking. Both of these are traditionally developed in a studio-type setting, and it is not clear how well they can be developed outside such a setting or in a setting that includes only some of this signature pedagogy, divorced from other aspects that support the whole and make it work—or in a setting that offers only one or two courses, or semesters, of studio education. We have seen in 2009 that students coming into the course from a full year in the HICD program which does emphasize design thinking (although not in a classic studio format) brought with them a little higher comfort level with some aspects of design thinking. However, we feel the need to return to the vision level of the design tensions framework to address in more detail the difference between what is and what ought to be in instructional design education. In point of fact, we have done so; our department is planning the conversion of our onsite masters program to a one year intensive, full studio experience.

Findings: Design activities and thinking

The most frequently recorded design activity was working with external input (m=14.8), which may not be surprising for a class in which most students were beginners (in illustrations, if not in general design). This activity was an extension of the framework and covered discussion and guidance from the instructor, peer critique suggestions, and use of precedence materials. Of the activities in the original framework, the move was most common (m=12.3). Formulating (m=6.9), using tools (m=6) and evaluating (m=5.8) followed in descending order, with representing (m=4.8) and managing (m=3.5) lagging behind. (See Table 2 for summarized findings.)

	formulate	move	evaluate	represent	manage	external input	using tools
Han	10	11	6	6	3	13	8
Don**	12	14	9	7	2	18	2
Min	7	13	3	5	2	14	9
Van**	5	9	6	2	2	16	3
Nikki**	9	8	5	5	3	11	4
Randy*	5	12	5	4	3	13	6
Andy****	3	8	3	4	4	9	7
Ana**	6	12	4	6	1	16	5
Dan*	9	22	7	5	7	26	4
Dana*	3	14	10	4	8	12	12
mean/SD	6.9/2.9	12.3/ 3.9	5.8/2.2	4.8/1.3	3.5/2.2	14.8/4.5	6/2.9

Table 2 Recorded design activities by student (pseudonyms used) with means and SD for each type of activity. NOTE: *absent once **absent twice ****absent 4 times

The high standard deviation for external input activity may have been influenced by the absences of individual students from certain class periods and resulting lack of field notes for them. In addition, two students completed their projects after the class ended, one for health reasons and one due to loss of computer data, which affected both the mean figure (which presumably would have been even higher) and the difference between numbers of moves (which presumably would have been lower) across the class. However, we also mapped the activities of these students over time and then studied the maps. This study showed that each student exhibited an individual profile of activities across the class sessions (some were fascinated with tools and explored them more than others; some formulated and reformulated ideas then moved quickly to finish their work).

We came to see these profiles as representing in action the combination of predilections, experiences and existing skills brought by each of them to the class in interaction with the experiences afforded to them by the class and the guidance offered to them while they worked. They were clearly not an undifferentiated mass of “novices” who could be led via a pre-calculated set of experiences to become a uniformly improved group of graduates, and neither was any one representative of a fixed point on a path toward expertise through which every other one must necessarily pass; each needed to be developed with reference to her unique profile. Returning to our earlier study of design tensions, this finding informs our observation that a less structured course design produced more of the learning and design behaviors that we hoped to see in these students. External course structure (presentations, exercises, planned discussions, reports) was replaced with enough time for the instructor and opportunity for action on the part of each student to allow for responsive interaction within the context of meaningful work—different interactions and different work for each student.

As we noted informally in 2008, students in the 2009 class were documented reformulating their design problems more often, more significantly, and with less concern for the rework it was going to cause them than did students in previous summers. Every student reformulated one or more designs after the eight class period (halfway through the term) with 37 instances recorded and only four of these indicating projects that were simply started very late. In the illustrated case (Figure 2), Dan pushed his initial concept through three reformulations, one of which required total rework of all 100 images. The substantial amount of work time available to them, frequent critique sessions and desk discussion of their work in progress seems to have shifted their focus from reluctant revision of work after formal review by the instructor to self-motivated reformulations of their core ideas.

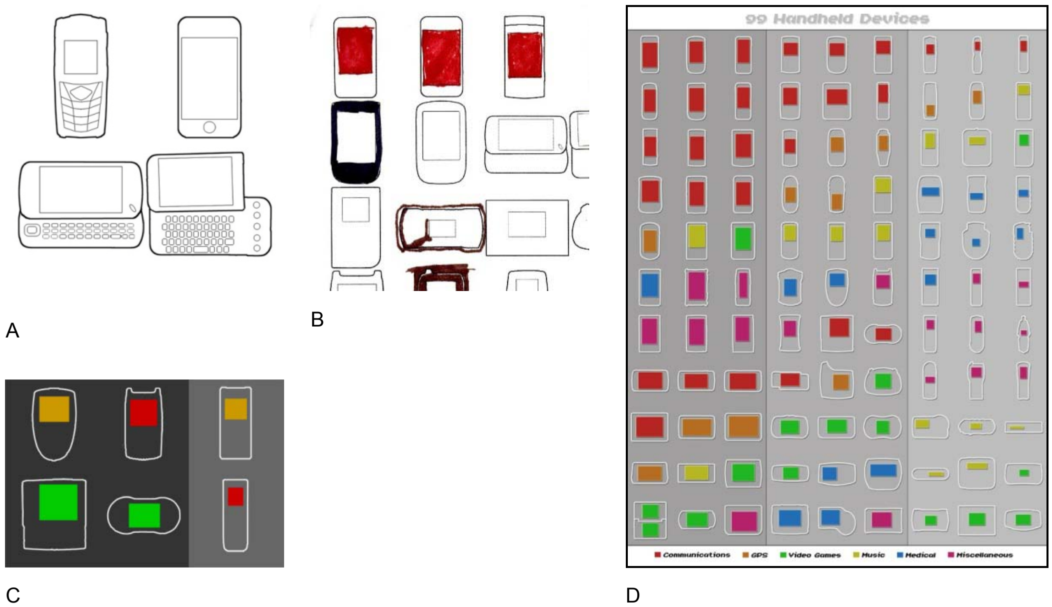
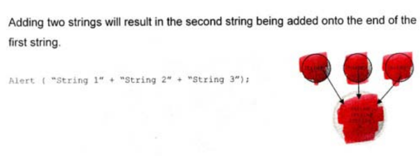


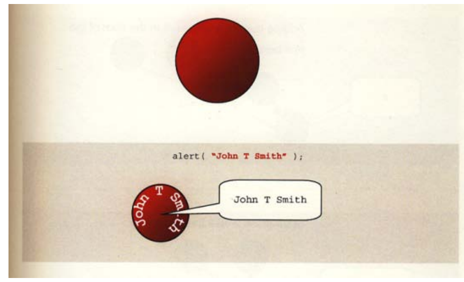
Figure 2. Dan's 100 Things were framed first simply as handheld devices (A), then as types of devices (B), then as demonstrations of different ratios of screen size to device size (C), and then as a more complex diagram showing three classes of screen/device ratio color coded by type of device.

In the first three iterations of the course, we noted that students spent very little time examining the examples of illustration on the walls of the classroom, and no time exploring the books. We logged the books online, assuming that these students might be more comfortable with rapid searching online that with browsing physical shelves and one summer we laid out books each week in the classroom relevant to the presentations for that week. Neither strategy made a difference. In 2008 and 2009, after presentations were discontinued, the instructor had time to pull books off the shelves and point to the walls while talking to students about their work in progress. In the 2009 field notes, of 164 notations coded as external input to design, 18 instances (about 9%) refer to the use of precedent on the walls or in the class library.

The field notes reveal that students were willing to make decisions about tools based on their goals and the moves they saw as important, rather than restricting design moves to the tools they knew or could manage already. In the two cases illustrated, Dan changed tools (incurring significant extra effort) in order to enable moves he needed to make (Figure 3) and Min chose a tool she had never used before to achieve the look she wanted for one of her graphics (Figure 4).



A



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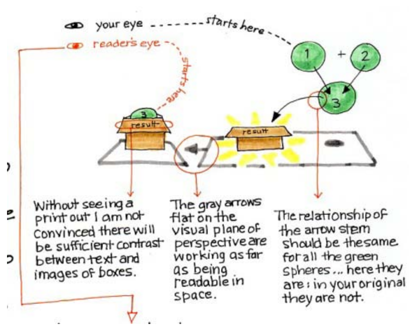

C

Figure 3 Dan sketched his vision for a booklet he planned that would teach programming through a combination of text and visuals (A) and he began producing pages in Word, a tool he already knew how to use; in midterm feedback (B), the instructor pointed out several problems with the graphics that Dan could not address with the functions available in Word; he decided on his own to rework the dozens of pages that he had previously considered complete using Publisher—he had never used this or any page layout tool before.

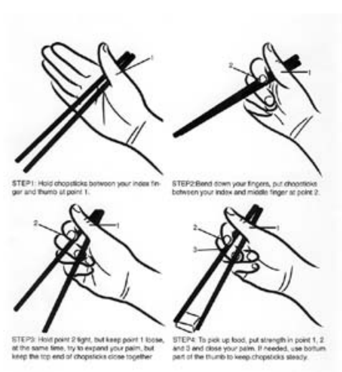

Figure 4 Min used the hand model provided for class to shoot source photos for her procedural illustration on using chopsticks; she reshot the images after realizing that the first set were not taken from the best perspective and was ready to trace these photos by hand to produce the graphic when she saw a classmate using the brush tool in Illustrator; she felt the tool would be appropriate for this graphic—although she had never used Illustrator, she chose this tool to create the final image.

Findings: Types of thinking

Students who situated their projects in contexts well known to them used situational and strategic thinking more often and to better effect than those who chose projects further from their own experience base. Andy and Ana's projects (see Figures 5 and 6) illustrate this connection between choice of project and the type of thinking students employed. While all the students made decisions based on convention, it appeared to us that deep understanding of the context for a design assisted some of the students in recognizing unique factors of a situation that demanded different thinking strategies. In the case of Andy's project, he also employed some strategic thinking, inventing what was for him a new process of design in which he sat with his in-laws and photographed them while they used their TV and CD player.

Paradoxically, strategic thinking did not necessarily produce artifacts that we also judged to have the potential for highest usability or appeal. That is, a student may have been exercising more expertise in one dimension of designing than another student, but have arrived at a result with less overall utility. The difference, at least in this illustrative case, is that the tangible realization of the artifact exerts its influence not just as a failure to realize the concept, but as a confounding factor that interferes with the concept. To make an analogy with writing, fuzzy writing is widely agreed to be a symptom of fuzzy thinking. However, clear thinking does not automatically result in crisp prose unless the writer has a practiced facility in the first place; and lack of such facility can actually infect the thought process. Just as process models are not sufficient to produce a good result (Rowland, 1995), so one or another type of design thinking is not sufficient. Of course this is hardly news, but in the quest to encourage one or another type of thinking in our students, it is worth remembering.

Figure 5 Single page from Andy's instructional booklet created to help his elderly in-laws use their entertainment system; Andy made strategic decisions about where his in-laws would keep the booklet, how easily he might replace it if it were lost (which was very likely); what size the images would need to be for them to be seen easily; and how showing a thumb on the remote would support the viewer—but he also produced an artifact in which it was difficult to follow the sequence of visuals and to interpret the captions.

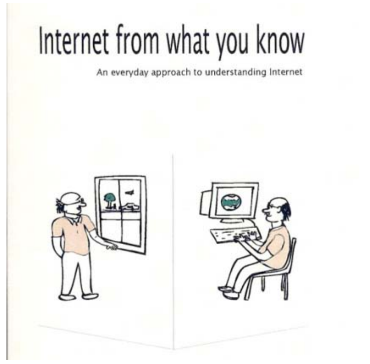

Figure 6 Cover of Ana's booklet explaining internet concepts to elderly people in India; although she was from India, her experience with the elderly ("people over 50") was not immediate or extensive and she struggled with finding appropriate metaphors and the right level of detail for presenting concepts—however, her attention to details in the images and to clear layout resulted in an artifact that we anticipate would reward close study with rich communication.

Findings: Levels of thinking

The students operated primarily at the project and principles levels, as might be expected in a short course focused on one specific aspect of instructional design. A few questions did arise from students, or were introduced by the instructor, regarding practice level issues in design (e.g., the influence of legal departments on what can be shown or not shown in procedural graphics, for example, or the degree to which an individual illustrator is responsible for optimizing a graphic for viewers from different cultures), but this was not the norm.

Summary

As we launched the second phase of this study, we expected to look for evidence that the students were making progress in design thinking during the course as described by the language of the Lawson and Dorst (2009) models of design. In actuality, we used the models not as a way to measure progress directly, but as a valuable lens through which to promote, observe and discuss design thinking and activities in our students, as well as to characterize the unique profile each student brought to the course. We were able to document the guidance given to students during class separately from their design moves and their own evaluations of their work, easing a design tension identified the year before. Some of our findings from these small case studies may not seem very radical to those who teach in studio settings all the time, but they represent important shifts in pedagogy for instructional design. We also found ourselves extending the model of design activities (Lawson & Dorst, 2009) to account for account for the contribution of external input to design and for grappling with the tools involved in designing.

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When Will Customers Claim Their Rights as Empowered And Creative Human Beings?

- a rhetorical perspective on co-creation

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Abstract

Designers as well as business leaders are strictly focusing on co-creation and co-creation activities as an effective method to innovation in business and product development. Paradoxically we seem to forget the perspective of the customers.

The intention of this paper is to bring a rhetorical approach to ‘co-creation’. This approach emphasizes co-creation as a specific form of rhetorical design discourse directed at customers who are introduced to new creative ways of expressing themselves. The rhetorical perspective also emphasizes how this discourse is capable of constituting its audience in new roles, here as empowered, active and creative people. This co-creation discourse is considered an art ‘constitutive rhetoric’ (Charland, 1987). The crucial effect of the constitutive rhetoric is the audience claiming its right on behalf of this constitution. This raises the question: when will customers claim their rights on behalf of these new roles - as creative human beings - and how can we possibly develop co-creation and reply to this possible demand?

In co-creation sessions designers are appealing to the customers´s creativity by presenting generative tools in order to make the customers express their creativity, their tacit knowledge, their dreams and needs. The paper agrees with Sanders that these generative tools entail the possibility of growing into a new language not restricted to co-creation sessions and organizational development (Sanders, 2002). Using the generative tools is a way of inviting design thinking and creativity into everyday peoples lives, offering them a way of reflecting and responding as creative human beings. Rhetorically this means offering the capacity to act also called ‘rhetorical agency’ (Hoff-Clausen et all., 2005) and as such a possible solution to customers claiming their rights as creative human beings.

The paper will outline different understandings of co-creation as well as bring experiences from co-creation activities conducted in a present research in a Danish bank. The paper will also bring an example of customers claiming their rights.

Keywords

co-creation; constitutive rhetoric; agency; generative tools; creativity.

Different perspectives on co-creation

The popular business researcher Richard Normann claims we are moving towards a veritable revolution where value creation will be the core activity of the organisation and customers will act as co-producers, co-creating values. Normann claims organisations to be value creating systems and co-creation to be a practical tool for involving the customers both in the value chain as a whole and in the business system of the company (Normann, 2001). According to Normann we are leaving an industrial strategic paradigm and moving into this new paradigm with focus on value creation. The industrial paradigm was about producing goods and services to be ‘pushed’ into a marked, where consumers were acting as passive receivers of the goods. In recent years companies have moved into a kind of in between state where the central concern is about 'relations' as seen in service and service management. Central here is customer relation management as customers are regarded as a source for information, ideas, needs etc. According to Norman we are now facing what he calls 'the real revolution' – the absolute opposite to the industrial paradigm – where the customer is regarded as co-producer involved in the creation of value.

In this move user centred innovation has been the dominant paradigm of the past decade and 'users' and 'co-creators' have been popular terms both in the field of design and the field of business. Unfortunately different and confusing understandings of co-creation are ruling. Here a crucial difference is whether you regard the user as 'a subject' or as 'a partner'. In von Hippel´s notion about 'the lead user' and in Prahalad & Ramaswarmy´s idea about co-creation the user as 'a subject'-perspective is present (Prahalad & Ramaswarmy, 2004). The fact that designers regard 'customers' or even human beings as 'partners' is a crucial matter and a very important reason why designers are having their heydays in relation to user studies. As Verganti claims designers are having an amazing capacity to get close to users and understand their needs (Verganti, 2009). An essential reason for this is that designers do not 'fixate' human beings into specific roles as 'customers', but consider human beings as co-creating partners. In that sense designers are releasing themselves from a very limiting organisational perspective and presenting a more holistic view on organisations and human beings – in fact the picture of organisations that Norman is sketching. Unfortunately designers are often employed by business leaders and as the business leaders tend to have the 'user as a subject'-perspective, this is the dominant perspective in business and the reason why co-creation activities often are limited into 'user inputs' rather than real co-creation activities in organisations. In this way designers seem to hold the key to real co-creation activities and to the reframing of organisations (Normannn, 2001).

Locked in an organizational perspective

The tendency that business leaders seem to overlook the fact that 'co-creation' means 'creating together' rather than getting inspired and getting ideas from users leaves both designers as well as customers in a locked position. Sanders who have developed 'Make Tools' as a new type of language already claims: *"Design is serving markets, not people. Design is serving the needs of companies, not people"* (Sanders, 2006, p.28). This article goes beyond Sander´s view in offering a rhetorical perspective that brings new insight to co-creation. The article focuses on how co-creation activities constitute customers as 'experts', 'creative human beings' or 'co-creators' and how these 'new' experts and co-creators often end up in the business organisation reduced to 'user inputs'. This raises the question: what effect does such a discourse have on the audience? Applying a rhetorical perspective on co-creation brings useful insights for designers when understanding and developing co-creation. First of all I will outline the nature of co-creation activities and techniques, among these also the activities used in a current research in the Danish bank, Middelfart Sparekasse.

Co-creation activities and techniques

In the field of co-creation designers and design researchers are developing an increasing amount of tools and methods for co-creating activities. (Gaver, Dunne, Pacenti, Mättelmaki, Sanders, Stappers, Visser et all). Some serve as cognitive tools that 'leave room' for the participants to express their creativity, their dreams, needs and tacit knowledge. Due to completed experiments in my current research in the bank, Middelfart Sparekasse I consider these methods powerful as the participants explain they achieve higher awareness about emotions and relation to certain issues.

When designing material for creative sessions Sanders suggests a converging perspectives approach that combines different methods, tools and artifacts that furthermore combine what people 'say', 'do' and 'make' (Sanders, 2001). A combination of approaches from marketing research *('what people say'),* anthropology *('what people do')* and participatory design *('what* *people make')* is applied. Following the converging perspective, the participants were interviewed, asked to do things and asked to make their own expressions. Central to this way of 'asking' is the idea that the designer leads the participants through a 'guided discovery' appealing to their creativity and inner feelings and hereby sets a stage for them to express their thoughts and ideas.

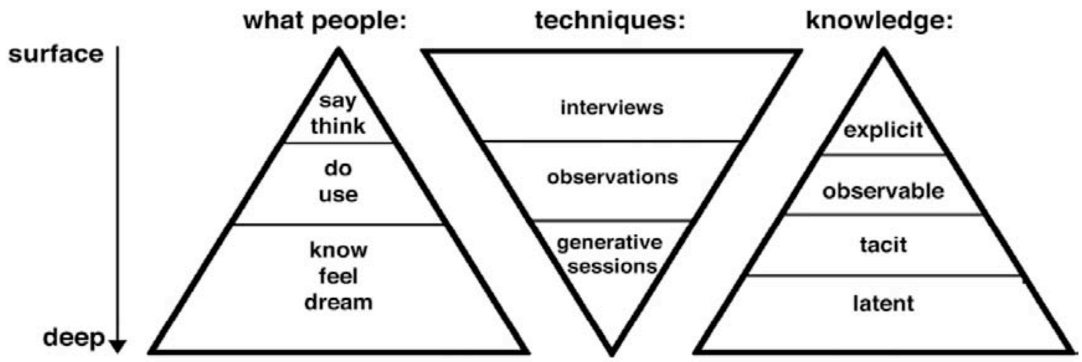

Fig. 1. Different levels of knowledge are accessed by different methods. (Sleeswijk Visser et al., 2005)

Talking with people by, e.g. interviewing them, provides information about what people can say, which is mainly explicit knowledge. Observation studies give insight into the physical context of people and how people do things. Generative techniques use the creativity of people to become aware and express their own experiences. Creative tools or self documentation techniques (Gaver et al., 1999; Mattelmäki, 2006) help people reflect on their memories, feelings, motivations, create awareness about their experiences, help them express themselves in a visual form, and help them use these representations as a basis for talking about the experiences (Stappers and Sanders, 2003).

Central in the field of generative design research are the 'generative tools', the thinking tools non-designers can use to express their inner dreams (or fears) for the future. Generative design makes us see how things *could be* and empowers everyday people to generate and promote alternatives to the current situation. In this field you find researchers such as Sanders, Stappers, Visser et all. A central concept in the field of critical design is 'probes'. Cultural Probes originate from Gaver et all. (1999), who designed them to provoke inspirational responses from elderly people in diverse communities. Originally probes are packages containing maps, postcards, a camera and a diary. These packages are sent to the private homes of the participants, who respond to them and return them to the designer. Probes are primarily used in places or circumstances too private for researchers to show up in person. Their aim is to "*make the participants think*", to "*provoke existing values"* and aim at "*generating and promoting alternatives to the current situation"* (Sanders, 2006, p.1).

In the present research project approximately 4 different types of creative sessions have been conducted with all in all 21 participants. The intention of the creative sessions was to meet human beings and to let them reflect and express their relation to money, private economy, banks, financial advisors etc.

Experiences from the creative sessions

When designing artifacts for the different co-creation session at the bank, I designed a box (Fig. 2). The intention was to make a private 'room' for the individual to respond in, but still having the possibility to observe and start plenary discussions. I have completed different co-creation sessions (a total of 22 persons). I one of the experiments, the participants were invited into the same room, and each received a box filled with material and tasks. I designed the box as a private 'room', leaving space for reflection, memories and ideas when responding to the questions, the provocative statements and the creative tasks. This 'reflective room' was designed with a happy artificial long green grass carpet in the bottom, topped by the material: pictures, pieces of paper, scissor, glue, coloured pencils. The box had an appealing and accommodating look, almost like a gift with long green ribbons attached to small notes, telling people what to do.

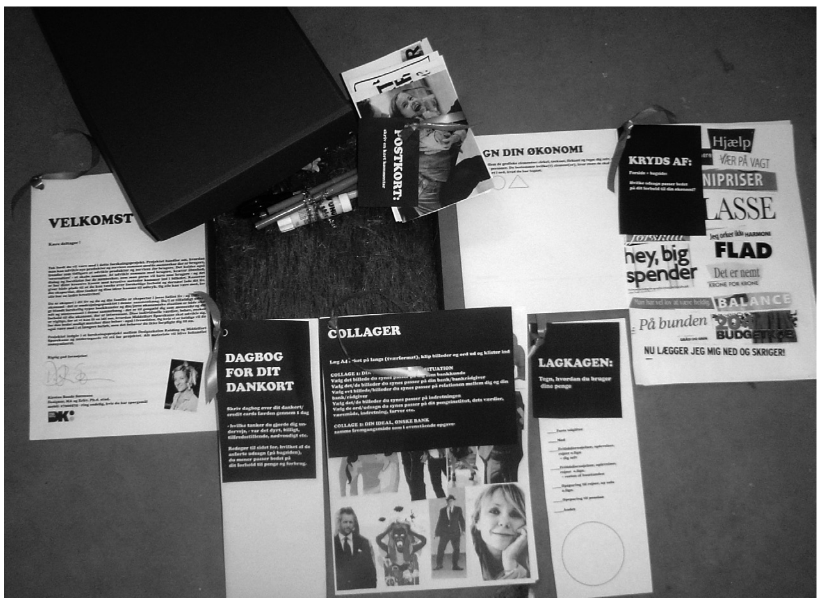

Fig.2: Illustrating the box containing different creative tasks, pictures, pencils etc.

The workshop started out the in the easy 'making' level of the creative tasks and ended up in the 'creating' level. As per Sanders (2008) there are four levels of everyday creativity, ranging from 'doing' to 'adapting', to 'making' to 'creating'. Where 'doing' represents an ordinary productive activity, 'adapting' means to make something one's own by changing it in some way. The motivation behind the third level of creativity, 'making', is to use one's hands and mind to make or build something that did not exist before. And finally the most advanced level of creativity is the fourth level, 'creating'. The motivation for 'creating' is to express oneself or to innovate and these types of real creative efforts are both guide by a high level of experience and executed with passion, Sanders claims.

At the 'making' level, the participants were asked to make comments to statements printed on postcards, asked to underline the preferred sentences, for example describing their relationship to their private economy. At the end, at the 'creating' level they were asked to make a collage (Fig. 3A) illustrating their current relationship to their economy by adding: 1) a picture illustrating themselves as customers, 2) a picture illustrating their bank/financial advisor, 3) a picture depicting the relationship between the two, 4) a picture illustrating the surroundings and 5) words underscoring the chosen pictures, all in their own words. Afterwards they were asked to make a new collage, (Fig.3B) in a similar way, but illustrating an ideal future situation. Finally they were asked how to get from Collage A to Collage B. These collages and answers were primarily used as material for analysis, as they were 'the final creations' presumably incorporating all the reflections. An important point is that the participants were asked to present their collages in front of a camera and these verbal presentations formed the primary material for analysis supported by the visual expressions.

Co-creation as constitutive rhetoric

From a rhetorical perspective co-creation can be considered an art 'constitutive rhetoric'. In the field of co-design researchers have introduced the importance of seeing and regarding the customer as 'empowered', 'creative', 'co-creators' and 'human beings'. Approaching the customer, it is crucial the participants (customers) feel 'empowered' and as 'experts'. Researchers from the field of co-creation are underlining this by purposing to give badges to the customer saying: "*I am an expert in my life".* Having completed several co-creation sessions in a bank (with approximately 20 participants), this manoeuvre is quite powerful and the participants actually do feel empowered and experts.

Charland´s notion about constitutive rhetoric (Charland, 1987) implies the idea of rhetoric that 'constitutes' the audience in a double way: It constitutes the audience in a specific subject position (here customers being creative and experts in their lives) but in the same time, Charland claims, this audience will claim its rights on behalf of this constitution, this 'new' subject position. Charland´s notion about 'constitutive rhetoric' is presented in his article: "The Case of the Peuple Québécois" (Charland, 1987). In Charlands study of the "Peuple Québécois" he shows how advocates for Quebec's political sovereignty *''addressed and so attempted to call into being a people quebecois that would legitimate the constitution of a sovereign Quebec state''* (Charland, 1987, p. 134). A key term in rhetoric is 'persuasion' which implies the existence of an audience free to be persuaded.

In Charland´s study of the nationalistic movement in Quebec he argued that certain forms of discursive practice function as constitutive rhetoric. Charland claims constitutive rhetoric does more than create an image of its audience, it generates the conditions of possibility that can structure the identity of those to whom it is addressed - analogues to Althusser´s notion 'interpellation', Charland claims. Interpellation occurs at the very moment one enters into a rhetorical situation, that is, as soon as an individual recognizes and acknowledge being addressed. Althusser uses the example about an individual walking down the street. He is challenged by a policeman calling: "Hey you!" and the individual reacts by turning around. By turning around he acknowledges the call was pointed exactly at him. In this simple bodily movement, by turning around, he gets transformed into a subject.

In Charlands study he concluded that *"it is up to the Québécois of 1980 to conclude the story to which they are identified"* and into which they have been interpellated. In Charland´s study he emphasizes the way narratives function: *"In other words while classical narratives have an ending, constitutive rhetorics leave the task of narrative closure to their constituted subjects. It is up to the Québécois of 1980 to conclude the story to which they are identified"* (Charland, 1987, p.143). Charland claims constitutive rhetoric to be an ubiquitous force that shapes the identity of its addresses. In the 'act of addressing' auditors, an advocate´s message awakens or energizes certain possibilities or a specific identity or subject position for that audience. In certain cases, Charland noted, this process is akin more to one of conversation as audiences come to inhabit a *"reconfigured subject position"* (Charland, 1987, p.142). An example to illustrate this is: *"In a television commercial for toothpaste, managers not only to sell its product but also to energize certain identity possibilities as it positions its audience in the role of 'consumers'. We become consumers or we are (re)positioned in the role as consumers, as we are addressed by the commercial",* Jasinski claims (Jasinski, 2001, p.107).

Charland´s conception of constitutive rhetoric was developed to illuminate the workings of political discourse, yet it provides a framework to understand how audiences are rhetorically constructed by advertising texts. Charland builds on Kenneth Burke´s proposal in "A rhetoric of motives" (1969) to use 'identification' rather than 'persuasion' as the key term of the rhetorical processes.

Nike – a case

Maybe we have already seen the first examples of interpellated and empowered customers claiming their rights in the following NIKE co-design case: On the internet, at NIKEiD it was possible to design your own shoes. Although customers are not explicitly constituted in new subject positions, NIKE implicitly addresses the audience as creative human beings with *"the freedom to choose and freedom to express who you are".* (http://shey.net/niked.html). A customer, Jonah Peretti ordered a pair of shoes with his personal ID: "sweatshop". NIKE rejected his order claiming "sweatshop" to be "inappropriate slang". Peretti referred to Websters dictionary saying "sweatshop" is standard English with the meaning: *"a shop or factory in which workers are employed for long hours at low wages and under unhealthy conditions".* Peretti continues in his mail to NIKE: *"I was thrilled to be able to build my own shoes and my personal ID was offered as a small token of appreciation for the sweatshop workers poised to help me realize my vision. I hope that you will value my freedom of expression and reconsider your decision to reject my order."* Peretti never had his shoes, but had to change his ID. The mail thread was sent to some friends, now it is available to everybody on the Internet, a menace to the brand and especially to their image as they were not capable of delivering what they promised.

This is an example of implicitly constituting customers with 'the freedom to choose and the freedom to express who you are' and customers claiming their right on behalf of this constitution. This also is an example on how companies are using the right words in order to appeal to the new customer, but unfortunately they have not realized the effect of the discourse.

In a broader perspective the NIKE example is only a small part of a present and immense promotional discourse including co-creation- and user-driven discourses. The case also illustrates how NIKE *apparently* offers huge 'freedom to express yourself '.

Co-creation - with or without rhetorical agency

In co-creation and co-design (a subnotion of co-creation) the very notion includes the idea about equality and freedom to create, design and act. In rhetoric the notion, rhetorical 'agency' stands for the capacity to act rhetorically. On one hand the notion refers to the instrumental aspects of rhetoric like rhetor´s use of resources in order to reach a goal. As such agency can be translated into rhetor´s capacity to act in relation to his talents and strategies. On the other hand the notion refers to both the circumstances in which rhetor constitutes him self and the circumstances rhetor is constituted by. Generally agency is focusing on the constellation of individual and structural elements and how the interaction between the speaker and the situation is of relevance to the rhetorical construction of meaning and influence. In a rhetorical analysis or discussion the chosen focus on aspects in a specific constellation will reveal the use and understanding of 'agency'. (Hoff-Clausen, Isager & Villadsen, 2005).

To elaborate on the notion 'agency', Hoff-Clausen et all. give an very illustrative example of a human being with an ethos based on the idea about rhetorical agency: Günther Wallraff, a German author and critic was hired as a reporter on the tabloid magazine 'Bild Zeitung' under false name. During 3 months he worked under the editorial principles he intended to bring into light and his following accounts of misrepresentations and fabrications, extortions, tappings and housebreakings caused a sensation all over the world. Hoff-Clausen et all. claim this to be an example of a citizen who responds intentionally to a discrepancy in the public space, as he uses his rhetorical competences in order to accomplish a rhetorical strategy that establish his personal drive and striking power and moreover gets an effect on the discrepancy in question. In the example 'agency' is illustrated in Walraff´s use of his capacity to act - his talents and strategies, but Hoff-Clausen et all. also claim that in this rhetorical scenario the persons who are 'borrowing

Wallraff´s voice', the persons who are being giving rhetorical agency, are the victims of the journalism and colleagues at Bild Zeitung.

Going back to the Nike case, the company actually acts and communicates as if they were offering rhetorical agency for the customers by offering them *"the freedom to choose and freedom to express who you are*". Peretti acts on behalf of this rhetorical constitution and agency and illustrates thereby that there actually is only very little and very limited agency.

This raises the questions in relation to co-creation activities: what kind of agency are these companies offering? Through co-creation activities customers and users as constituted as 'co'creators', 'creative human beings' etc. but what kind of reactions do they actually tolerate?

According to Buchanan´s mapping of design and designers, the Nike example also illustrates both the development but also the power within design. In Buchanan´s mapping (2001) design and designers are mapped within four orders: In the first and second order focus on 'symbols and images' and later on 'things' and gave rise to graphic design and industrial design. In the third order changed its focus to 'action' and gave rise to interaction design. The fourth order is related to action, but focuses on the 'environment and systems' within which action takes place. This is the area of 'thought', since it is fundamentally concerned with the organising idea of principles that operate behind environment and systems, i.e. human systems. Designers in this order can be seen as facilitators of organizational processes. *"They organise conversations and debates about the values of a community and how those values may be implemented with productive results"* (Buchanan, 2001). In this Nike example it gets very clear how the NIKE company considers the 'ID-shop' as a matter within the first order of design, but the design discourse, the very co-design discourse affects the customers, so Peretti 'answers' from the fourth order of design, this co-design thing is not only a matter of designing your own cute logo, it is also about 'the freedom to express who you are'. Rhetorically Peretti answers from the 'offfered' rhetorical agency. This leads to the question**:** *If rhetorical agency is the act of effecting change through discourse, how can we develop co-creation activities to include rhetorical agency?*

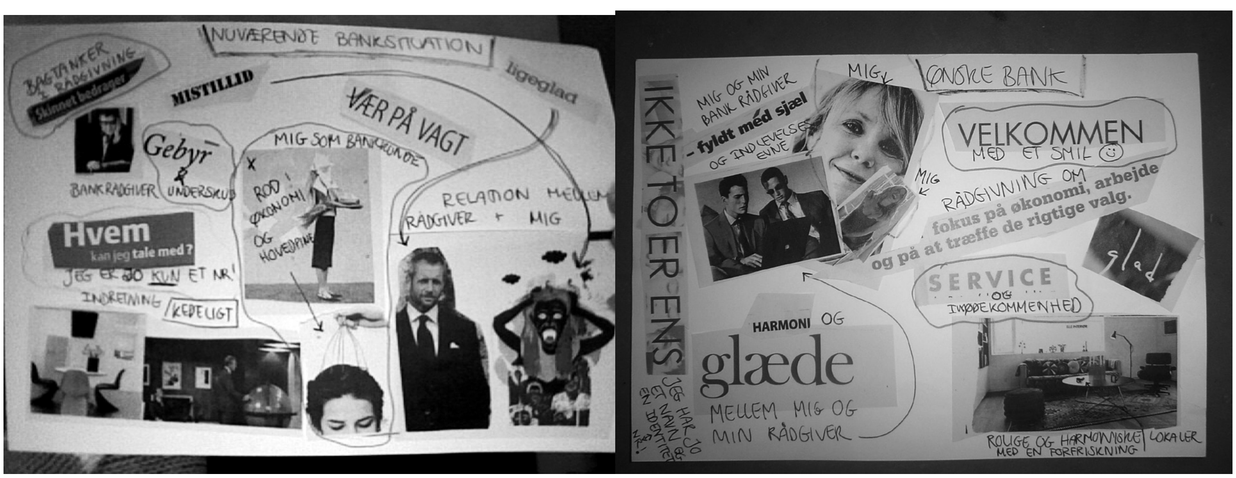

Fig. 3 A+B: Collage A illustrating the present situation, and collage B illustrating the future situation.

Changing the focus in the co-creation sessions

A look back to the completed creative sessions and the reflections of the participants, they rather precisely outline the nature of the generative tools and equal to Sanders description. The different levels of creativity, the guided discovery that appealed to the participants inner feelings and tacit knowledge is for example described by one of the participant, Anne Marie: *"…performing the tasks in the box was one long process, where I got deeper and deeper into the concept of 'economy': first filling out the postcards, choosing statements and so on. I think these tasks were necessary in order to make the final collages. In these collages I felt I was able to express my reflections and final statement; my frustration about my personal finances got released. Actually I was surprised I got so emotional upset, now I am more aware that I must do something about my economy."*

The process performing the creative tasks made her reflect, and finally she claims she ends up being more aware of her specific needs and wishes. When she explains her wishes for the future bank she expresses that she wants to get in control of her economy and how this is supposed to be done.

Another participant claims in the interview before doing the creative session that she is quite satisfied with her bank and her financial advisor, but having done the creative session she tells she actually is quite irritated on her financial advisor as he has a certain way of talking to her and accusing her for having only 'a small arrangement' in the bank. This example illustrates that also smaller issues can be revealed during the creative sessions using the generative tools.

This creative session resulted in a lot of information about financial customers in general (here 21 persons) and their thoughts about the bank – and *this* is the focus of the traditional co-creation sessions and research. To me there are plenty of new and much more interesting perspectives: the fact that this guided discovery is having a personal effect on several of the participants like Anne Marie is triggering my creativity and interest in developing these tools. The facts that the use of generative tools actually is letting people get more aware of their financial situation and sometimes make them want to act and change their situation, is triggering my creativity and interest in developing these tools into a new type of banking service.

Future perspectives

Business leaders still consider co-creation a new and interesting way of getting information and ideas from the customers. Designers are having their heydays as they are very good at getting close to users, understand their needs and generate ideas (Verganti, 2009). This leads to new challenges, because executives now think about design and designers in two perspectives: the first – and the very traditional one – is styling. Designers are asked to make products look nice and beautiful (Buchanans 1.order of design, 2001). The second – and more recent perspective – is user-centred design. And as Verganti stresses, first the styling and then the user-centred design have been portrayed as vehicles by which companies differentiate themselves from the competition. Many analysts claim design in these ways make the difference (Verganti, 2009) and no company would dare release a product without caring about style and analyzing user needs and as such design is in its heyday. But what are the visions in the field of design?

Looking deeper into the co-creation activities and especially the generative tools, there seems to be plenty of possibilities if these are developed and not only limited to 'user studies'. Using the generative tools in co-creation sessions is also a way of introducing creativity and creative thinking to non-designers.

In the current research these generative tools are being developed into a new type of service offered for people in order to become more aware about personal values, needs and dreams. The service presumably will be offered for customers in the bank but there will be no expectations except for the customers to become more aware of their values in life, including their economy. As such customers are treated as creative human beings and offered the agency to act - to feel free to go to another bank or stay in Middelfart Sparekasse. As such the service will become a radical new way of doing consumer communication, based on customer awareness rather that persuasion.

Conclusion

Normann (2001) claims we are moving towards a veritable revolution with organisations as value creating systems. Maybe we *are* moving towards a veritable revolution, but until now co-creation mainly is conducted within the dominant organisational perspective and that is the reason why co-creation has primarily been operating on the outer edges of companies´s value chains. As a result of this the paper claims customers are being left in a gap. The claim is underpinned by applying a rhetorical perspective that sheds new light on the communicative consequences, how these co-creation and co-design discourses affect the audience. The notions, 'constitutive rhetoric' (Charland, 1987) and 'rhetorical agency' (Hoff-Clausen et all. 2005) illustrates how the popular user-participation and co-creation discourses actually constitute customers in new subject positions, as 'creative human beings', 'co-creators' and 'co-designers' 'with the freedom to act' and 'to express who you are' ect. The example from NIKE precisely illustrates how customers are constituted as creative human beings and with the capacity to act, but here the customer, Peretti makes visible how this rhetorical agency is only an illusion – in reality the case showed is only offering very limited agency. Unfortunately companies have not understood the effect of these discourses and here the Nike example also proofs customers have already started 'claiming their rights' on behalf of this constitution (Charland,1987) here as empowered co-creators and creative human beings.

Considering co-creation an art design discourse is a way of regarding design and creativity as a 'new language'. The paper brings examples from a current research in a Danish bank, Middelfart Sparekasse. Here co-creation sessions resulted in different, but no radical information or ideas from the users, whereas the very meeting with the generative tools gave inspiration to the designer and researcher to develop a new and total different type of service. The idea is to transform the generative tools in a new service as they work as tools for reflection and can create more awareness about values in life, dreams and needs – a rather central issue in private economy. The service will presumably be offered in the bank in the future and without any expectations. On the contrary, the bank will let the customers feel free to change bank or stay. As such banking service is changing its meaning (Verganti, 2009) from an issue about money and economy to include a service that offers reflection and greater awareness about underlying and sometimes unconscious presumptions and essential values in life. As such the new service also will become a total new way of doing customer and company communication based on increased awareness instead of persuasion.

Transforming the generative tools into a new service is only one way of inviting design thinking and creativity into everyday peoples lives, offering them a way of reflecting and responding as creative human beings. Rhetorically this means both constituting people as creative human beings and in the same time offering them the capacity to act also called 'rhetorical agency' (Hoff-Clausen et all., 2005). The example is just one of presumable many solutions to customers claiming their rights as creative human beings.

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Reframing Business – and Design?

– A critical look at co-creation

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Abstract

The collaborative aspect has become a prominent focus in design discourse and words like *user-driven innovation*, *user studies*, *participatory design* and *co-creation* are frequently used in the design terminology of researchers, practitioners, not to mention business organizations. This reflects a shift in attention from product and manufacturing to users and experience.

Normann (2001) speaks of reframing business and arguably the changing landscape of design as described by Sanders and Stappers (2008) is making designers reframe their practice. (cf. Schön, 1991). Employing user studies, participatory design and co-creation looks like an easy and accessible way towards innovation, unlocking the creativity of the customers to develop future business. To no surprise these words are buzzing around the business and design offices.

However it seems, the buzz is failing to deliver, and it is important to question why. Using *co-creation* as an example, we claim that businesses and designers are stuck on the buzz. Borrowing a term from cognitive psychology, we argue that co-creation has created a *fixation* among businesses and designers, where the strong focus on the innovative potential of users as co-creators paradoxically has become an obstacle for both radical innovation and *real* co-creation.

The paper brings an overview of different and conflicting perspectives on co-creation, and explains how these perspectives stem from different paradigms. Furthermore, the paper suggests designers to consciously reflect upon the image of design and designers.

We want to highlight researchers from both design and business who claim design and design thinking to be a new way of bringing both insight and innovation, a new way of working with thought, human systems and *design-driven innovation* (Buchanan 2001; Verganti 2009). We think it is time to encourage designers to expand their current vision from user-driven innovation to design-driven innovation. It is time to reframe design from a designer's perspective – and why should designers not have the capabilities to reframe business as well?

Keywords

Co-creation; fixation; design practice; business perspective; design perspective; paradigms; innovation.

The origins and original meaning of co-creation

Co-creation can be defined as any act of collective creativity, i.e., creativity that is shared by two or more people (Sanders & Stappers, 2008). Opinions vary widely on who should be involved in these collective acts of creativity, when and in what role, but basically co-creation, as the abbreviated prefix indicates, implies some sort of equality between the co-creators, whether we are speaking of designers and users or companies and customers. However, this essential and seemingly obvious definition does not appear to be equally obvious and easy to act in accordance with.

Co-creation is not a brand-new phenomenon; nevertheless, it represents a radically new definition of what constitutes value to consumers. From a business and innovation angle, co-creation is interesting not because everything has to be or will be co-created in the future, but because co-creation is tapping into the collective experiences, skills and ingenuity of consumers around the world, and thus provides companies with valuable information. As such co-creation *could* look like a complete departure from the inward looking, company-versus-consumer innovation model that still is common in companies all over the world.

In the literature, co-creation is described as a phenomenon, which started out several years ago with enthusiastic amateurs, who for example wanted a bike that could be ridden off-road. The amateurs created the mountain bike themselves, and later on it was put into production (von Hippel, 2005). Enthusiastic users also developed equipment for kite surfing. As the existing kites did not meet the needs of the super users, they themselves developed new and better kites. On the Internet these super qualified users exchanged drawings and models and software for rapid prototyping and developed new super kites (von Hippel). Eric von Hippel's point in his notion about *the lead-user* is that kite manufacturers should ask these super users to help innovate their products, and the result would be better kites for the company, the super users as well as other users.

The above-mentioned examples illustrate, how co-creation started from real life needs and wants, furthermore, von Hippel notes that the Internet had an enormous influence. The Internet enables knowledge sharing and provides access to sophisticated computer programs, which is pushing forward democratisation of innovation, co-creation activities, and open source innovation; an obvious example is Wikipedia (www.wikipedia.com). In that sense, the Internet as a medium gives people a voice and calls upon open source and democratic innovation. Additionally, the Internet gives people agency, a capacity to act rhetorically as co-creators as they have a genuine interest in developing a specific item or feature. The problem seems to arise when researchers, designers and especially business leaders seek to develop this autonomous and self-directed group activity into a new way of *running* innovation. It is essential to acknowledge the difference between co-creation evolved from a self-directed group activity and co-creation evolved from an organisation.

According to Richard Normann co-creation will be an essential part of the future for organisations. Normann claims that we are moving towards what he calls *the real revolution* (Normann, 2001). The influential business researcher accounts for his radical view in his book *Reframing Business*. He argues that we are moving beyond the industrial paradigm with a focus on the production of goods and services being *pushed* into a marked with consumers acting as passive receivers of the goods. In recent years, companies have moved into a kind of in-between position where the central concern is about *relations* as seen in service and service management (according to the service-dominant-logic by Stephen L. Vargo and Robert F. Lusch (2004)). Customer relation management has become a central issue as customers are regarded as a source for information, ideas, needs, etc. In turn, we are now, according to Normann, facing the real revolution – the absolute opposite to the industrial paradigm – where the customer is regarded as co-producer involved in the creation of value.

The conflicting perspectives on co-creation

In the move from the industrial paradigm into this new paradigm with customers involved in value creation, *users* have been brought into focus. Likewise, *user centred innovation* has become the dominant paradigm of the past decade and *users as co-creators* has become a popular term both in the field of design and the field of business. Unfortunately, different and confusing understandings of co-creation are ruling. A crucial point of difference is, whether you regard the user as *a subject* or as *a partner*. In the business field there is a tendency to regard the user as a subject – C. K. Prahalad and Venkat Ramaswarmy, (2004) represent this approach and so does von Hippel's notion about *the lead user*. In contrast, research in the field of participatory design often represents the user as a partner. These two and different approaches stem from the different paradigms. Co-creation originally evolved as a self-directed autonomous group activity where users were creating values together, like the above-mentioned kite surfers. Business leaders saw this activity as a new and interesting way to innovation. Business researchers predict co-creation to be the future and some bring special details like Prahalad and Ramaswamy declaring *empathic dialogue* to be one of the building blocks of co-creation (Prahalad & Ramaswarmy). However, these authors do not leave any explanation on *how* to obtain co-creation or indeed empathic dialogue. This results in a huge demand for tools, methods and instruments for facilitating these user-involving processes.

Roberto Verganti claims design is in its heyday. As opposed to organizations, designers are users themselves, thus, they are empathic to user needs and wishes and seem to possess the capacity to provide insight knowledge about co-creation and its use. In the field of participatory design and co-creation, an increasing amount of different tools, methods and projects testify not only the designers´ interest in co-creation, but also their ability to get close to users (Verganti, 2009). Figure 1 gives an overview of the different approaches and related tools and methods in the fields *led by research* and *led by design*, respectively.

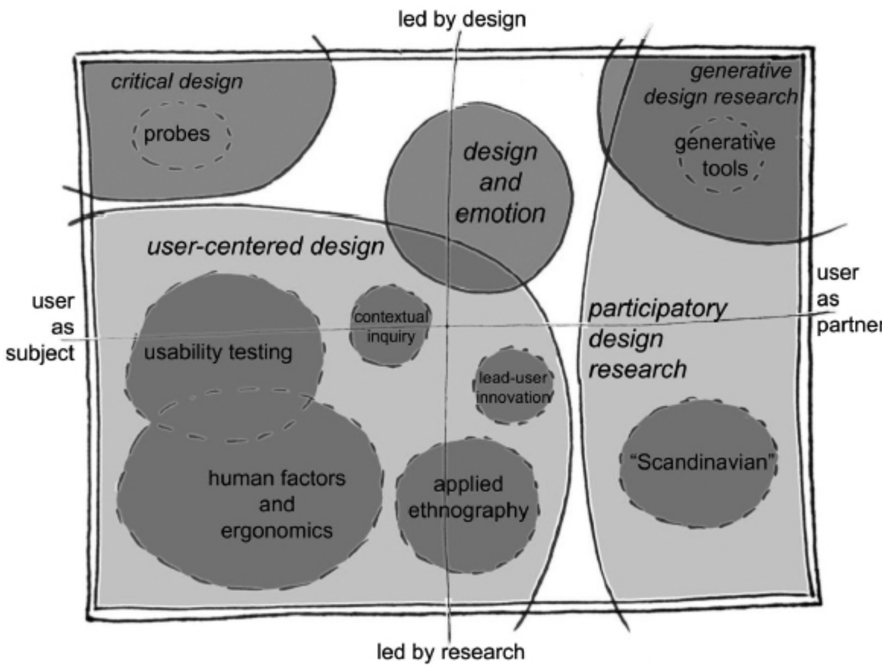

Figure 1: Current landscape of human-centred design research as practiced in design and development of products and services (from Sanders & Stappers, 2008, 2).

The rapidly growing research in the led by design field indicates a huge interest in co-creation and an eagerness to meet the demands from the business field in terms of providing tools and methods to unlock the creativity of costumers and pave the way for innovation and future business.

We are aware, researchers and practitioners will claim they have conducted plenty of successful co-creation projects – even when these projects have been conducted only at the outer edges of the companies´s value chains, and also when they have only resulted in refinements of existing products or services. We consider this type of co-creation to generate user insights and not to be *real* co-creation with users as partners. The high expectations for the innovation potential of co-creation in business as well as design have yet to be met. Whereas the user insights may contribute to incremental innovation, we have failed to find evidence of radical innovation based on user-driven-innovation or co-creation sessions. A subtle reason for this could be rooted in the human psychology and the notion of *fixation*.

The notion of fixation

One of the obstacles to come up with new and innovative ideas is that human beings are creatures of habit. Speaking of innovation and design, we often refer to the notion of *thinking out of the box*, which is in fact much more difficult than it sounds. Thinking out of the box means mentally divert from familiar paths or patterns, often however, our way of thinking remains fixated inside the already known framework the proverbial box.

Originating in gestalt psychology, the notion of fixation has become a subject of special interest in experimental cognitive psychology to understand innovation and creative problem solving (cf. Purcell & Gero, 1996). Fixation or fixedness is a general psychological phenomenon that in simple terms stems from the nature of human information processing, which is inherently selective and thus connected to our decision-making abilities. This is of great value to our everyday life as the cognitive system prevents information overload, however, this selective aptitude can be a hindrance to creative problem solving. Fixation is a familiar occurrence in design process and is to designers often "experienced as a premature commitment to a particular problem solution" (Purcell & Gero, 364). In a seminal paper from 1991 entitled *Design fixation*, David G. Jansson and Steven M. Smith introduce a possible definition of design fixation as: *"*A blind adherence to a set of ideas or concepts limiting the output of conceptual design, [that] is a measurable barrier in the conceptual design process*"* (Jansson & Smith, 1991, 3). This is a simple and comprehensible description of a complex and difficult to explain cognitive function. Within the context of this paper, the full complexity of fixation and related cognitive workings cannot be addressed, for an in depth discussion, we refer to two recent papers by Edward Chronicle, James MacGregor and Thomas Ormerod (2002; 2004). For our purpose, we find it useful to present three cases of fixation; two from the experimental psychology literature, and one from our own design research.

Case 1: The two-string problem

Experimental psychologists have studied fixation in problem solving processes since the 1930s. A classic study from this period is Norman R. F. Maier's *two-string problem*. In the study, volunteer subjects were placed individually in a large room with two long cords hanging from the ceiling, and each subject was presented with the problem of tying together the ends of the two strings (cf. Maier, 1931). However, the cords hung so far apart, that it was impossible to hold onto one string and reach the other. In addition to the cords, the room was furnished with a number of objects, among them were poles, a pair of pliers, clamps, tables and chairs, and the subjects were told they were free to do or use whatever needed to solve the problem.

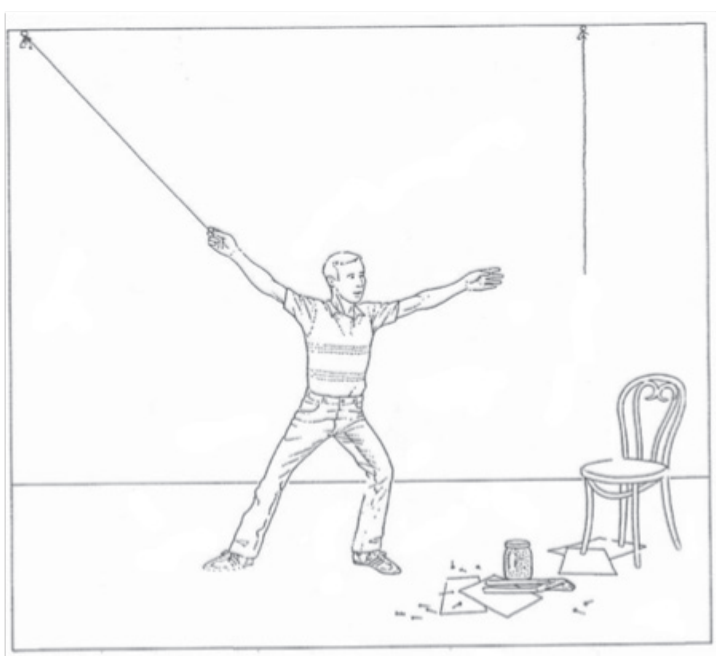

Figure 2: The two-string problem, illustrating the impossibility to hold onto one string and reach for the other (after Maier, 1931, 181-194).

The two-string problem experiment had several possible solutions, one of which was using the pliers to grab onto one of the strings and make it work as a pendulum weight, thus making it possible to hold onto one string and capturing the other as it swung by. However, such a use of pliers is unusual, and what Maier observed was that many subjects found it difficult to see beyond the usual function of the pliers and employ them in a new way to solve the problem at hand. The subjects experienced a type of fixation in problem solving termed *functional fixedness*, which characterizes a restriction in one's handling of an object to previous encountered functions of similar objects (Jansson & Smith; Purcell & Gero).

Case 2:The eight-coin problem

A recurrent topic of interest in the experimental psychological literature is the question of insight in problem solving. The insight process is somewhat a mystery and it has proven difficult to determine what exactly constitutes an insight problem (Chronicle et al., 2004). However, recent literature argues that for insight to occur in problem solving activity, it requires "removal of one or more unnecessary constraints imposed upon the problem solver upon the actions that they take in attempting to solve the problem" (Ormerod et a., 2002, 791). In the experimental psychology literature there are many variants of insight problems, a novel example of an insight problem is the *eight-coin problem*, designed by Chronicle, MacGregor and Ormerod (Ormered et al.). Basically, the eight-coin problem presents a subject with a configuration of eight coins, which through a number of specified moves must be transformed into a new configuration, where each coin touches exactly three other coins.

The constraints of the problem are embedded in the initial configuration, which is presented as two-dimensional. This restriction creates a fixation. The primary insight needed to solve the problem is to perceive the configuration as three-dimensional, which allows the subject as well to move the coins in three dimensions (cf. Ormerod et al.).

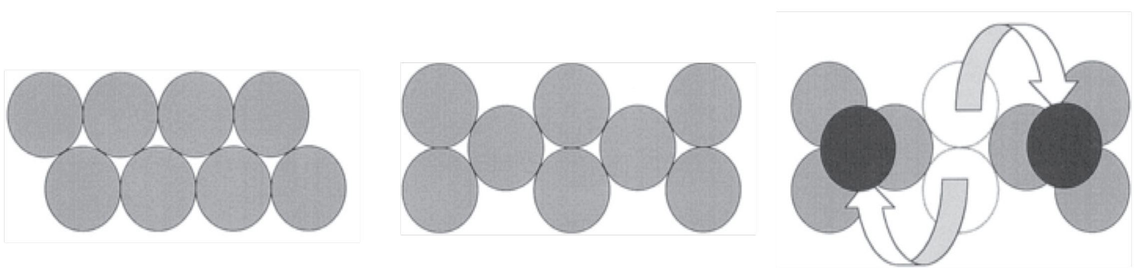

Figure 3: A configuration of the eight-coin problem and the two moves to create the new configuration, where each coin touches exactly three others (after Ormerod et al., 2002, 793).

Fixation can be associated with a wide range of information processing biases that lead to selective attention to a problem. Whereas Maier's two-string problem revealed a bias related to our perception and use of objects, the eight-coin problem illustrates a bias, related to a the perception of the constraints in a given context – if perceived as two-dimensional, movement in the context is perceived to be restricted to two dimensions. For most subjects, the selected strategy for solving the problem adheres to the initial representation of the problem; however, to actually resolve the problem, a restructuring or re-encoding of the representation must occur.

Case 3: Experiences from co-creation sessions in a bank

In her research conducted at a small savings bank headquartered in the Danish town of Middelfart, Kirsten Bonde Sørensen included experiments that mixed probes from the critical design approach with generative tools from the generative design research (cf. Gaver, Dunne & Pacenti, 1999; Sanders, 2008).

People's private economy is often considered a personal and somewhat intimidating issue, which Sørensen experienced in her first creative sessions. This led her to experiment with a mixture of probes and generative tools. She ended up making a box filled with different creative tasks just like the probe, but instead of sending it to the participants, she experimented with inviting people in groups to a *neutral* room or conducting the creative session with the participants in their private homes. In her approach, she considers the tools to be generative and the user to be a dialogue partner.

In the creative experiments, different themes were used in order to ask people about their needs and wishes for a future bank. The answers were dominated with suggestions and ideas in the category *more of what we already have*. People responded with statements like "closer contact to my financial advisor", "extended openings hours", "better rates", etc. When suggesting the bank could offer a new special banking service, a *saving coach* for people with financial problems, most of the participants, who responded positively to the idea, were the ones who had seen the Danish television show: *The luxury trap* (in Danish: "Luksusfælden") – a television show with two professional financial consultants helping out families struggling with their ailing economy.

The creative experiments illustrate an important weakness in user studies: people often are fixated in what they already know. As Alberto Alessi claims: "There is a way of doing design that is giving people what they ask, which is never something innovative", (quoted in Verganti, 2009, 48). Sørensen discovered no radical ideas about a future bank in her experiments. Instead, she got inspired by the way the generative tools were working, as people actually got more aware of their relation to money, their private economy and their bank. As such the creative sessions served as an inspiration for a designer to develop a new type of customer service in a bank.

As part of a design research or design investigation into the bank's services, the creative sessions resulted in the prospect of developing new meaning in banking business with costumers being offered a way to obtain greater awareness about values – and economy – in life. Asking the participants about this, they did not know how to react, saying: *"*But is it possible to do this in a bank?*"* or *"*I cannot imagine doing this in a bank". These expressions underpin Verganti´s claim*: "*If a company tests a breakthrough change in meaning by relying on a typical focus group, people will search for what they already know*"* (Verganti, 2009, 49). Sørensen's creative experiments with bank costumers become a real-life example of how difficult it is to think out the box and how biases can produce fixation. As noted earlier, human beings are creatures of habit. Most of us have a very conventional perception of what bank is, how bank business is conducted and which services a bank provides. The participants in the experiments were restricted by these conventions, they fixated on already known paths or patterns to express their needs and wishes as well as their take on new ideas for a future bank.

Co-creation as fixation

As noted above, the rapidly growing research field of co-creation can be seen as an indication of a huge interest in co-creation and a readiness in designers to respond to the demands from the field of business. But the success in the designers' amazing capacity to get close to users, understand their needs and generate ideas creates new challenges.

Businesses generally think about design and designers from two perspectives: the first, and very traditional one, is styling. Designers are asked to make products look nice (cf. Richard Buchanan's 1rst order of design: *symbols*; Buchanan, 2001). The second, and more recent one, is user-centred design. As Verganti stresses, first styling and then user-centred design are perceived as vehicles, by which companies differentiate themselves from the competition. Analysts claim that design in these ways makes a difference (Verganti). Today, almost no company would dare release a product without caring about style and analyzing user needs. However, there is more to design and innovation, which begs the question: Are user studies and co-creation actually contributing to innovation or has the idea that they do become a fixation for business and design?

If businesses are not aware of how users use their products, co-creation sessions can bring insightful knowledge when developing better products, but as a way of obtaining radical innovation, they seem to be of little value. As the case with co-creation sessions in a bank showed, it was difficult for the participants to let go of the conventional perception of what a bank is and does and imagine new types of bank interactions and services. Verganti claims that user-driven innovation and co-creation can only to bring incremental innovation (Verganti, 2009). To obtain radical innovation, we need to think out of the box and not be fixated into something we already know. In that sense, user-driven innovation and co-creation may actually be putting a brake on radical innovation. Whereas users may have difficulties with thinking out of the box, business leaders have difficulties in changing their perception of users as subjects. Yet, they continue to put their trust in co-creation, user studies and user-driven innovation enabled by designers, developing the requested tools and methods. And in that sense, co-creation, user studies and user-driven-innovation have become a fixation both for business leaders and designers.

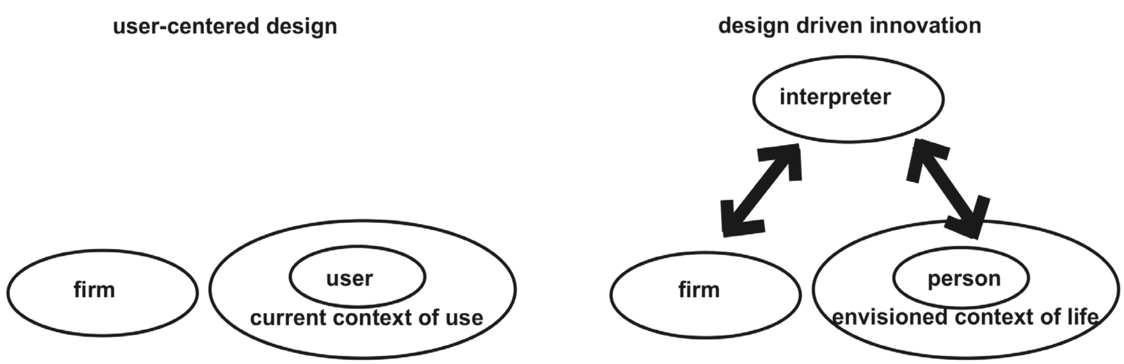

Figure 4: User-centered design versus design-driven innovation (after Verganti, 2009, 118)

Design driven innovation instead of co-creation

For this paper we have been very inspired by the business professor Roberto Verganti. In his recent book *Design Driven Innovation* he gives designers a well-deserved wake up call. He claims that designers at present design in accordance with a “codified, predictable, and mandatory process – making it more digestible for executives educated in traditional management theories” (Verganti, 2009, p.xi) He predicts the consequences of doing so are that designers lose their ability to do forward looking research.

As co-creation brings only incremental innovation, we contend that the *real* success to co-creation lie in the very perspective of the designers, the design thinking, the thinking out of the box, which t is crucial to obtain radical innovation. Verganti claims *design-driven innovation* to be the way to radical innovation. He defines design driven innovation to be about *meaning innovation*, which means understanding, anticipating and influencing the emergence of new product meaning. The way to do this goes through *"*a broader, in-depth exploration of the evolution of society, culture and technology" (Verganti, xi).

The original meaning of design also goes back to the latin "de" plus "signare", which means making something, distinguishing it by a sign, giving it significance and designating its relation to other things, owners, users or gods. Based on this original meaning, one could say: Design is making sense (of things) (cf. Krippendorf, 1989).

The meaning that a user gives to a product depends on her/his cognitive model, which in turn is significantly affected by her/his inner socio-cultural context. Proposing new product meaning therefore implies understanding the inner dynamics of socio-cultural models, beyond what is explicitly visible. The shaping of socio-cultural models and their impact on the interpretation of product languages depends on millions of unpredictable interactions between users, firms, designers, products, communication media, cultural centers, schools (Verganti, 2009).

In his study of some of the successful Italian design companies such as Alessi or Artemide, Verganti found that their innovation process hardly ever starts from close observation of user needs. Instead, they follow a different strategy, which he calls design-driven innovation – a strategy that aims at "radically change the emotional and symbolic content of products (i.e. their meanings and languages), through a deep understanding of broader changes in society, culture and technology. Rather than being pulled by user requirements, design driven innovation is pushed by a firm's vision about possible new product meanings and languages that could diffuse in society" (Verganti, 2008, 436).

Alessi and Artimide can be considered to create radical innovation in their respective markets. It is a common perception, that the world needs radical innovation and subsequently, there is a need for radical designers and radical researchers. These are, according to Verganti, experts who envision and investigate new product meanings through a broader in-depth exploration of the evolution of society, culture and technology. Radical designers and researchers are not asking people about what they want. So Verganti´s point is to make designers stop customizing design and making it digestible for managers educated in traditional management theories.

Looking back at the Sanders and Stapper's mapping of participatory design, we could identify different conflicting perspectives: a business approach considering the user as a subject and a design approach thinking the user as a partner. Thinking *the user as a partner* is crucial and the only way to *real* co-creation, but in the field of business, co-creation is reduced to user inputs and the customers, users, *co-creators* or whatever they are called, will always remain *a customer*, buying products or services. The traditional business perspective is fixated into an image of an organisation, producing something to be sold to customers or users outside the organisation. From this perspective co-creation is a tapping into the brains of the customer in order to get more information about him or her to be transformed into better selling products, but this is not co-creation. Co-creation implies equality; co-creation is the kite surfers doing an autonomous and self-directed group activity. The problems in co-creation arise when business leaders seek to transform this autonomous and self-directed group activity into a new way of *running* business innovation. You cannot run innovation in that way, and you cannot expect users to contribute radical ideas, but you can start regarding users as your partners and appeal to their interest in a certain issue. This is the design approach. In their heart designers know that, but in their eagerness to meet the requests from business leaders, they seek to develop new tools, methods and instruments for co-creation sessions within a fixated business framework. This is what Verganti called the "codified, predictable, and mandatory process" that makes design more palatable to business leaders educated in traditional management theories.

Designers seem to forget that the idea about the practice of collective creativity has been present in the design field for at least 40 years! Yet in business literature, books about co-creation have become bestsellers and are considered to contribute absolute new insights (e.g. Normann, Prahalad & Ramaswamy), but the idea about collective creativity was presented at the very first international conference by the Design Research Society in Manchester in1971and was simply entitled: *Design Participation* (DRS history website; Sanders & Stappers, 2008). *Participatory* *design* was the terminology used until the recent fixation on what is now called co-creation. Before co-creation, participatory design was a common practice in design and design research in Europe, in particular in Scandinavia (cf. Sanders & Stappers, 2008). The designer has never been far removed from the user. Just take a look at a Charles Eames sketch on the design process from the1969 exhibition *What is design?* at Musée des Arts Decoratifs in Paris.

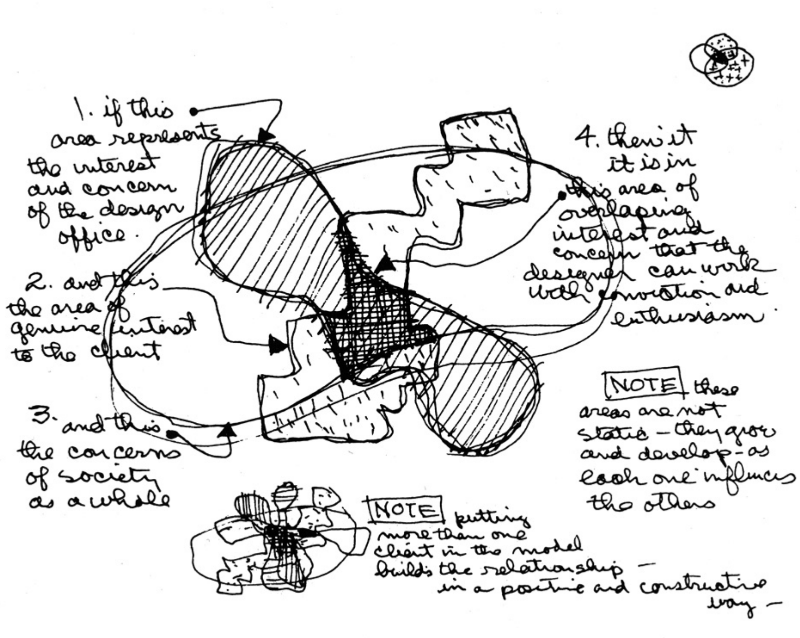

Figure 5: Charles Eames: What is design? (from Eames, 2002, inside front cover).

In his mapping of the design process, Eames considered design to be a dynamic activity consisting of four areas influencing each other noted in the diagram:*The interest and concern of the design office*, *the genuine interest to the client*, *the concerns of society as a whole*, and finally the area of *overlapping interest and concern that the designer can work with conviction and enthusiasm*. In Eames´s notes he underlines that “these areas are not static, but grow and develop as each one influences the others,” and furthermore, he writes next to the thumbnail model: “Putting more than one client in the model builds the relationship in a positive and constructive way” (see fig. 5). Eames saw design not as something removed from the user (the client) or society, but at something created in dynamic relationship with the user and society. The drawing testifies to the fact that Eames was thinking of design process as a process in line with Verganti´s ideas about designing in a socio-cultural context.

According to Richard Buchanan´s mapping of the development of design, designers are moving from a first level focus on *images* or *symbols* onto *things* and later *services* and finally to the fourth level, which related to action, but focused on *the environment and systems within which action takes place* (cf. Buchanan). This is the level of *thought*, since it is fundamentally concerned with the organising idea of principles that operate behind environment and systems, i.e. human systems, Buchanan explains. Designers in this field can be seen as facilitators of organizational processes. They are capable of organising “conversations and debates about the values of a community and how those values may be implemented with productive results” (Buchanan, 2001, 202).

The different examples of Verganti, Eames and Buchanan should remind designers not to leave their own perspective behind in their keenness of meeting the demands of business. The design perspective is a precious asset and includes the ability of bringing new and useful insights to create new meaning.

A meeting between two opposite paradigms

What happens when design thinking meets management thinking? The field of *design management* is about the integration of design into management and vice versa. Talking about co-creation from a design perspective versus a business perspective, it seems relevant to look into the field of design management. The design management field is only a few decades old, whereas the management discourse is about hundred years old and the design discourse about half of that. In their paper 2008 *Towards a better paradigmatic partnership*, Ulla Johansson and Jill Woodilla uses the well known framework on sociological paradigms by Gibson Burell and Gareth Morgan (1979) to illustrate the paradigmatic differences between management discourse and design discourse. The authors problematize the way knowledge from design merges with knowledge from management – a kind of rigid partnership between design and main-stream management research (Johansson & Woodilla, 2008).

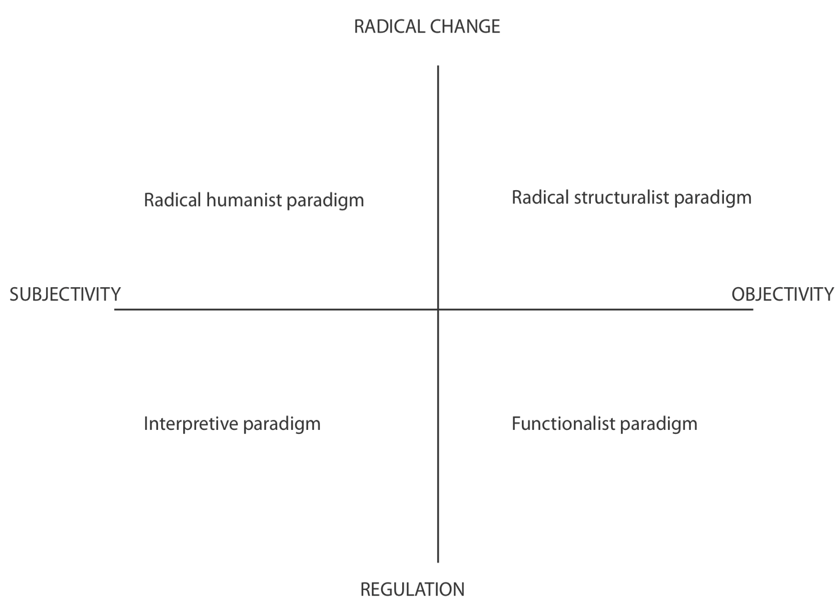

Figure 6: Burell and Morgan divides management history into four social paradigms (after Johansson & Woodilla, 2008, 7).

The field design management was expected to bridge design and management and consequently be represented in all areas; however, this has not been not the case. In fact, the field of design management is only represented in the functionalist paradigm, relying on objectivity and regulation as foundational assumptions. From a design perspective this is somewhat problematic, claim Johnsson and Woodilla, because design thinking is being differentiated from rational, analytical processes, rather than being defined as a holistic way of creating something new and unanticipated: “Management most often lacks sufficient knowledge about design to take advantage of the strategic potential that design promises. As a consequence, research is most often of a normative and prescriptive character” (Johansson & Woodilla, 2008, 16).

Conclusion: Designers need to take the lead

From a business perspective co-creation may look like an easy and accessible way towards innovation, unlocking the creativity of the customers and letting their creativity be part of the development of the future business. Different understandings of co-creation result in co-creation often being reduced to user inputs used for improvements or incremental innovations. In fact, co-creation brings enormous challenges.

Borrowing a term from cognitive psychology, we argued that co-creation has created a *fixation* among businesses and designers, where the strong focus on the innovative potential of users as co-creators paradoxically has become an obstacle for both radical innovation and co-creation.

We think it is about time to *reframe design* (and business), to think about the future role of the designers, to think out of the box and not fixate on user studies, as they may already be the paradigm of yesterday. When business researchers as Normann speak about *reframing business* and turning business organisations into value creating systems the job requires a total different look at business organisations, which is not limited to – and fixated in – a traditional organisational perspective. But as long as business leaders are the ones to decide, co-creation activities will mainly result in user inputs or value creation at the outer edges of the value chain.

Verganti brings a refreshing and to some maybe also a provocative point of view into the field of design. We are inspired by both Verganti and Buchanan, but also the designers and design researcher who developed the idea of participatory design (now called co-creation) back in the early 1970, including Eames, who back in 1969 sketched a design process in line with Vergati´s contemporary idea of designing in a socio-cultural context.

Design history shows designers have the holistic perspective and the possibilities of bringing useful insight. Design thinking both stems from a humanist paradigm and represent an abductive way of reasoning that makes designers think in a radically different way and far removed from traditional causal reasoning in business.

The intention of this paper is not to belittle business leaders and managers, but to remind designers and business leaders that we need to prepare the ground for meetings and exchanges of meaning and ideas *between* the two different paradigms, both the business oriented functionalistic paradigm and the designers humanist oriented paradigm. Right now the functionalistic paradigm is dominating the discourse and unfortunately there is a tendency for designers to seek only to meet the demands from business leaders in terms of providing tools and methods.

We hope to stimulate the discussions and to encourage a reframing of design and the designers´ image as practioners who do more than user studies or beautiful styling of products. Radical designers and researcher do not give the business leaders what they want – radical designers and researchers offers a totally different perspective and a fundamentally different way of reasoning and that is why they truly have the capabilities to reframe business.

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Expanding Design Space: Design-In-Use Activities and Strategies

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Abstract

This paper introduces an analytical framework for understanding the collaborative nature and distributed structure of what is often referred to as *design space*. We propose that the design space should be conceptualized as the space of possibilities for realizing a design, which extends beyond the concept design stage into the design-in-use activities of people. By locating different activities and mapping participants' possibilities in a continuum from consumption to active creation, we develop a framework for understanding and locating design research interventions and a tool for mapping design activities. We argue that: 1) a design space is always actively co-constructed and explored by multiple actors through their social interactions with and through technologies and 2) the participating actors, resources, conditions and supporting strategies frame the design space available. In doing this, we bring forth relationships between an expanded view of the design space, contemporary discussions on the nature of innovation and the imperative to support explicit collaborative and participatory design activities.

Keywords

Design-in-use, design space, collaborative design, participatory design, practices, social practices, use, user innovation

The term design space seems to be fairly common concept in design research literature (see e.g. Westerlund 2009). While many make use of the evocative dimensions of the word-pair to convey a place that can be explored, few define it explicitly. In general terms we can say that the concept of design space is used to highlight the freedom to choose from many options and to explore alternatives (e.g: Fischer & Giaccardi 2004, McKerlie & MacLean 1994, Sanders 2001, Westerlund 2005). Sometimes it also seems to refer to all design relevant information that is available in a design process (e.g: Hassenzahl & Wessler 2000). Another common use is to describe it as a territory that expands and contracts as the brief or challenge for the project changes during the process (e.g: Gero & Kumal 1993). However, two common threads emerge from the literature. First, the fact that the discussion of the idea of a "design space" is taken up from the point of view of a typical ”design actor” – a designer or an organization involved in the creation of a product. It is usually the professional who defines and explores the design space, or if it is done in collaboration, he or she will be the one typically initiating the explorations. Second, the design space seems to be considered as a space that is mostly present at the concept design stage or rather a feature of it.

This is in contrast to other strands of research located in-between innovation and science and technology studies, which could contribute to the design field new dimensions for understanding the nature of a design space. For instance, the capacity of so-called lead users (von Hippel 2005) to actually envision and construct the design space themselves leads them to create new product genres, as e.g. described by Baldwin et al. (2006). Building on those insights, distributed accounts of innovation that focus on the role of users suggest how a design space could be effectively and collectively explored and constructed by a network of users alone (von Hippel 2007). Furthermore there is a range of research contributions that argument for expanding the scope of what counts as innovation, suggesting a richer and varied view of what counts as the design space that is been explored when innovations emerge (Tuomi 2002, Shove & Pantzar 2005, Hyysalo 2007). These accounts, for example, point out how individual user customizations and more importantly, the social practices of users, form a part of the design space that is being collectively charted and created.

There are two important and most immediate implications of this view: firstly, more people are exploring the design space (not only producers or designers, or designers inviting users into some user centred process) and secondly, what counts as design space should also be expanded to include other things like social practices and agreements and not only physical artefacts. In so far as the design space available to stakeholders frames largely the evolution of the artefacts involved and the practices that carry them (e.g Hyysalo 2007, Shove & Pantzar 2004), a clearer account of what could be considered as design space and what are its components is needed.

In the rest of the paper we will follow Redström's invitation to develop accounts that explore "*what it is that we do rather than who we are*" (2008:410p) with respect to a design process in order to avoid unproductive user-designer dichotomies. The paper is structured as follows: first we will introduce our definition of the concept and its relationship to design-in-use discussions. The next section concentrates in locating different activities in a continuum from consumption to creation in order to develop a framework for understanding and locating design research interventions and a tool for mapping design activities that make those design spaces explicitly visible. In addition we introduce some design research cases and related support strategies for designers that we have experimented with. The paper closes with some remarks and directions for future research.

Expanding design space

Westerlund´s elaboration of the concept of design space, in terms of a conceptual tool to design and understand design processes (2009), is a good starting point to elaborate more on the potential of this concept. In his work Westerlund describes how workshops are ideal locations to explore jointly the design space of future product functionality with a variety of actors in a user centred design processes (UCD). He found out that the exploration of the design space is not only done from the point of view of problems, but rather from the vantage point of view of possible solutions. Those solutions, he claims, are what actually constitute the design space. From this perspective, the design space is turned into a useful concept to reframe and develop more up-to-date design process by focusing in "possibilities" rather than dwelling in the problems alone. While his conceptualization identifies the co-operative nature of this exploration and moves the focus from problems to possibilities, it leaves a lot of explanatory weight on the shoulders of complete "solutions" or at least ideas that are considered as meaningful solutions. In this conceptualization other surrounding factors, like for example the resources available to participants to actually imagine those solutions are not thoroughly explored.

In this paper we will refer to the design space as the space of potentials that the available circumstances afford for the emergence of new designs. This space though, is not constituted in a vacuum or somehow "pre-existent". It is rather made possible through the presence of different stakeholders, tools, technologies, materials as well as social processes and agreements. Within that space all of those who are designing make choices and eventually a design comes to being in an ongoing process that extends beyond the concept design. The design space in this case is actively co-constructed and co-designed by multiple actors in their social interactions with and through technologies and processes, which are brought to the design space and mobilized by the participating actors.

Building on this expanded view of the design space, we believe that it is increasingly important to recognize the role of the former "users" as designers, more so because of changes in our technology landscape and new opportunities for collaboration. In an earlier era, where the capability to manufacture products was tied to an industrial mass production process, considering the idea that so-called end-users have always been designers in their everyday life, at home as well as at work, was philosophically interesting but had very little significance for design practice. However, in the digital, globally networked circumstances, a dramatically wider diversity of roles and potentials beyond consumption and production become relevant.

Design-in-use

From an earlier exclusive focus on the role of the "object" and "the design brief" as the focal points of the design process, we have seen a gradual opening up towards more situated perspectives on design activity. It is more common today that designers and researchers situate design activities in a wider complex socio-technological context, where it also matters how a project is approached, and not only its results (Findeli & Bobaci 2005, Krippendorff 2006). As asserted by several commentators, the relationship between "design" and "use" has become central concern in developing design approaches and theory (Jones 1984, Redström 2006, Ehn 2008). The opening up of new concerns is perhaps more evident today in the growing popularity of techniques for user orientation and user experience and a general embracing of so called user-centred design approaches. As a matter of fact, studying people and use situations to inform design process has become a recommended design practice in many areas, especially in relation to computer artefacts and digital systems and services (see Bekker & Long 2000 and Iivari & Iivari 2006 for reviews). These approaches, especially the pragmatic orientations, are today no longer an obscure research endeavour of a few, they are rather relatively well recognized lines of practice, or at least featuring high in the list of differentiation factors of design “expertise”.

There is no doubt that concerns regarding user orientation and involvement have brought a wave of fresh air and new insights for professional design practice. However it has been questioned whether these stances truly recognize the complexities of what it is at stake (Iivari & Iivari 2006, Stewart & Williams 2005); or whether they are able to recognize that so called “user needs” and “experiences” are not phenomena that exist a priori or in isolation (Shove and Pantzar, Shove, Watson, Hand & Ingram, 2007). In line with insights made through decades of research in areas like Science and Technology Studies, there is a need to recognize that a variety of people, through their everyday activities, are already engaged in a continuous and dynamic process of learning, creative appropriation, domestication and shaping of technology (Shove et al. 2007, Haddon et.al. 2006), and furthermore, that these appropriations take place even under adverse circumstance (see e.g Eglash et.al. 2004). Some commentators even remind us that people are not necessarily waiting to be taken into consideration by a user centred process (Spinuzza 2003), and that there is an unproductive stance that needs to be challenged, specifically when some of the user oriented perspectives in design tend to portray designers as the “heroes” that fix the situations while users are considered sort of “victims” in need of salvation (Spinuzza 2003, Stewart & Williams 2005).

In contrast, the idea that indeed a variety of use situations can display design-like characteristics invites us to consider that it is in supporting those instances (of design-in-use) that more work needs to be carried out from professional designers’ side. Already in the early 60’s design theorist and architect Christopher Alexander described processes of “unselfconscious design”, in an attempt to account partly for the pervasive enactment of design activities over time well beyond the professionals’ intervention. These activities, he claimed, were usually taken for granted but nonetheless exercised by all kinds of people; in order to maintain the equilibrium of designed systems (Alexander 1964). More recently Brandes (2008) and Wakkary & Maestri (2008) have provided concrete illustrations of some of the resourceful, adaptable and emergent qualities of everyday designs in contemporary mundane and domestic contexts. To support these types of pervasive design-like activities, several propositions have been made. An important earlier conceptualization made by Henderson and Kyng (1991) identified continuing design-in-use and tailorability as key things to consider for truly collaborative design. Extending these arguments, Fischer & Scharf (2000) and Fischer and Giaccardi (2004) amongst others have advocated for strategies to support meta-design. Despite these advances on our understanding of design-in-use activities, the fundamental ways in which these activities are articulated in our everyday life practices and vice-versa have not been fully understood and analysed (Shove et. al. 2007).

When new practices and contemporary forms of innovation have flourished in parallel to the growing access to network technology, collective endeavours and sometimes bottom up creation projects have been made visible. There is no doubt that computer users and developers are probably one of the most recognized and discussed user-designers and innovators in the literature (see e.g. Tuomi 2003, Floyd et. al. 2007). The case for blurring up the division between design and use (production and consumption) has been made several times using examples from Free and Open Source projects. These communities have a long history where software developers and advanced users engage in a collaborative design and development process with established tools, methods and work practices.

Unfortunately, everyday people without particular technological expertise (i.e. knowledge of specific programming languages) have had very limited possibilities to explore some areas of the design space of these technologies. However, recent emergence of collaborative digital tools, technologies and their associated practices (e.g. linked to blogs, wikis and RSS-feeds) have also made other types of active and concerted participation more visible. It has also opened the possibility for more diverse contributions that are not limited to programming. This effectively expands the design space that is visible and available for the people. These developments locate current discussions of design-in-use in a very different setting than the one that existed when user centred design approaches emerged.

These issues outlined above effectively invite us to reconsider: What does design-in-use mean for professional designers interested in creating partnerships and collaborative alliances, and what should we do about it? In doing this we propose that a better understanding of the scope and structure of the design space is needed. We proceed now to introduce the main components of the framework and its relationship.

Structure and components of the design space

In this section we present an analytical framework that aims to understand the structure of the design space we see emerging and to locate and identify different strategies. The following key questions are discussed in particular: What kinds of activities are people engaged in? What kinds of possibilities for appropriation are available? To construct the framework we have made use of several strands of research that have discussed similar issues in the past, and complemented it with empirical observations of current digital practices, when deemed necessary.

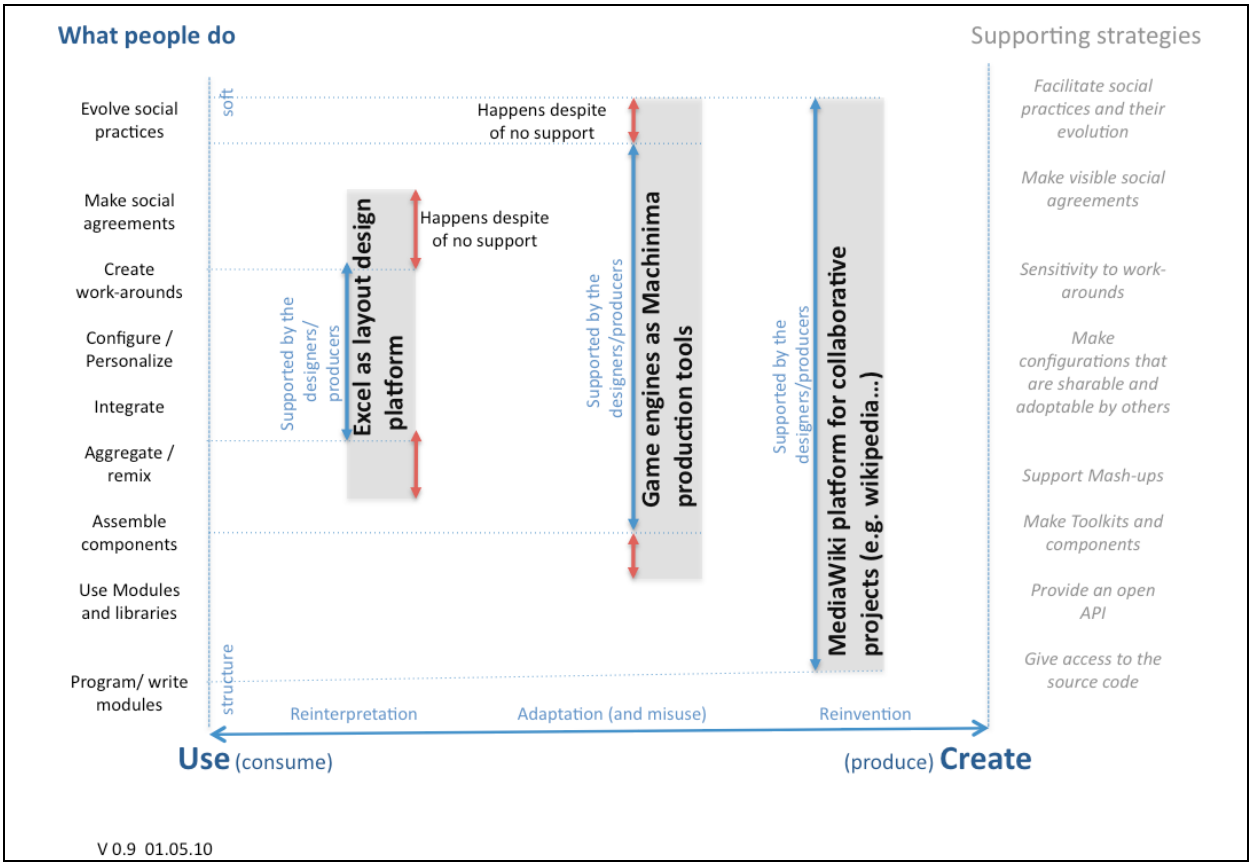

Figure 1 Framework for a structure of the design space

Figure 1 presents the basic dimensions of the framework. The vertical dimension presents an account of "**What people do**" as a *layered view* on different design activities in the digital realm. The activities are located in a continuum from “structural” to “soft” types as a way to convey the different points of view that need to be reconciled and that effectively complement each other. The horizontal dimension is meant to qualify those previous activities, by proposing that they might relate differently to the continuum between “**Use and Creation”**. Some of these activities might be more linked to basic aspects of consumption (understood in its more passive side), and others are aspects more linked to engagement and creation. To elaborate the discussion further, we illustrate the framework by positioning three contemporary examples along the continuum. In this case, their particular position depends on the conditions and possibilities that surround the activity carried out, which, effectively makes “slices” of the design space more explicitly available for people. We will now elaborate further on the components and meaning of each element.

What people do:

The bottom part of these design activities deal with issues of composition, material selection and definitions of structures. These are easy to recognize as activities pertaining to design or development professionals. In identifying them we draw on contemporary practices around human computer interaction, interaction design and software programming, all which deal with the design of digital media and technology. Every time a layer is added, the upper element represents more of an organizational or social type of activities. Some of these top layer activities would not necessarily be considered as design activities from a pure product design point of view. However, these activities increasingly account for what can be considered as design (Shove et al. 2007, Hyysalo 2007). To define and synthesize these "soft" design activities, we used concepts and ideas from literature in Science and Technology studies (STS) and issues explored in e.g., Participatory Design (PD).

- *Program / write modules:* On the basic level, digital system design operates with compiled software programming languages, such as C, C++, Java, and on a slightly higher level with interpreted languages such as JavaScript and Python. These activities require understanding of algorithms, data and information management, and include design decisions and exploration that affect the technology choices and production tools. Moreover it deals with the actual writing of code and the abstraction process required. The resulting designs are usually organized into modular reusable components that provide streamlined services for other designs through an Application Programming Interface (API).

- *Use modules and libraries*: On the next level of software design, software is composed into applications that perform some functions relevant to users. These integrated software packages take advantage of underlying modular software libraries. This usually takes place within one computer.

- *Assemble components*: Some software design can take place without extensive software experience, and many toolkits have been designed with the intention that non-experts could design their own systems or at least customize ready-made systems for some more specific purpose. Usually some, but most often quite a lot of programming expertise is still required. (MacLean et. al. 1990, Henderson & Kyng 1991). These types of design activities customize and expand a system by attaching new components, such as plugins, that bring new capabilities to the system and create localized manifestations of it.

- *Aggregate / remix*: A complex ecosystem of loosely connected services is evolving (Hartmann et al 2008, Nestler 2008), where mash-ups (a recent evolution of Internet applications and representative feature of the Web 2.0 phenomenon) can be considered as new service designs created by aggregating selected information from other web services, to some extent relying on services that offer an open web API.. A lot of contemporary design activity is concentrated in developing skills to aggregate and remix in inspiring ways. (Several web services, such as Google Maps, YouTube and Flickr, have quickly embraced the opportunity to become the platform of choice to be a standard component in mash-ups by offering e.g. map, video or image related services).

- *Integrate*: Most of the software that we use daily in our personal devices is in some ways connected to other software, those particular configurations are only known in use. Since the diversity of circumstances of use calls for a diversity of tools this represents a formidable and growing system integration and design-in-use challenge that faces us in our everyday lives.

- *Configure / personalize*: This is a typical area where more and more end-users need to engage in design activities when it comes to digital products. Software based systems usually include many kinds of settings, and as they often also mediate communications and interactions, they often contain also a lot of various types of information that is very much context dependent and often quite personal.

- *Create workarounds*: Workaround is a type of activity used to describe the ways in which users of some product or system develop creative ways to overcome a shortcoming of the product or service they have encountered. Creating workarounds is not only creative but also dynamic way of weaving artefacts to own working and ways of doing thins. It is an especially familiar term for software developers, but has also been used widely within the sociology of technology community, to highlight the ways in which users can act when facing an inflexible technology (Pollock 2005).

- *Make social agreements*: A social agreement is a shared understanding or consensus around a particular task or objective within a certain group or community. The nature of the agreement is usually a small group initiative that later evolves into a commonly implemented convention. One example of a social agreement with growing creative and practical consequences is *hashtagging*, the use of the hash symbol (#) to precede a term when microblogging in services like Twitter. The hashtag (e.g. "#opendata") adds additional context and metadata to the posts/tweets that makes it also easier to follow, organize and disseminate later.

- *Evolve social practices*: Social practices are embodied and materially mediated arrangements of human activities; they describe a particular way of going about an activity with its associated resources (Reckwitz 2002). Social practices, as an analytical unit, are shared and persist, because a group of people continuously reproduces them (De Certeau 1984). Eventually a set of social agreements (like the ones described above) or patterns of behaviours can evolve into a social practice that makes use of specific artefacts and conventions. For example, in video sharing sites like YouTube there are very advanced community initiated social practices for inviting and sustaining audiovisual conversations, via specific uses of visual genres, annotation workarounds, making visible of time-coded information and so forth.

Use-Create:

The Use - Creation continuum is structured around three intermediate positions: reinterpretation, adaptation and reinvention. These analytical categories are borrowed and further adapted from the ones introduced by Eglash when referring to technology appropriation (2004:xi), which we found insightful and relevant to this endeavour.

- *Reinterpretation*: This stage refers mostly to possibilities that exist for surpassing the semantical associations that are proposed to people in relationship to a given structure. An example provided by Eglash was that of the graffiti artists' interventions into the urban space, which provide a reinterpretation of the function of that space as a place for self-expression or political commentary without changing the structural conditions of the space itself. In digital environments, reinterpretation is obviously a possibility that is always available and relays strongly in the activities occurring at the soft layers of our "what people" do categories. An interesting case of reinterpretation can be found in the unintended uses of spreadsheet programs designed to calculate and manipulate numbers, as graphical layout design programs to create interiors and user interfaces (Berger 2006). This is done by reinterpretations of certain features of the software and basic shared agreements between a group of users. As seen in Figure 1, from a design process point of view the explicitly available design space is made visible mainly through the possibilities for basic configuration of the product, but there is little support to share and or extend user practices as this are mostly developed informally or in closed circles. In this case the possibilities of changing or adapting the lower layers are also more restricted; although there is always hacking strategies, this is not something that is encouraged.

- *Adaptation*: this second stage according to Eglash, implies a certain degree of flexibility in the underlying technology coupled with a sense of violation of intended purpose. These means not only of the designers' intentions, but also equally of the marketing strategies and / or gender assumptions embedded in a product. An adaptation involves creativity to look beyond assumed functions and recognize new possibilities, while the underlying structures are not necessarily changed. Eglash's classical example includes the "misuses" of early cassette players by Beduine tribes that saw beyond the playback machines (as they where marketed and sold to them) and used them as recording equipment for their own cultural productions. An example from digital realm can be found in the use of real-time three-dimensional game engines to produce computer animations. These animations where originally made to record playing episodes and performances, and they soon evolved to include the creation of new story lines and different creative appropriations for game-based movie making (Lowood 2008). This practice generated a new genre termed "Machinima". In Figure 1 we illustrate the layers that are covered by this example. Besides of being a very clever reinterpretation of what computer game software is meant to be for, the further development of the practice includes activities such as custom made adaptations and hacks of the software engines, in some cases supported directly by the game engine producers. Machinima practitioners gather in online forums to develop and discuss the genre as well as present their work in festivals, which effectively support the consolidation of a community with a shared practice.

- *Reinvention*: In the category of reinvention, a manipulation of semantics, use and structure is usually achieved and new functions are created. A true reinvention usually involves being able to produce changes and alterations to the original structures, like the case reported by Eglash in which Latino mechanics appropriate automobile shock absorbers to create shock producers for their low-rider cars. The multiple adaptations and recreations of the MediaWiki engine that runs Wikipedia to endeavours different than and encyclopaedia writing can be considered as an example of reinvention on the digital realm (see an overview in: MediaWiki 2010). As Figure 1 shows the platform is offered with open access to the code, so it includes explicitly the possibility of altering the lower levels. However reinvention is complemented strongly by the soft layers as well. The Wikipedia project exemplifies how it also involves adapting and evolving the social practices that made these type of collaborative production possible through many sophisticated and well-documented community agreements (Slattery 2009).

Making the design space explicit: some supporting strategies

In previous sections we introduced a layered view on design activities in the digital design domain by giving examples of what people do in the design space; with the focus on revealing design-in-use activities. In the digital realm shifting and moving between stages is –in theory– easy to perform, but in practice it is hampered by such things as the type of programming knowledge required to make the changes, standards conflicts between products and services, providers' and producer's use and licensing policies (open or closed), lack of support and shared practices, to mention just a few. For these reasons, the project of making the design space more explicitly available also in design-in-use, requires changes and support in mostly all the layers of the design activities.

In this section we will briefly introduce three design research cases we have conducted that have helped us to reflect on the possibilities of the suggested analytical framework. Based on these cases we have identified resources, conditions and supporting strategies needed; these characteristics will be elaborated and discussed further.

Facilitating practices of creative production and reuse of media: Today more communities are engaged on audiovisual creative activities, while some have not yet been able to take advantage of the many possibilities that audiovisual media could bring to their activities. How to make it easy for anyone to create, reuse and share audio and video productions over the Internet legally, without costly servers and complicated system management? As part of our research strategy we designed and implemented the Fusion platform (http://p2p-fusion.org/). The platform binds together a peer-to-peer network, a distributed metadata layer, social processing and enrichment features, support for embedded licenses and a component-based toolkit called Social Media Application ToolKit (SMAK). A Specific, practical goal for the system was to support social activities that include the creative use and reuse of audiovisual content, and to provide a software toolkit with re-usable components. The aim was to enable people to build their own applications with SMAK to share and distribute videos, edit and socially enrich them collaboratively. The work was carried it in collaboration with different Finnish communities (possible end-users) ranging from a music makers' community, to an extended family as well as enthusiast practitioners of acrobatics and parkour (For a more complete account of the case see: Marttila et. al. Forthcoming).

Facilitating practices for active citizenship: This case deals with the role of digital technologies, specifically location based services, in the emergence of new forms of citizen participation in the urban environment. As a research strategy we initiated the collaborative design of a prototype environment and service called Urban Mediator (UM). UM is a server-based software that provides users with the possibility to create, obtain, and share location-based information (http://um.uiah.fi). The service contains a set of tools for both city administration officers aimed at increasing their capacity to construct more active forms of citizenship and thus initiate innovations in the way digital participation services are being planned and delivered, by offering an in-between-space that is not in control of any actor. Collaborations were initiated with both active citizens and city officials in

Helsinki (For a more complete account of the case see: Botero & Saad-Sulonen 2008, Saad-Sulonen & Botero 2008)

Facilitating the coordinating of everyday life in a project of growing old together: This case intertwines with a collective project to develop and experiment alternative social arrangements for growing old initiated by a seniors association in Helsinki. Together we asked ourselves what kind of applications and digital media would be interesting and meaningful in such a community? Besides of other experiments, the biggest intervention made was centered around the collaborative design and development of what the community called their Everyday Life Management System (DailyWorks) and it's articulates to their project of ongoing design of the communal living arrangements. In concrete terms this is a collection of web-based tools for the seniors, which assists in the coordination and sharing of everyday life activities and information (http://arki.uiah.fi/adik/dailyworks). (For a more complete account of the case see: Botero & Kommonen 2009)

Based on the experiences gained in the cases, we want to discuss how e.g. professional designers or other stakeholders who are in a position of power regarding the design structures in question, could support and facilitate these multiple activities that vary from "soft" creations into "structured" and more rigid designs. In other words: How to expand the design space, in Eglash (2004) terms, to accommodate more explicitly "reinterpretation", "adaptation" and moreover, the "reinvention" activities (the results of design-in-use activities)? We open up the discussion by proposing four key factors we have identified based on our projects:

* *Support open-ended design process and flexible agency:* Design space, as traditionally perceived by designers, has been available for everyday people only by invitation or engagement through a professional designer or a predetermined process with objectives and outcomes that are identified a priori. This setting implies also preset roles and agencies available for people, which might prevent the richness of design-in-use activities that would trigger and uncover the social patterns, agreements and practices that people might possess in the design space. Moreover, these "soft" social designs should be carefully turned into design descriptions, structures and functions without losing the essence of the design knowledge (e.g. practices, agreements and workarounds).

* *Provide meaningful access to the resources available:* In order to facilitate the creative design-in-use activities and expansion of the design space, professional designers should provide access to infrastructures a pool of resources that are reusable. By granting open and meaningful access (e.g. contextualization of data, digital tools and guidance for various levels of engagement) we might enhance the different agencies in the space. Also access to knowledge can be critical when people are experimenting and being creative.

* *Create means for sharing designs:* another key factor is to create means for sharing "designs" that have been created in design-in-use. Individuals, groups and communities share their design knowledge and experiences with peers, social networks and other stakeholders in the design space e.g. in discussion boards, wikis and social media platforms. In these environments for sharing, professional designers should acknowledge existing procedures and collaboratively design and develop mechanisms for giving recognition and attribution to contributors, aim for nurturing trust and building motivation, and when applicable, create means for compensation.

* *Design for openness and designability:* The fourth and final aspect of supporting strategies of design-in-use is the design for openness and further designability of other designs. Fischer (2000, 2003) refers to a similar stance with the concept of Meta-Design. This strategy should acknowledge people as potential designers of future applications and platforms, and should provide an open access to different levels of software from source code to API's and CSS, through appropriate licensing and publishing of the designs – for instance: Free, Libre and Open Source and Creative Commons, and so on.

Formulating insights and sharing these design-in-use strategies are focal to the extended design space and its vitality. The means of exchange of design knowledge, e.g. solutions, workarounds, practices and innovations, varies from diverse things such as ad-hoc crowd-sourcing to the formation of communities (see e.g. Botero et.al. 2009). It is also important to notice that sharing design knowledge and experiences in a design space does not only happen between peers; but also with other stakeholders who have access to the information (e.g. what companies like Google can infer based on their user data).

Conclusion

The emergence of the digital environment and its ecosystems has created a new set of circumstances for design. These new circumstances provide many new opportunities for all types of stakeholders to benefit from new design interventions and engage in design activities. The framework presented here has been of great value for our work, as we have tried to make such new potentials visible and relate them to already familiar design processes and patterns. The framework highlights how the design-in-use activities of a very diverse set of actors can become realistic sources of innovation and material for other designs. By mapping specific activities on the graph, and through considering their potential design interactions with new actors or the adoption of new strategies, new collaborative design spaces can be envisioned and possibly explored. Since, these different activities have not been discussed with in a single framework it is possible that further refinement of the categories would be needed in the future. In any case, we believe that the novel combination and holistic understanding of the activities we are proposing has interesting implications and presents a useful view of the design space. Our future work includes testing the validity of the model with other empirical cases with a view to iterate the concepts and the structure of the framework.

As design is usually a pragmatic activity, the actors engaged are concerned with finding a workable solution, and are likely to draw the boundaries of the design space so that they exclude unrealistic options. This of course also means that things like ideas, ideals, imagination and inspiration belong all to the category of conditions that influence the dynamic composition of the design space. Along the same lines, all design operates with tools and on the basis of earlier designs and design expertise or experience that is available to stakeholders. These aspects can become available through personal experience, knowledge sharing, external services or collaborative team effort. In this sense, the design space of a stakeholder that has the necessary economical means, access to tools, a good design network around and working experience of collaboration within it, has most likely a persistently wider design space for a variety of projects than an actor with few means or bad and un-motivating earlier experiences. Thus for supporting successful design-in-use, it would be important to make available useful and realistic sets of resources and conditions for constructing solid design spaces.

The expansion of the design space has also wider societal significance. If the design capacity of free and collaborative actors that operate in the various levels of design-in-use activities we outline, is grown through open strategies as we propose in this paper, and they are linked together in a well functioning and dynamically self-organizing ecosystem, the collaborative design space is expanded and made more persistent for all – in effect increasing the design capability of all people in society. This is a very powerful strategy to increase the capabilities of more people to influence the transformations that are taking place in society. We hope our work is a contribution in this direction.

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Food Orbits: A novel design tool for complex systems

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Abstract

Food and our relationship with it is important to our very survival. To understand the different natures of various food systems it is critical to understand some of their general characteristics. We must know the components of the system and how they work together. Currently, there are several conceptual models of food systems available to facilitate the understanding of such: the linear, radial and loop models, none of which seem suitable for a design application. Natural food systems are complex adaptive systems that operate in a closed loop, with all inputs emanating from and all residuals returning to the source. However, rather than resembling these closed-loop ecosystems, modern food systems have much more in common with 19th century factories designed around a strong input/output efficiency model. Food Orbits is a novel graphical tool for plotting the relative industrial intensity of a food as it moves through the system from soil to dinner plate. This paper will introduce the concept of food orbits through a brief discussion of their context in the modern food system, their composition and construction, and an overview of a brief study done to assess their graphical intuitiveness. The focus of the paper will be the application of food orbits as a design tool and a device for understanding complex adaptive systems.

Keywords

sustainable design, systemic, eco-design, life cycle analysis

In this paper we consider the 'food system' as all those products, processes and activities that become entrained in the passage of a component of human nutrition as it moves and transforms from source to residue, a cradle-to-cradle system (McDonough & Braungart, 2002). There is a long historical association involving design and components of this food system from the design of simple utensils like bowls, pots, knives and forks through complicated scientifically-based appliances like microwave ovens and eventually genetically modified (designed) foods like tomatoes (Martineau, 2001). All of these associations, however, tend to reflect the activities of conventional design practices and operate at the low systems level, i.e.: a product rather than a system of products.

Design practice is now entering a higher systems level, often referred to as strategic design, and whilst this has generally been associated with design's relationship with and in business (Best, 2006) it also gives rise to new kinds of designers (Press & Cooper, 2003; Inns, 2007). In these respects, we believe strategy also applies to food systems and that 'food orbits' is a strategic design tool, which applies to the designer's visual and intuitive skills in this field (food) and at the systems level. Recently, Baxter (2010) has referred to this strategic move as “design thinking entering new domains”. In doing so it widens its perspective and links the systems' scale, from product, to service and ultimately to a “comprehensive anticipatory design science” (Fuller, 1969). This latter perspective is at the worldview level. Baxter also suggests, however, that this is only one dimension (vector) of what will create the new 'field of play' for designers. A second key dimension is the ecological perspective in which “ecological thinking enters design domains”. These dimensions taken together – ecological thinking entering design and design thinking entering new domains, constitutes what Orr (2002) has called “ecological design”, Wann (1990) has called “deep design” and Baxter (2005) refers to as “natural design”. This new combination will, according to Baxter (2010), lead to the *transmutation* of design and give rise to a new breed of designers, who he refers to as the “new alchemists”. Orbiting (Brogan & Baxter, 2010) often applied to the design of food systems (food orbits), is a technique which is located at the interfaces of these two dimensions of thinking (ecological design). It is a contribution to the transmutation of design practice.

Design and complex systems

Understanding the system or the environment in which a design functions is critical to the efficacy of that design. Conventional design methods are, often by necessity, reductive – reducing difficult design problems to systems of smaller solvable problems. Whilst this approach is powerful and effective it means the solution will be optimised, and essentially designed for that simplified context. However, even these designs are always part of larger systems that then operate as part of other truly complex systems such as the greater human society or a natural ecosystem.

Some designs function directly within a complex system, such as a social network. It is within these systems that a reductionist approach often yields unintended results because the design process cannot model the level of complexity needed to explore all consequences. There are numerous examples of large-scale designs, such as hydroelectric schemes or highway networks, having large and unpredictable impact on society and the natural environment. There are also many examples of small designs such as mobile telephones or web-based social networking sites, having similar effects.

The designer, by training and experience, is prone to immediately designing toward an end defined by brief or specification, whether real or implied. If one is employed as an engineer with a large microwave oven manufacturer it is unlikely that any non-microwave oven solution would even be considered when developing a new cooker. Part of this problem exists at the beginning of the process when the design problem is defined. The problem is defined in both context and scope. Often widening the scope of the design is referred to by the cliché of 'Thinking outside the box'. This is often done through a brainstorming exercise in which different possible solutions are explored. In the example of the microwave, “thinking outside the box” might mean investigating microwave-convection ovens, halogen cookers or possibly even a gas cooker, but almost certainly not solar cookers, raw food diets, or communal campfires. Clearly, this level of complexity is too much to handle.

Simply thinking about these systems, possible problems, possible solutions and their consequences is too much for a designer or even a design team – no matter how large. The usual outcome is to simplify and return to the proverbial box. Our ability to effect change has now outstripped our ability to understand the consequences of the change.

The problem with design and complex systems is that the systems cannot be assessed by standard design methods, as the least understood part of these systems tends to be at a higher scale and traditionally conventional design works at a lower scale. Therefore, a new suite of methods are required to better assist designers in their understanding of these systems and to help them design *within* the system whilst leaving space for emergence and growth.

J. Chris Jones explained something of these levels of complexity in his justification of the need for new design methods, breaking the sphere of design influence into four strata – community, systems, products and components. He explains that “Many of the unsolved problems of designing occur at the systems level of the hierarchy.” but that conventional design methods are only effective at the two lowest levels. He goes on to suggest that:

> such an extension of the design process is at least as great as that from craft work to design-by-drawing (a shift from the lowest tier to the two lowest tiers). This change (to what Buckminster Fuller has called 'comprehensive designing') cannot fail to have drastic consequences, implying, as it does, the power to continuously remodel the whole fabric of industrial society from top to bottom. (Jones, 1992)

Jones contends that the tendency to move the designer's role from the products level into the top two tiers results in too much control and he rightly dismisses it as having drastic (likely catastrophic) consequences. However, the notion of 'comprehensive design' may be appropriate when one considers 'comprehension' to mean 'understanding of the whole'. It is this area of design that is lacking in many established methods and practises.

To date there have been some methods, such as systems modelling (Odum, 1983), pulsing, lensing (Baxter & Bruce, 2008) and orbiting (Brogan & Baxter, 2010), developed to help designers navigate this 'systems geography'. Orbiting is an exercise that designers can participate in to understand something further about the interrelationship between a system and a design. This concept is exemplified here in relation to food as it provides an excellent example of complex systems and the implications of design. It also provided the original basis for the concept developed by Brogan and Baxter.

Food orbits

Aside from design issues, there are many reasons why we may want to understand the origin of our food and especially the system, which brings it from the field to the plate. Of most importance to the consumer is probably that of food quality. Issues of food adulteration are as old as food itself - Unscrupulous producers or processors somewhere along the way 'bulking out the loaf' or 'watering down the whisky'. The Food Adulteration Act of 1860 banned these practises and eventually led to a system of inspection and enforcement that guaranteed foods to be safe, sanitary and pure (*The fight against...*, 2005). However, the lack of international standards and the lax definition of what is safe, sanitary and pure can lead many people to look deeper in to a food's origin to assure themselves of its claims.

After food quality, concerns might be expressed about a food's secondary or external qualities. These issues might not be directly linked to the food's internal quality, but often have what are best described as *health* implications. An example is feedlot-fed beef. Two physically near identical steaks purchased at a supermarket may be clean and unadulterated beef that earns the highest grade, but have travelled through very diverse channels. One may originate from a local farm where the animal was raised on pasture grass until it grew to market weight after which it was processed, humanely, in a local abattoir that sold it directly to the supermarket. The second may come from the American mid-west where the animal spent 80% of its life in the cramped and dirty conditions of a feed lot eating low-grade corn, subsequently being slaughtered in a large plant employing unskilled migrant workers, boxed and sent along to a cutting plant where it was cut into a steak, frozen, shipped a few more times until it landed at the supermarket, where it was thawed and repackaged for sale. The second steak represents what many consumers would term 'unethical' food, but in terms of health (of the environment, animal, workers and the local economy) it is also the unhealthy choice, despite the identical nutritional information 'sticker' on either steak.

To add to the ambiguity of the various food choices, the process of tracing the origin and genesis of foodstuffs in a globalised market has become quite difficult. Most processed foods contain a myriad of ingredients from different sources, which then merge to become one product that may then be again combined with other products shipped onwards through a complicated distribution network. Even whole foods, foods that are consumed in the same state in which they were harvested, may have equally complicated origins as evidenced by the aforementioned steak example.

Adding to these problems, there is the general situation of public knowledge. Whilst a certain sector of the population may be well informed about food and its origins, an American study showed that most people think very little about the origin of their food, mostly due to the lack of a mental 'model' of the system, stating: “...the lack of a specific model of food systems means that certain kinds of information has no place to 'stick' in people's minds.” (Aubrun, Brown, & Grady, 2005). Unpacking this mystery inevitably leads to the construction of a model or simplification of some sort.

The first type of model we considered to help us understand such complex systems was a spatial-survey model showing where food had been and perhaps some detail as to what had happened to it at each point in the food system. The result would be either a geographic map with pinpointed locations and descriptive boxes or a more logical box-and-arrow systems diagram. The latter affords the viewer a more generic depiction that can then be easily compared with alternatives by eliminating the spatial confusion of a map and crossing lines. Such box diagrams are commonplace in engineering and science fields and are best suited to analyses that target process efficiencies. The focus of such box diagrams is on the process rather than the product itself.

The process-based model has at its core the weakness/strength problem of most models. In any model, the more that is left out to help focus the user on a solution, the greater the danger in neglecting certain parts of the system. In a complex, non-linear system, leaving out what might appear to be a small or even insignificant component can have large effects. So, whilst a systems-based model is critical to the understanding of systems-aspects such as layout, relationship and flow, it is only a part of a suite of models that could together shed light on the entire system.

One of the main challenges of constructing a systems-model for something as complex as a food system is actually gathering information about the system, especially when so many systems converge and diverge. Often what is most critical about the process (the product and the environment) is lost. In the 1980s, engineers facing just such a problem in one aspect of the food system, potato production, developed a novel solution to view the system from the inside by creating what is now commonly referred to as the 'electronic potato' (Anderson and Parks, 1984). The electronic potato is a potato-shaped data-logger, which monitors various physical parameters that a potato might encounter, such as: physical force, temperature and relative humidity. The 'potato' is then buried in a field and eventually retrieved at the processing facility days (or weeks) later. The data, once downloaded, provides a story of what has happened to the potato. This can illuminate where in the process the potato is exposed to excessive heat, moisture or physical force. It is a 'potato's eye view' of the post production process and often shows a very different story from that told by the systems model.

An alternative method at the early design stage is the use of a model, which exploits tacit knowledge, readily accessible information and intuition.

Understanding macro organic mass flow through the world's modern food system ultimately leads us to the study of naturally occurring food systems, because, despite our best efforts to mechanise, the food system still has living systems at its base. It is comprised of living organisms and systems that have been modified by our efforts to adjust or control the flow of water, nutrients and organic mass, resulting in natural systems with varying degrees of intervention. Whilst systems thinking has been applied to ecology (Odum, 1983) and this has, to a great degree, influenced our understanding of how they function, there are still many unknowns. Nevertheless it is known that natural systems have a variety of common characteristics such as a tendency to be highly stable over the long term, a high degree of complexity, self-sustaining characteristics and usually operating in a closed-loop with a high degree of feedback and redundancies. They are resilient. The entire premise of agriculture is the isolation of small components of natural systems with intensification of certain aspects for the benefit of mankind. By definition it is a disturbed ecosystem. Agriculture, in effect, takes humans, as a species, not just to the top of the predator-prey pyramid, but out of it, free to browse the entire structure. This then gives humans the unique ability to stand back and consider the structure, which compromises every other living organism. In recent history it would appear that we have seen this system as a simple machine that can be optimised and fine-tuned.

The degree to which we intervene in the ecosystem might be referred to as 'intensity', coming from 'intensive agriculture'. The idea of intensity can be applied to most processes such as: intensive training in education or intensive care in health. At its root, 'intensity' simply means the application of stronger or more forceful action and is well appreciated by most people at the intuitive level. Applying the term to systems it can be said that intensive systems are those which are designed to apply strong or forceful action toward the achievement of their purpose. Living systems, by their very nature, are not intense. They may well be complex, detailed and adapted in execution, but usually eschew strong and forceful action, despite often having very significant outputs. Food systems, being comprised of living systems, which cannot be designed themselves, must then undergo intervention. In food system terms, it is not the intensity of the system we refer to but rather the intensity of the intervention.

Quantifying intervention is easiest done in qualitative terms with an arbitrary numerical scale (i.e.: one through five or one through seven). Whilst it would be possible to develop a numerical or statistical method to derive an intensity 'score', this is unnecessary given the simply didactic application of the food orbits tool.

A qualitative numerical scale has been adopted here. Such a scale allows for the scoring of various aspects of the system – a rating for each major part of the system that is encountered. This activity allows the designer to think about each aspect of the system individually in terms of intervention and how they affect the complexity of the overall system.

To further develop this scale into a powerful visual tool, we decided that the best form would be that of a loop or orbit, further emphasising the 'cradle to cradle' concept. The food orbit is then formed between concentric circles denoting the intensity scales. Radial arms show each step of the process from beginning to end. Typically, the following stages are represented – Source, Processing, Marketing, Consumption and Residuals, giving five arms. The arms are scaled as per the intensity scale chosen and points plotted and connected to form an orbit around the centre. An example is shown below in Figure 1:

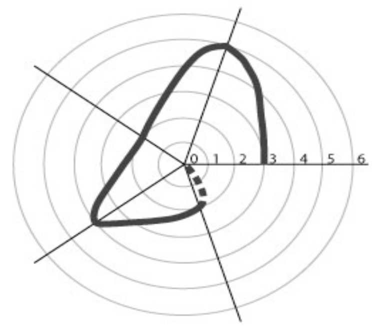

Figure 1: Example food orbit.

The orbit itself was developed as a design tool, but can have application elsewhere. Visually, it offers a very simple way of seeing the intensity of the system. The circular shape adds emphasis to greater intensification. A designer can look at the orbit and quickly see which part of the system is most intense. The orbit and the process of creating it are quite intuitive, simple and holistic, making it a quick exercise for designers to perform to help them balance some of the detail-oriented systems modelling.

We acknowledge that there may be many other applications for this concept – including those which take it down a much more predictive or calculated route – but at this stage it was most critical to evaluate the strongest property of the concept: its basic intuitiveness. What follows is an early exploration of the intuitive nature of the food orbits concept.

Preliminary exploratory experiment

A group of design students from the University's Masters of Design and Masters of Design Ethnography programme were taken as a sample group. The group were not all specialist designers, but most had some traditional design experience, either in the form of a Bachelor's degree or in industry.

The group was given a very brief introduction to the concepts of intensity and orbiting, totalling no more than fifteen minutes and then given the task of drawing four food orbits for selected foods, individually. Each food was described minimally (see Table 1). Two minutes were given to draw each orbit on a blank sheet, showing only the scale via concentric circle. Questions were answered on specifics as asked – although no numerical intensity values were given for the first food. In the three subsequent foods, intensity scores were given for parts of the orbit. The table below summarises the information given. A picture was also shown to the participants.

Local Strawberries	Grown locally under poly-tunnel, some chemicals use, sold at nationally branded supermarket, consumed at home with cream.
Tinned Baked Beans	Beans grown in USA under conventional agriculture, processed with sauce added in the this country, tinned and sold here, bought and eaten on toast, *Source = 5.*

Olive Oil	Cold pressed from organically grown Spanish olives, bottled in Italy, sold locally at a small organic market and eaten on a salad, *Residuals = 3.*
Baguette	Locally baked from conventional Canadian HRS wheat flour, purchased from a small shop near the university, *Source = 4, Residuals = 0.*

Table 1: Information given to students to generate food orbits.

The group consisted of 24 individuals who produced a food orbit for each specified food. The resulting sketches were collected and results compared. It was expected that, should the food orbit concept be basically intuitive, the results would be similar in shape and scale.

As it would be impossible to visually compare the results, each food orbit was converted in to a series of numerical values, representing the five stages of the process. The standard deviation for each sample of intensity values was calculated, shown in Table 2 below.

Table 2: Standard deviations of intensity scores.

	Source	Processing	Marketing	Consumption	Residuals
Strawberries	*1.5*	*1.2*	*1.1*	*1.4*	*1.1*
Beans	*0*	*1.2*	*1.1*	*1.3*	*1.3*
Oil	*1.4*	*1.2*	*1.5*	*1.1*	*0*
Baguette	*0*	*1.4*	*1.3*	*1.7*	*0*

Omitting the standard deviations of zero, where the value was given, the others ranged between 1.1 and 1.7. This indicates that, whilst there were a range of values, the majority sat within one to two units of the mean. We realise this is not an exhaustive analysis, nor was the experiment intended to be conclusive, but simply a first look at the validity of the concept.

As discussed in the main body of the paper, the greatest value of the orbiting concept is as a design tool to work in concert with other systems modelling tools. Further research is planned to both further investigate the intuitive nature of the food orbit as well as its efficacy as a design tool in assisting the designer's awareness of complex systems

Conclusion

Understanding complex systems is critical to the ability able to design in a holistically effective manner. Not simply knowing the environmental impact, which is usually framed in a negative sense, but the place and appropriate function of a design as part of a natural system is necessary. Natural food systems are complex adaptive systems that operate in a closed loop, with all inputs emanating from and all residuals returning to the source. Food Orbits are a novel graphical tool for plotting relative intensity of a food as it moves through the system from soil to dinner plate. This concept has been shown to have some intuitive value and future studies are planned to investigate further application outside the realm of food. It would appear to be well suited to the early design stages of a complex problem.

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Seaton Baxter

Seaton was born in Aberdeen, Scotland in 1939. He has academic qualifications in building technology and philosophy. He worked for 20 years in agricultural research mainly concerned with the design of buildings and equipment for animal welfare, before joining the Robert Gordon University, Aberdeen in 1983 as Head of the School of Construction Management, Property and Surveying. At the Robert Gordon University he acted as Assistant Principal, Dean and Reader where he established the Centre for Environmental Studies (c1994) and the first ever MSc in Ecological Design. He is currently an Honorary Professor at Dundee University where he heads the Centre for the Study of Natural Design. Seaton has worked with several Scottish environmental NGO's - Scottish Environment Link, Association for the Protection of Rural Scotland, Deeside Forest Advisory Group and was formerly a board member of Scottish Natural Heritage.

He was awarded an OBE by the Queen for his services to Scotland's Natural Heritage in 1998. He currently lives in Fife, Scotland.

Poetics as a Strategy of Inquiry:

Productive Science in Design Practice and Research

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Abstract

For many years practicing artists and designers, as well as design researchers, have struggled to find useful models for their creative work. To understand this struggle, we will use a model that gives intellectual strength and direction to research and creative projects, offering an alternative to other approaches such as *Design Science, Dialectic* and *Rhetoric*. The strategy is called *Productive Science* or *Poetics*, and it is a way of focusing and understanding the struggle of a practicing artist or designer as he or she seeks to develop creative work. There are three central features of the strategy: the identification of the essential functional elements of design; the exploration of those elements with an appropriate degree of precision; and the *integration of those functional elements* in design and artistic practice. The exploration of the elements is the process of designing: phases of analysis and synthesis in concrete production, with reflection on the implications and principles that emerge in the course of creative work. The goal of this paper is to explore the potential and significance of *Productive Science* as a strategy of inquiry in design practice and design research. I will illustrate the importance of this strategy with a concrete example drawn from my own practice-based design research. The deepest hypothesis of my work was that *perception, meaning, and emotional expression work together in creating a unity or wholeness in the products of design and in the experience of the people supported by such products*. Exploring this hypothesis in the different stages of the analysis and synthesis is what this research was about.

Keywords

Poetics; Productive Science; experience; perception; emotions; unity; design practice; aesthetics/acoustics

The term *practice* resonates well with designers as well as with artists through concepts such as intuitive thought, imagination, emotional expression, and what Richard Sennett calls “the spirit of craftsmanship” (Sennett, 2008, p. 286). However, the name and historical lineage of *Productive Science* or *Poetics* may not be entirely familiar to practicing designers and design researchers. The community of researchers and designers has struggled for many years to find useful models for their work. For example, researchers in the Design Methods Movement found it important to seek a new “scientific” basis for designing that would lead to a methodology of design. Whether this effort was successful is open to debate because of conflicts among the various proposals, leaving the issue open for further exploration. As an alternative to other approaches such as *Design Science, Dialectic* or *Rhetoric,* we will focus on a model that gives intellectual strength and direction to research and creative projects. The strategy is called *Productive Science* or *Poetics*, and it is a way of focusing and understanding the struggle of a practicing artist or designer as he or she seeks to develop creative work.

There are three central features of the strategy: the identification of the essential functional elements of design; the exploration of those elements with an appropriate degree of precision; and the *integration of those functional elements* in design and artistic practice. The functional elements include the materials of embodiment, the manner or technique of execution, form as the unifying structure or idea, and purpose as the ultimate goal of the work. The exploration of the elements is the process of designing, divided into phases or stages such as finding a meaningful problem, doing background research, finding creative ideas, developing those ideas in the process of creation and iteration, and finally synthesizing a work that has impact and emotional integrity. The final integration of the functional elements of design in practice is the creation of a work with compelling correctness of expression, both in achieving a practical purpose and in bringing appropriate emotional force to the solution. This summarizes the creative aspect sought in *productive science*, but there is a further outcome. This is found in reflection on the implications and principles that emerge in the course of creative work. It is *reflection* that transforms practice into a *productive science*, a systematic study of human creation based on principles. The goal of this paper is to explore the potential and significance of *Productive Science* as a strategy of inquiry in design practice and design research.

Four Strategies of Inquiry

As with most of the methods and strategies of intellectual investigation, the strategy of *productive science* may be traced to the ancient Greeks. Aristotle was the first person to employ the method of *productive science* in the investigation of the human-made world. For him, *productive science* or *poetics* covers any kind of making, including both useful products as well as the products of all of the fine arts. His inquiry is recorded in the *Poetics* (Telford, 1961), a treatise on the art of tragedy. By Aristotle's approach a work of art or an artificial "thing" is a unified structure or synthesis of parts. The unifying structure of the work of art is what Aristotle calls its *form*, while "the parts are the *material* which is unified by the form" (Telford, 1961, p. 63.) By this approach, the problems of making are stated and solved in terms of the requirements of the work of art that arise from the process of thinking, doing and making.

The method of *productive science* has been employed by many writers and researchers in the investigation of literature, the visual arts, music, and in the twentieth century, the design arts. For example, a variation of this method was important at the Bauhaus and in the work of the designer Laszlo Moholy-Nagy. As in the case of other writers (Santayana, 1955; Sessions, 1958; Telford, 1961), Moholy-Nagy (1970) also emphasized the role of inspiration that comes from nature and the importance of the unifying structure or *form* as an interconnecting link of parts or essential elements in the creative process. But it has also been an important method for designers and design theorists holding quite different positions on the nature of design. An example is Herbert A. Simon's *The Sciences of the Artificial*. Richard Buchanan argues convincingly that the structure of Simon's book follows key structural features of Aristotle's *Poetics*. He suggests that Simon's book could be regarded as a modern variation of *poetics* and *productive science*, although Simon employed and positioned the approach well within the framework of his positivist philosophy and his vision of a *design science*. In other words, Simon ultimately turns the pattern of productive science into a strategy of *design science*, seeking the basic elements that underlie the complexities of the material world, and to investigate the processes and mechanisms by which those elements are combined to yield to world of experience and the cognitive processes of designing.

John Dewey's (1958) *Art as Experience* employs a variation of *productive science*, positioned within the framework of his philosophy of pragmatism and his theory of *logic* and inquiry. In *Art as Experience*, Dewey focuses on what he calls "*an* experience" rather than discuss experience in general. *An* experience, Dewey argues, has form and structure. It is a coherent interaction with the world, with a beginning, middle and end that embody the activity of a person and the conditions of the environment. It moves from resistance and struggle to a consummation in a completed work, whether the "work" is practical, intellectual, or aesthetic. The work is not an object. Rather, it is an activity. And the activity has a mixture of practical actions, intellectual dimensions, and emotion. Inquiry, as Dewey argues in *Logic*, "is the controlled or directed transformation of an indeterminate situation into one that is so determinate in its constituent distinctions and relations as to convert the elements of the original situation into a unified whole." (Dewey, 1964, p. 104-105). The strategy of inquiry, in this case, is "to seek the resolution of theoretical, practical or productive problems and move toward the advancement of knowledge in the various branches of human learning and activity." (Buchanan, 2009). Productive Science focuses on the discipline and methods of making, the properties of the made-thing, the analysis of the functional elements of products, and the synthesis of all these functional elements.

However, there are two other important strategies of inquiry: *rhetoric* and *dialectic*. Instead of focusing on methods of making and the production of human-made products, *rhetorical* inquiry focuses on the ethical and inventive character of the artist and designer, and his or her ability to effect social change through argument, communication, and action. *Dialectical* inquiry is most difficult to manage, but at the same time adopted and used in many fields, among them design. Donald Schön (1983), in his book *The Reflective Practitioner*, calls for "reflective conversation" in the work of designing. The central feature of *dialectical* inquiry is to overcome oppositions, conflicts and contradictions encountered in everyday life by bringing them within a system or ordered whole.

These four strategies – *productive science, design science, rhetoric* and *dialectic* – have significantly shaped the methods employed by designers. According to Buchanan (2009), they also point toward two of the philosophical problems that are significant issues in design practice, the problem of *parts and wholes*, and the *problem of means and ends*. The interplay of these four strategies, Buchanan (2009) summarizes, helps to explain the otherwise bewildering diversity of design practice and design research in the 20th Century.

However, the potential of productive science as a strategy of inquiry is still not fully understood, and the significance may remain unclear for many researchers. For this reason, I will illustrate the importance of this strategy with a concrete example drawn from my own practice-based design research (Tooming, 2007).

A Concrete Example of Productive Science

An idea expressed by John Dewey speaks well to the complex mixture of art and philosophy that a reader will find in my work: "Philosophy is said to begin in wonder and end in understanding. Art departs from what has been understood and ends in wonder" (Dewey, 1958). It is not for me to say whether the ensemble of works produced as the centerpiece of this inquiry are wonderful, but I can say that the philosophical foundations of *productive science* and the philosophical problems of the unity of art and design and emotional expression are a central expression of what I have come to understand about fiber art and design through the inquiry.

The inquiry is an example of what I consider "practice-based research" in art and design. What the term means to me is that the inquiry began in the practical experience of my work as an artist and designer. It continued through practical experimentation with a technique of production, and it has yielded results that have practical as well as theoretical value. It does not matter whether we call the research practice based or something else. It is a design inquiry and an example of design research.

The *central question* of the inquiry was whether fiber art and design could serve a practical purpose in enhancing the quality of sound in interior spaces as well as an aesthetic purpose in adding beauty to an environment. The problem of sound absorption has been addressed in a variety of ways by different professions. They have tended to use unappealing materials in the form of panels attached to walls or suspended from the ceiling. Solutions are typically hidden from view, or when visible they are not aesthetically pleasing. And if solutions are aesthetically pleasing and are not hidden from view, they do not have a high quality of sound absorption. The selection of materials is more often random rather than based on any systematic analysis of acoustic properties. In short, there is limited understanding of the acoustic properties of materials, and the research in this area is often inadequate. Where there is testing of acoustic properties, most of the materials are simply not adequate to solving the problem effectively. The answer to the question “could fiber art serve purposes that are practical as well as aesthetic?” is that it can, under certain qualified conditions. Finding the nature of those qualifications is more than a matter of artistic intuition and sensibility. The artist’s intuition and the engineer’s common sense tell us that the fiber art work must have some proportionality to the total surface area of the environmental space. Beyond this, we know little more, unless we have specific knowledge. Gaining this knowledge, and understanding how it bears on the practical and artistic matter of creation, is one of the problems of inquiry, calling for what I earlier referred to as the exploration of functional elements with an appropriate degree of precision – in this case the exploration of material properties and a manner or technique of execution.

The inquiry pursued two closely related lines of investigation. The first issue was the nature of materials and the manner or technique of production. It was necessary to investigate the acoustic and aesthetic properties of a variety of fiber materials. In all cases, the materials were subjected to careful acoustic testing based on recognized methods of measurement of sound absorption and speech transmission. However, it was not enough simply to test the fiber materials. The materials had to be formed in such a way that they could be tested – and, hence the testing was a study of the technique of handling the materials as well as the materials themselves. The technique employed in this research is called *hand tufting*. Hand tuft technique designates the modern weaving technique by which thread is shot into a vertically suspended backing by means of a hand-steered machine that is driven by compressed air (Figure 1). This is an emerging technique whose history and characteristics are not well addressed in the literature. Hand tufting is a powerful technique of modern weaving, when it is used appropriately and with imagination (Figure 1-4).

Figure 1. Hand tuft technique

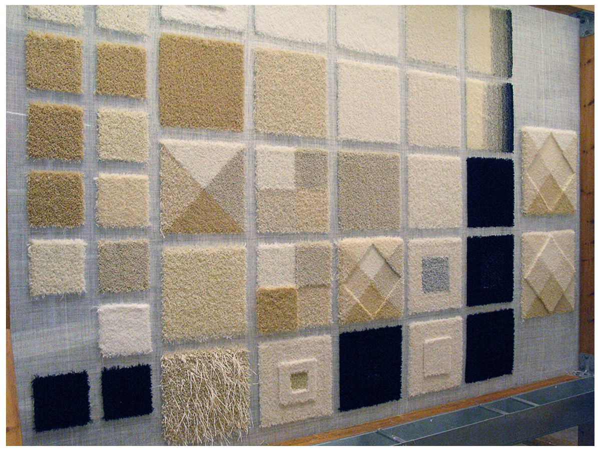

Figure 2. Hand tuft samples on frame.

Figure 3. Kaja Tooming, *Celebration*, 1999. 61x61cm

Figure 4. *Celebration*, 1999. Reverse view.

The second issue, already foreshadowed in the technique of hand tufting, was the artistic and design use of the technique in creating forms that possess some measure of beauty and charm (Figure 3-4). In formal theory and design methodology this is called "synthesis," but this is a dry, academic term for the struggle of the artist and designer who seeks to bring together all of the functional elements of his or her craft, art, or discipline. How do we study the *informed intuition* and *inventiveness* of the artist and designer? This is a critical question because it is not enough to understand the acoustic and aesthetic properties of materials. The materials must be formed, and formed by an idea that is progressively realized in the work of art and design.

To pursue these issues, one must settle on a specific strategy of inquiry, and this is when my work turned toward productive science. This involved a deliberate decision to turn away from what is sometimes called design science. Design science, as understood by some investigators, seeks an explanation of issues of design practice by a reduction to the underlying materials of the world and the mechanisms of the mind by which decisions are made in art and design. Instead of a study of the physics of the materials or a psychological study of the fiber artist or a consumer study of the fiber art and its reception by an audience, I turned to the functional elements of art and design – the elements that are necessary for the existence of a work. In the traditional and contemporary use of this strategy, I explored:

- *manner of production*,
- *materials employed by the artist and designer*,
- *qualities of form in the created work*, and
- *purpose or function to be fulfilled by the work*.

I assumed, in accordance with the assumptions of this strategy, that artistic and design creation is the *integration of these functional elements* by whatever means or methods are suitable to the individual artist or designer.

The inquiry began with an analysis of the manner of production (hand tufting) and the fiber materials (various kinds of fibers and threads). It continued with an exploration of form and function, testing through artistic creation the combinations of manner and material that may be suited to the final product. In the course of the work, small samples were developed and then tested in a solo exhibition *Backside* at the *Town Hall Gallery* (see Tooming, 2007, p. 77-83). The *Backside* exhibition was the first step toward formal synthesis of the elements of fiber art in expressive forms (Figure 5-10).

Figure 5. The view of the *Backside* exhibition.

Figure 6. The *Backside* exhibition at the Town Hall Gallery in Kuressaare, 2003.

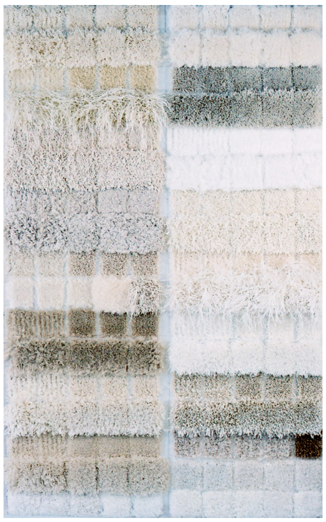

Figure 7. *Backside,* 2003.

Figure 8. The view of the room: *Backside's* back side and reliefs.

Figure 9. Floor installation *The Japanese Garden* with hand tufted rug elements and sand. Detail.

Figure 10. Installation *The Japanese Garden*.

Based on the results, this preliminary step led to the second phase of the research: the creation of an ensemble of fiber art works for a specific architectural environment, where aesthetic and acoustic problems are the central issue. I was using fiber art as a design element in a complex and culturally important building: the *Jonsered Manor*, known in Sweden as the *Jonsered herrgård* (Figure 11. See Tooming, 2007, p. 85-104).

Figure 11. Jonsered Manor, Sweden.

Figure 12. Dining room.

An elegant dining room presented a difficult problem of poor acoustics (Figure 12). When many people were in the room, echoes created disturbing level of noise. The architects have been cautious in attempting to solve this problem because of preservation ambitions; obvious solutions were ruled out because they conflicted with the historical nature of the room. The design constraints imposed by the historical setting of the room suggested that a subtler approach was needed to deal with the poor acoustics. It is in this context that a fiber art approach began make sense. The goal was to meet two needs simultaneously. The first need was for fiber art work that would add an appropriate aesthetic expression, enhancing rather than detracting from the experience of the room. The second need was to design the fiber art work in such a way that they might help to improve the acoustics of the room. Behind this, there also had to be careful consideration of the larger context of the building, including historical, social and cultural factors.

The first step was to investigate the environment through perception, observation, interpretation, and reflection on what factors should influence the final creation of forms suited to the history and traditions of the building and its contemporary use. It was important to experience the dining room in its entirety, as a place of social interaction and communication. This is the “experienced whole”, which brings together the perceptual elements and the meaningful relationships of the space and adds to these the expressive qualities of human interaction. A key point here is that fiber art becomes an art of design when the purpose of creation is more than pure aesthetic expression. In this case, the work of fiber art no longer exists as an isolated object but becomes part of an environment, supporting and sustaining practical experience in the lives of human beings.

My work took John Dewey’s idea of *an* experience as a beginning point. However, I have found it important to develop Dewey’s idea in a somewhat different direction than he did. I found it important to focus on three considerations or three aspects of experience: *perception, meaning,* and *emotional expression*. Of course, Dewey discusses issues related to these three themes, but for the practicing artist and designer the role of perception is very significant and deserves careful attention as the first step in one’s interaction with the environment of daily living. Therefore, a major part of the early research focused on perception: the perception of materials, sound, and other features of the materials with which the designer must work. This is an analytic, scientific task. I have found phenomenology to provide an initial framework for such considerations and to be helpful in the observational method employed as part of the investigation. A theoretical foundation for this work comes from the phenomenologist Edmund Husserl (1969), and the existential philosopher and phenomenologist Maurice Merleau-Ponty (1963; and 1964).

Perception is important, but how we interpret perceptions and make meanings out of them is also important. That is, the role of meaning is also important for the fiber artist who conceives of his or her work as an art of design. In fact, the designer works in an environment that is rich in associated, traditional, historical, and cultural meanings. Any new work of design must engage and interact with such meanings if it is to be successful in supporting the experience of people in their concrete environment. For this reason, I have also found structuralism to be helpful, particularly in the form developed by Roland Barthes (1964). The idea that an environment possesses a deep structure of parts and relationships is very useful to the designer. It enables one to explore the details of placement of objects and artifacts in an interior pace, and it also enables one to better understand how other meanings – social, cultural, and historical – enter into consideration in the activity of making meaningful experiences.

Ideas about perception and meaning come together in John Dewey's concept of experience, but under a third consideration that is also critically important for the designer: *emotion* and *expression*. For Dewey, emotion is what unifies an experience, whether the experience is artistic and aesthetic or intellectual or practical. In short, if the designer is to be successful in supporting the practical experience of people living in interior spaces, he or she must explore the emotional and expressive aspects of the final solution. As Dewey argues, emotion is not something separate from an experience – something added onto everything else. Rather, it is the heart of an experience – the unifying "glue" of daily life. The deepest hypothesis of my work was that *perception, meaning, and emotional expression work together in creating a unity or wholeness in the products of design and in the experience of the people supported by such products*. Exploring this hypothesis in the different stages of the analysis and synthesis is what the research was ultimately about.

Productive science has an affinity with what is sometimes called "practice-based research." It is certainly more precise than the vague descriptive phrase "research through design." Productive science suggests the artistic logic of someone who studies a situation, reflects on all of the factors that bear on creation, carries out the work of realizing an idea in concrete form and materials, and then reflects on the total experience in order to gain deeper understanding of an art. Intuition is informed with the results of analysis, just as this work has been informed with the initial technical studies and then with a careful consideration of the environment of the Jonsered Manor.

Reflections on Principles and Results

What we have learned from this strategy of inquiry and its organization of the methods and techniques of research is at times surprising and at other times a confirmation of initial ideas. For example, we learned that some of the fiber threads that were tested are nearly ideal in sound absorption, as determined by acoustic science (Tooming, 2007). This was a surprise not only for me but also for the acoustic engineer who performed the tests. We also learned the specific absorption properties of all of the materials that were tested. In addition, the weaving technique of hand tufting appeared to contribute to the quality of sound absorption because of the intertwining of fire threads and the use of unglued backing.

The solo exhibition *Backside* demonstrated that audiences found the color and forms of the fiber models to be warm, inviting and intimate, surprising, natural, and almost sacred (Figure 5-10). In fact, many viewers were surprised at the combination of aesthetic and practical purpose. We were encouraged that this is a reasonable direction for further artistic and design exploration. The *Backside* exhibition also generated more knowledge on how to use the technique of hand tufting, and to use it in unusual and innovative ways.

The creation of the ensemble of fiber art works for the Jonsered Manor led to more complex insight. For example, it led to the recognition that fiber art and the hand tuft technique could be used to create sculptural forms. There are other examples of fiber art sculpture, but none that we know about that are formed with the double-weave hand tuft technique (Figure 15-16). This is something new and innovative in the field of fiber art that deserves further exploration. We also learned – and this is a personal learning related to professional development as an artist and designer – that it is possible to create fiber art works deliberately within a specific environment, and that a working method which grows out of analysis and research can achieve a degree of alignment with the traditions and history of that environment (Figure 13-16). No strategy of inquiry or method of research can predict the final quality that an artist or designer can bring to a work. At best, we hope to explain the factors that bear on the problem and gain insights that can better inform creative intuition.

Figure 13. Kaja Tooming, *Flow*, 2007.

Figure 14. *Flow*. Detail.

Figure 15. Kaja Tooming, Sculptures *Growing I* and *Growing II*.

Figure 16. *Growing I.*

The matter of acoustics is more precise. Acoustic testing at the Jonsered Manor yielded several important findings. The first finding is that the choice of fiber materials and the form of their presentation resulted in an absorption pattern that closely approximated a so-called ideal absorber, as understood within acoustic engineering (Tooming, 2007, p. 59-72). That result was expected, based on earlier testing and analysis. What testing at the Jonsered Manor further revealed was that the total surface area of the works of fiber art was not large enough to considerably reduce reverberation time in a vast, hard-surfaced space like the dining room of the manor. That is, further use of fiber art would be needed to effect a major change in enhancing the quality of sound in the room. This was not unexpected. Indeed, our initial proposal suggested three alternatives, each of which would have increased the surface area of the fiber art works. An appropriate proposal was selected for a variety of reasons. Nonetheless, the test provided a proof-of-concept that is encouraging for further exploration.

Of special interest for further work is the idea of mobile fiber art screens. Properly designed and fabricated, screens of fiber art could easily support the idea of a "reconfigurable" room or even an office space. The dining room of the Jonsered Manor is a grand room, with high ceilings and many hard-surfaced tables. Sound control in this space is certainly a challenge. In other rooms and kinds of work or social areas, fiber art works, for example screens, could function effectively. However, one thing that has been learned is that fiber art and design, used most effectively, should be site specific. It should grow out of the unique features of each situation and environment as much as possible.

Significance

The final step in poetic inquiry or productive science is a reflection on the nature of unity and emotional expression in a work of design. It speaks to the question "what is the significance of this work and how does it advance understanding and practice."

The significance of this work is quite practical. It contributes to the body of knowledge that may be useful for architects, designers, and design researchers as they pursue the practical problem of enhancing the quality of sound in interior spaces. We have discussed the nature and value of the double-weave hand-tuft technique, the specific acoustic properties of a variety of fiber materials, and how the exploration of form and function may contribute to enhancing the experience of interior spaces. These matters are certainly an aspect of the unity that we have sought in understanding how fiber art becomes an art of design. Unity is found in an integrative discipline of thought and action, informed with appropriate and relevant technical knowledge.

However, there is also theoretical significance. This approach contributes to the theoretical foundations of the study of design and the place of fiber art and design within the broader domain of the design arts and sciences. This first form of contribution is the demonstration of the strategy of *productive science* as a strategy of inquiry. As Richard Buchanan (2007) has argued, this strategy has emerged from time to time throughout the twentieth century, and the present work shows its application to a new area of design thinking in exploring the aesthetic and acoustic qualities of fiber art and design. While the strategy of *productive science* is perhaps unfamiliar in its name and its formal rigor, it is a strategy that is quite familiar in the common sense of the practicing designer and artist. And, of course, it is familiar to some design researchers, although not necessarily by the name of *productive science* or *poetics*. As noted earlier, the central feature of the strategy is the identification of the essential functional elements of design, the exploration of those elements, and the integration of those functional elements in design and artistic practice. By elaborating this strategy and developing an inquiry around its concepts and methods, we have contributed to further use of the strategy in other inquiries.

The second theoretical contribution concerns the nature of unity and emotional expression. If the first contribution lies in the area of strategy and method, the second contribution lies in the area of principles. We have sought principles in three unities: the unity of the *perceptual whole*, the unity of the *meaningful whole*, and the unity of the *wholeness of experience* (see Tooming, 2007, p. 109-118). In the course of our search, we have discussed the ideas of Maurice Merleau-Ponty, Roland Barthes, and John Dewey – leading figures of phenomenology, structuralism, and pragmatism. By combining some of these ideas in succession, we have found principles in the progression of unities that lead to emotional expression. This has yielded the paradox of necessity in fiber art and design – the *necessary intelligibility of emotional expression* arising from the intimate connections of form and purpose as they work together to integrate materials and the manner of human action. This is the basis of the compelling correctness of the artist's decisions in creating a work of art and design. It is the criterion that we sought for artists and designers through our reflections on principles and unity.

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Author Biography

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Kaja Tooming Buchanan is Assistant Professor of Design Theory at the Cleveland Institute of Art, USA. She is currently investigating the positive social influence of design through perception, the construction of meaning, and the forms of experience in human interaction and services. She received her Ph.D. in Design in 2007 from the Faculty of Fine, Applied, and Performance Arts at Göteborg University, Sweden in 2007. Her doctoral research is an example of practice-based design research guided by the strategy of Productive Science and Poetics, offering insight into the aesthetic and acoustic qualities of hand-tufted fibre art in the context of interior spatial design. A central feature of her work is a philosophical reflection on the nature of unity and emotional expression in art and design. She received her Fil. Licentiate degree in Design from the same Faculty in 2005. She also has Master of Arts in Art History from Göteborg University and a Diploma (5 years program) in Art and Craft from the Estonian Academy of Art. As a practicing artist, she has had more than ten solo exhibitions, and has participated in a dozen international group exhibitions. She has received more than twenty cultural and research grants and fellowships.

Visual Creativity and the Threshold of Uncertainty in Product and Automotive Design

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Abstract

An investigation into the development of visual and spatial creative capabilities in industrial design students is described. It focuses on establishing whether or not spatial intelligence represents a threshold concept in studying industrial design and evaluating whether or not visuo-spatial intelligence can be a measure of a student's cognitive ability to design. A four year longitudinal study highlighted a number of threshold concepts the most significant of which was the toleration of design uncertainty. A separate range of tests and studies covered spatial comprehension, drawing exercises, and pattern-solutioning capability, and they demonstrated that spatial capability represents a baseline requirement and is not a key threshold concept. Further reflection on the uncertainty threshold located it within the concepts of the designerly way of knowing, as a key ingredient in a 'conversation' between two modes of thought in a dual processing model. This was seen as key to facilitating the development of visual creativity in a holistic approach to Coventry University's design curriculum. A range of teaching interventions can be mapped onto this approach. This has informed the basis for an enhanced industrial design study programme which is being introduced.

Keywords

Creativity, Technology, Education, Industrial Design, Spatial Design Intelligence.

Introduction

The Centre of Excellence for Product and Automotive Design (CEPAD) is one of Coventry University's three HEFCE-funded centres for teaching and learning. It has implemented a five-year plan to reinforce existing teaching excellence within the Industrial Design Department of Coventry School of Art and Design (CSAD) and reflect upon its practices to inform future design education. The project pursued a number of themes such as the exploration of design education in the context of the design community of practice; the internationalisation of design education, threshold concepts in design education and the exploration of visual and spatial creativity through digital technologies.

This paper discusses visuo-spatial design intelligence and its relationship to the industrial design curriculum in CSAD. It focuses upon three questions:

1) Is spatial intelligence, pertaining to industrial design, a threshold concept for students?
2) Can visuo-spatial intelligence actually be a measure of a student's cognitive ability to design?
3) How do we engage with 'design uncertainty' in the industrial design curriculum?

Methodology

The first question was addressed through a four year longitudinal study of student experience involving interviews, observation and focus groups to investigate the identification of threshold concepts within industrial design in CSAD. Staff interviews were also conducted.

Question two included three interrelated activities. The first two involved implementing the The Purdue Visualization of Rotations Test (Bodner and Guay, 1997) in parallel to an internally developed test with a cohort of first level undergraduate transport and product design students (Osmond and Turner, 2008) The aim of these two tests was to identify whether it was possible to measure student conceptions of spatial awareness on entry to the industrial design courses and correlate this with their end of year assessment results. The third activity involved conducting a pattern solutioning exercise to establish whether it is possible to recognise visual solutioning capability that could reliably indicate design capability.

Question three is centred upon the results of the first two and leads to the exploration of curriculum interventions that can promote confidence to engage with solutioning processes at the early stages of industrial design study.

Is spatial intelligence a threshold concept for students?

Staff and student understanding of spatial awareness was addressed through interviews with staff and ten first year transport students in 2007. The question explored whether spatial awareness, considered by staff as being at the heart of the Transport and Product Design course was a Threshold Concept (Osmond, Turner, 2008). Meyer and Land describe threshold concepts as “akin to passing through a portal” or “conceptual gateway” that opens up “previously inaccessible way[s] of thinking about something”. Cousin (2009) also provides a practical description of exploring threshold concepts in education.

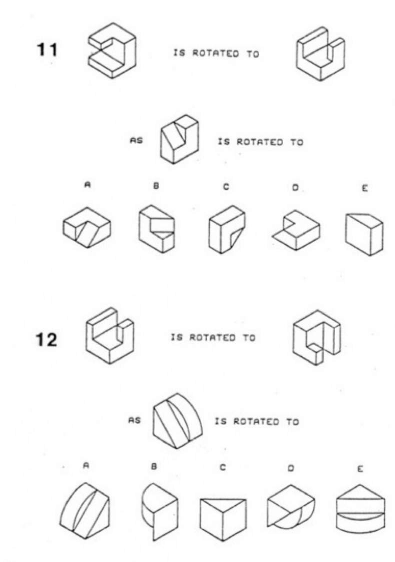
Threshold concepts provide a useful framework for exploring design learning because for the design student, design learning is highly focused on aspiring to become a practitioner and aligning with the design community of practice (Tovey and Owen, 2006, Wenger, 1998). From the beginning of this study design learning was recognised as a transformative process that required a range of cognitive shifts based on engaging with practical design experiences and professional communities along with the acquisition of design knowledge. The research team endeavoured to define the thresholds associated with design learning and findings led to a focus specifically on the toleration of design uncertainty.

A literature search demonstrated that the examination of spatial awareness was well established. Gardner (1983) for example provided useful definitions of spatial intelligence. However sources were more difficult to locate when CEPAD identified that spatial intelligence in the context of industrial design moved beyond the bounds of ‘transformation’ and ‘modification’ to the creative interpretation and progression of form-based ideas. The study became even more challenging when it was identified that even design experts differed in their interpretation of what spatial awareness meant. However interviews led to some themed categories associated with: all-around awareness; co-ordination; design sensitivity; space; intuitive/6th Sense; looking at an object from the outside; mental rotation; positioning system; time; visualisation; and, volume (Osmond, Turner, Land, 2007).

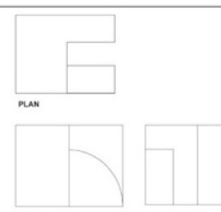
The student interviews, which took place in their first term of study showed a relatively untheorised appreciation of the concept of spatial awareness – some students said that they had not heard of the term, others offered approximate guesses such as ‘Like distance from things and if something will fit into a certain space or if it doesn’t?’. It was evident that spatial awareness is not a threshold concept and that after a few months students developed a more sophisticated spatial understanding. This seemed to indicate that design teaching is effective in the development of spatial ability. While students may arrive with a ‘baseline’ capability in spatial intelligence e.g. show the potential to sketch in three-dimensions, it needs to be nurtured through teaching practice both in terms of skill and articulation.

This phase of the research highlighted that within the field of industrial design education, skills and knowledge practices that staff share with the students in relation to developing visuo-spatial understanding are also relatively untheorised and tacit. However design teaching is recognised by the researchers in CEPAD as being part of a characteristic ‘episteme’ (a system of ideas or way of understanding) of design education practices. The interviews reinforced the perception of spatial intelligence as a fundamental component of the ‘designerly way of knowing’ as defined by Cross (2006). In the context of industrial design this ‘knowing’ is concerned with integrating spatial understanding with solutioning capability along with the application of cultural, technological and empathetic appreciation. The processing involved in this holistic and solution focused approach seems to be centred on matching linear and holistic modes of thinking.

Measuring spatial intelligence



The Purdue Visualization Test

Task	
Draw a simple cube at a size you feel comfortable with (5 minutes)	
Draw the object (boxes or bin) in front of you from the angle you can see (5 minutes)	
Draw this object in 3D from the authographic views. (5 minutes)	
Draw the unseen side of the chair in front of you. (5 Minutes)	

The Transport and Product Design Test

Figure 1: Spatial Intelligence Tests

In parallel with the threshold investigation, two spatial intelligence tests were organised to ascertain if there was a correlation between student scores on the measurement tool on entry to the course and in relation to end-of year assessment results. If a significant correlation existed pedagogic interventions could then be targeted at students on entry to the courses. No clear correlation would require further exploration to understand the centrality of spatial awareness to the first year of study.

The first test was The Purdue Visualization of Rotation Test (PVRT) (See fig. 1 - left) which was developed by Bodney and Guay (1997). It was specifically designed to evaluate courses developed to enhance the spatial skills of students. It focuses on Gestalt processing and the transformation of visual images as a whole, rather than breaking down the whole and re-mapping relationships. The time constrained test involved asking students to recognise a rotation pattern and then select from a range of alternatives a form that represented a similar rotation. This test acted as a benchmark for an internally piloted tool that required students to complete a series of drawing tasks within a limited timeframe to demonstrate skills in spatial awareness (Osmond and Turner, 2008a) (See fig. 1 - right).

The testing showed a lack of correlation between the performance in the PVRT and the internal tests. Performance on the course suggested that the elements of spatial intelligence measured through the tests are not explicitly assessed in the first year of the programme. It was recognised that students already possessed baseline level of skills and creativity sufficient to underpin work for their assessments. Those who scored poorly in their PVRT test did not score poorly in the course assessments. It was concluded that spatial awareness was not a threshold concept, but a required capability that may underpin other potential threshold concepts.

Can visuo-spatial intelligence actually be a measure of a student's cognitive ability to design?

The third test designed by CEPAD centred on the measurement of pattern-solutioning capability at the early levels of study. A small exercise was implemented with a sample of students from both visual and non-visual disciplines at Coventry University. It included students from all levels of industrial design study and a group of non-visual students. The exercise required participants to organise shapes into a harmonious and orderly arrangement (See fig. 2).

The results emerging from visual analysis of the arrangements highlighted that in many instances patterns of solutioning correlated with assessment marks where they were available. However it did highlight differences between sample units in terms of constructing narrative, layout, and accuracy of arrangement, as well as having the confidence to challenge the brief. Non-visual students for example paid less attention to narrative and characteristics such as juxtaposition, use of grids and proportion. It was evident that as students progressed through their study they showed a greater ability to challenge the brief and stretch boundaries in solutioning. However, at the early levels of study the results were less distinct. Students with no visual training were generally able to produce results showing similar capabilities to first level designers.

The exercise highlighted that a student's articulation of their solutioning efforts seemed to be only a coarse measure of solutioning capability. Non-visual students were often more experimental than first year industrial design students, who were often more concerned with geometry and layout. There were also cultural differences in the way the results were organised.

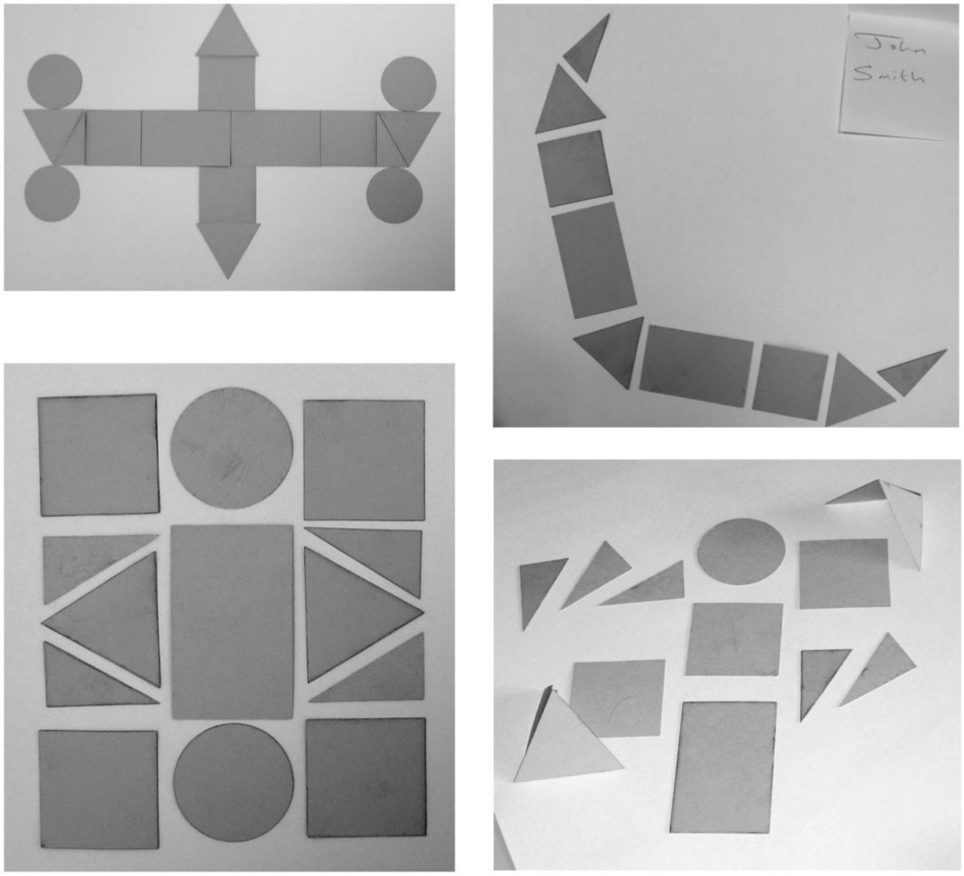


Figure 2: Examples of the visual creativity exercise

Initial Conclusions

From these investigations we came to the slightly unexpected conclusions that we had not demonstrated that spatial intelligence was a threshold concept, and we could not say that visuo-spatial intelligence was a measure of students' cognitive ability to design.

We came to a somewhat more obvious articulation of the importance of spatial ability as a baseline requirement which we perceived as underlying the development of design capability.

'Design uncertainty' in the industrial design curriculum

The results of the evaluation of spatial awareness showed no distinct correlation but did reinforce the view that spatial awareness is a baseline capability that underpins the potential to be a successful industrial design student. What appeared to be more significant was that students needed to gain confidence in design processing activities in order to progress their visuo-spatial capabilities. This 'confidence' relates to the identified threshold concept the 'toleration of design uncertainty'.

CEPAD researchers propose that this threshold manifests itself strongly because it sits between two modes of thinking which range from the analytical (linear and logical) to synthetic (holistic and simultaneous) modes. The ability to integrate these two cognitive modes is core to developing design thinking capability. Experience of new Industrial Design students arriving at Coventry (especially where they have not received a broad, art and design foundation like experience) is that they often have a highly analytical approach to design thinking and have followed a strongly procedural approach to problem solving and project management. The 'free-thinking' engagement with synthetic approaches appears to be predominant to the early years of school education and it could be argued that it is somewhat 'unlearned' during higher levels of study. This means students can often arrive with a lack of confidence to engage with open briefs which require from them the ability to engage with problem and opportunity definition, and a strong solution focus. They are not equipped for 'risk-taking' and conceptual thinking, and often get stuck in the 'conversation' that enables them to engage effectively with the solutioning process.

Designerly thinking

The importance of the design 'conversation' and its relationship to the threshold of design uncertainty became evident in this research. Our investigation into how it might sit within a design process framework suggested two fundamental characteristics of designing that locate the toleration of design uncertainty within the design process as something familiar and routine. They were:

- 'Wicked problems' that commonly present within the 'designerly way of knowing'
- The analysis –synthesis dialogue that sits at the core of the design process

In the 'Designerly Way of Knowing' Cross (2006) characterises design as an activity involving tackling 'ill-defined' problems through a 'solution-led' problem-solving approach. Designers employ constructive thinking by using codes to move from the abstract to the concrete and deploying these codes as an object language. Cross makes a number of useful and relevant observations about the design cognition process, noting that designers are solution-focused not problem focused. The designer's attention oscillates between the problem and its solution, in an appositional search for a matching problem-solution pair, rather than a propositional argument from problem to solution.

Designers are pro-active in problem framing, actively imposing their view of the problem and directing the search for solution conjectures. Problem framing, co-evolution and conceptual bridging between problem and solution seem to characterise design behaviour. Effective design teaching supports and encourages visual creativity within a solutioning framework. However, observations of our curriculum and the longitudinal study have suggested that solutioning needs to be more clearly 'labelled' and consciously supported in the curriculum to reduce apprehension surrounding 'uncertainty' and reinforce familiarity, especially at the early stages of design learning where the threshold issues are most visible.

These factors are relevant to and support CEPAD's view that design education should reinforce activities that strengthen the way students engage with the 'conversation' that is at the heart of design cognition. This conversation begins with a 'concept design' which involves the designer's attempt to provide a sketchy representation of what the finished design might be or look like. If the designer or design manager sees the concept as providing a basis for proceeding then the structure of the rest of the process falls into place. This is the solution-led approach.

At its core is the process of moving from an abstract statement to a visual object. The designer learns to think in a sketch-like form, in which the abstract patterns of user requirements are turned into the concrete patterns of an actual object, using the code to effect this translation from individual, organisational and social needs to physical artefacts. This is the use of the visual language of designing, employing its translation codes. It is the match of the analytical (left hemisphere) statement to the holistic (right hemisphere) solution. The manifestation of this outcome will be as a visual representation, a drawing or a 3D or virtual model.

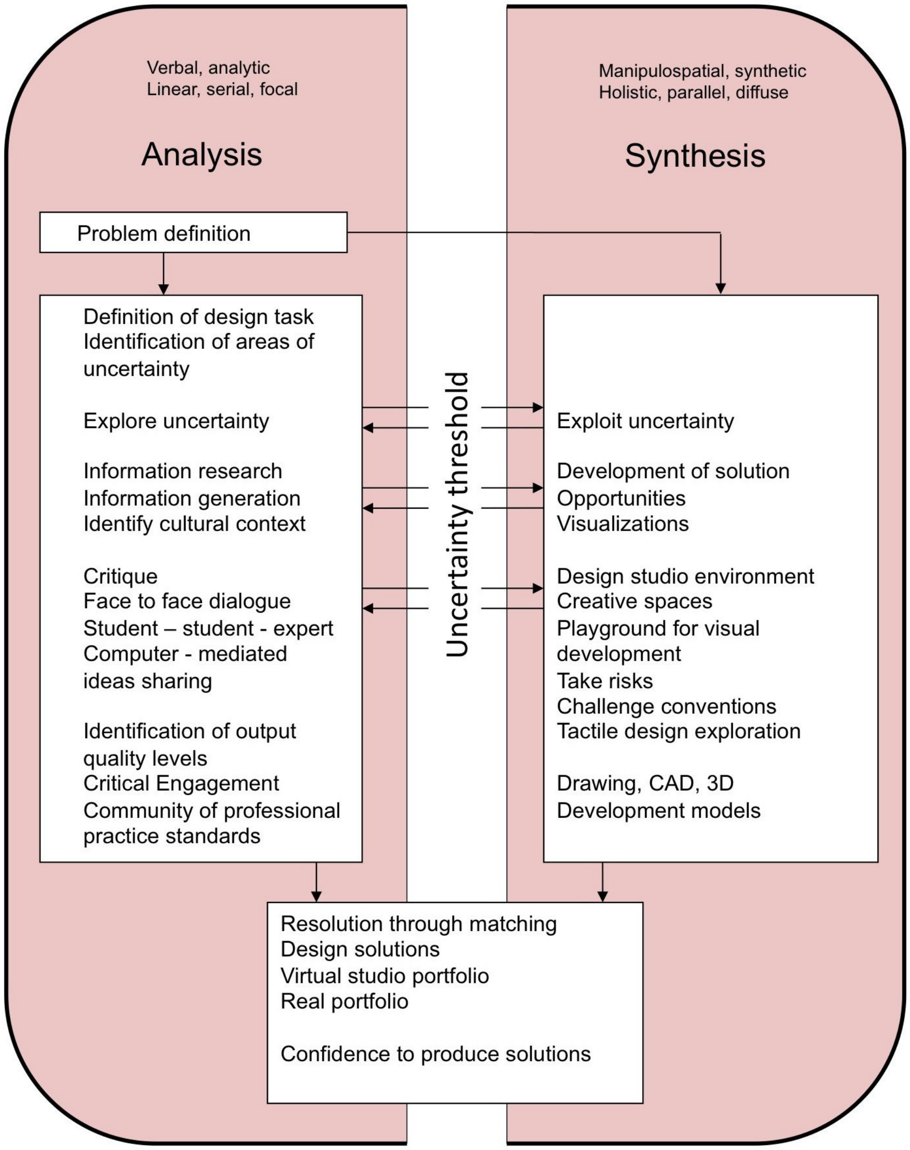


Figure 3: Dual-Processing Model for Industrial Design Education at Coventry

The analysis synthesis dual-processing model

Based on the identification of the preferred processing modes of the two halves of the brain, the essence of the dual processing model (See fig. 3) (Tovey, 1984) is the interaction of the two modes of thought, each stimulating and modifying the other. The evidence for such difference is based on long established research into cerebral laterality. The left hemisphere preference is for local, linear, narrowly focused attention. As figure 3, 4 and 5 demonstrate, the right's preference is for simultaneous, broad, global and flexible attention (McGilchrist 2009). Bruce and Bessant also reinforce this notion, suggesting that creativity is not an entirely rational or conscious activity but rather that "It involves the interplay between conscious and rational thought and unconscious and apparently random or dream-like association and activity".

Serial and simultaneous thinking

Both types of cognition are crucially involved in the evolution and resolution of a fully detailed design proposal. Although the application of such a model to design is of course speculative, it does provide a framework within which different design approaches can be accommodated. The relative emphasis given to serial-analytical and to simultaneous-holistic thinking varies both between designers and between types of design problem. For example engineering designers may give first priority to analysis and the derivation of a specification, whereas product designers may concentrate more on the holistic processes used to derive a design concept presented as a drawing or a 3D model. Nonetheless it is assumed that the design process will always involve both modes of thinking (see fig. 5), in the approach identified as appositional matching (Cross, 2006) and that it is their relative proportions which will vary.

CEPAD and curriculum innovation

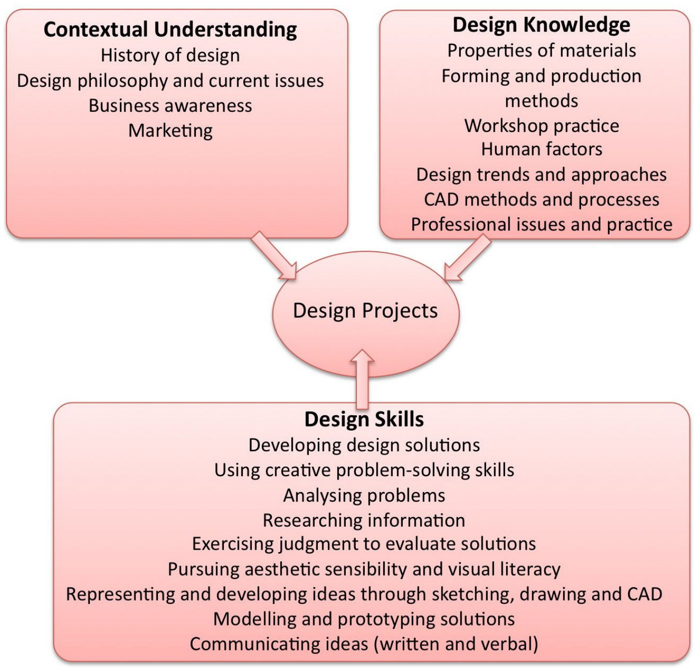


Figure 4: Design education (Adapted from Cooper and Press, 1995)

Cooper and Press (1995) highlight the distinctive nature of design education, explaining that it is based on a 'traditional learning by doing' approach. Design students conduct projects (see fig. 6) that help to integrate knowledge and skill through practice, essentially engaging in a dual-processing approach. They stress that industrial design education encourages students to gain and experienced-based knowledge that involves experimentation and risk of failure. Industrial design education has therefore always supported more novel and participative forms of teaching, however this has often been difficult to embed in a strict modular structure (familiar in the UK HE environment) that works well with linear and highly structured models of teaching. It is more challenging, within a modular structure to incorporate more flexible and holistic practices that are required if both analytical and synthetic modes of design exploration are to be engaged with simultaneously. However in CSAD we have explored a number of activities that have helped us to move from the 'standard' and established practices of teaching that are fairly straightforward to implement within a modular framework, to exploration of a set of activities built around the 'Dual-Processing Model for Industrial Design Education' as defined in this paper (see fig. 7).

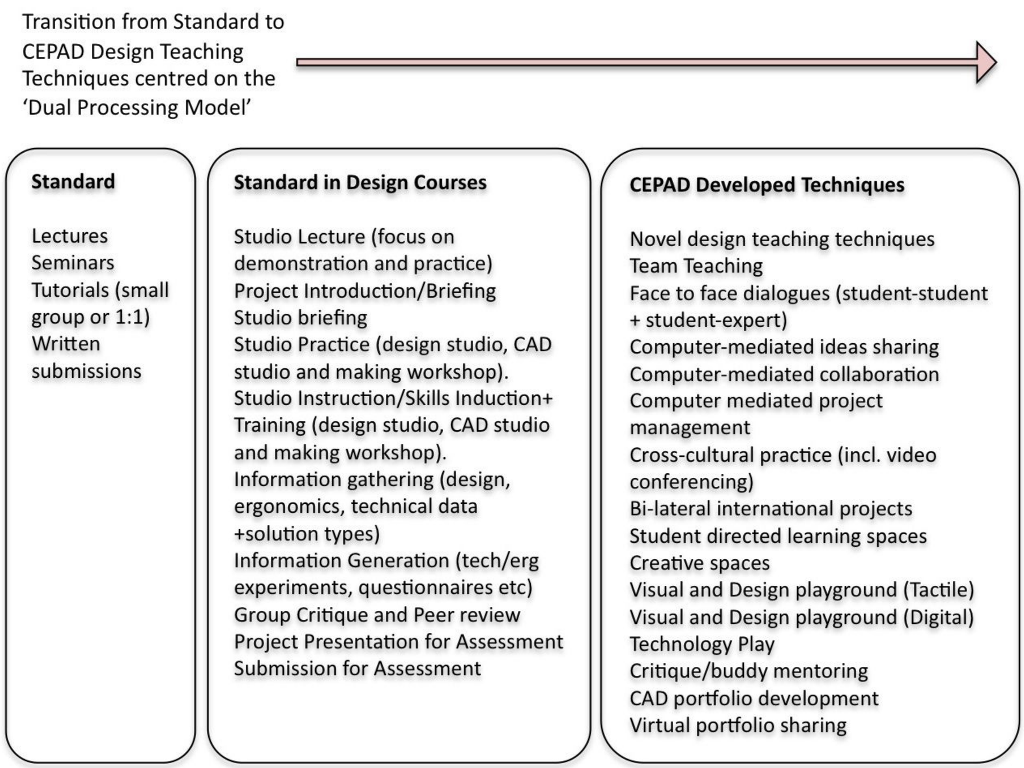


Figure 5: Types of Teaching

Based on this understanding the intention in CEPAD has been to explore teaching interventions that would focus around developing student engagement with the toleration of design uncertainty threshold. This is recognised as sitting at the centre of the two modes of thinking, analytical and synthetic, and across both linear and holistic design approaches. The aim is to encourage a 'conversation' or engagement with design problems and opportunities by drawing a student through a set of activities, modes of thinking and design approaches that support a more exploratory and playful approach without too much systematic constraint (See fig. 3).

As a result the following recommendations were developed:

1) structure course around larger more holistic packages of learning;
2) create a 'playground' for unrestricted, unconstrained design thinking;
3) provide flexible and adaptable environment for organising teaching groups;
4) encourage a personalised and individualised teaching environment;
5) introduce formative 'gateway' reviews rather than formative assessments;

6) provide an explorative environment that integrates both traditional and advanced technologies for designing;
7) provide opportunity for professional and international engagement.

Many of these recommendations have been applied in October 2009 to the first two levels of our four year industrial design courses in CSAD. Early feedback collected via interview and focus group is positive – further data is being collected.

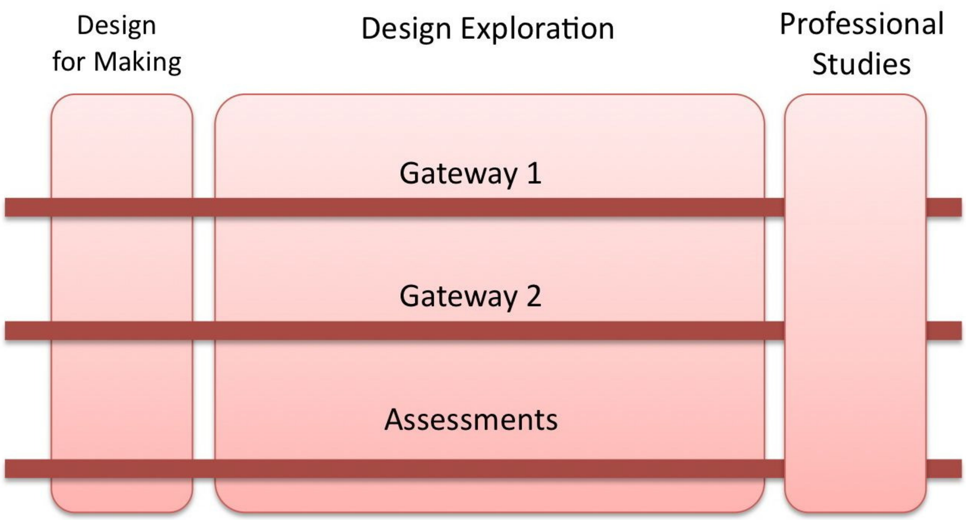


Figure 6: Simplified Curriculum Model (A year of learning)

The above simplified model (See fig. 8) based on a revised model of the industrial design course specification (Owen, 2009) shows design exploration being placed at the centre of the course, rather than being separated out within singular specialist module activities phased during the year. At level one and two multiple modules have been introduced. These enable a much more open learning environment that is not driven by a single brief. The objective is to have a number of smaller assignments with different emphasis and depth, some of which are interrelated. For example, new students were given a five week induction project (rather than the traditional one week) that: provided space to reflect upon personal aspirations, promoted broad design horizons; and, instigated an explorative and experimental approach without an assessment focus. The project required students to explore their own identity, design costumes against a fantasy scenario and present them in a social setting. The teaching environment encouraged a playful approach with little constraint. This appeared to give students confidence and a sense of their emerging identity as a designer. Following projects had more focused learning objectives, introducing ergonomics and other specialist subjects in a highly integrated way so students would engage with design learning as a whole rather than in assessment driven silos of study (See fig. 7).

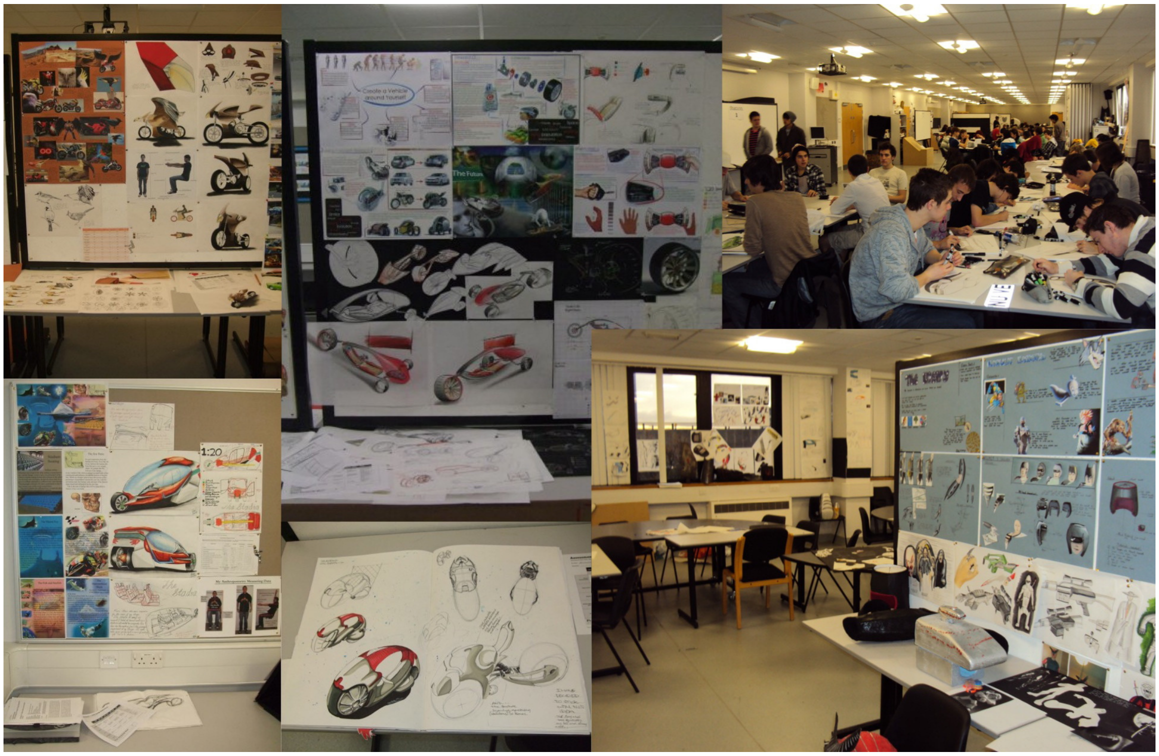


Figure 7: Students in first term of industrial design study

Because large group sizes also proved to be a problem for the encouragement of a personalised and individualised teaching environment, students were divided into smaller sub-groups for teaching at the early stages of their course. This enabled them to get to know a sub-group better rather than being lost in a sea of students. They were encouraged to develop a group identity.

The quadruple modules include small one day/ one week projects in the teaching mix. These have been labelled as 'Wild Card' projects. They enable students to engage with a project of very short or focused duration, such as a rapid concept generation project for car merchandising. Importantly, the choice to submit this work for review is given to the students. This is made possible by the Gateway model that has been adopted. It also allows the tutor some opportunity to provide additional teaching support where necessary, or to allow students the opportunity to relax and enjoy a bit more freedom after an intensive phase of activity.

Gateways (see fig 6) are review events that happen two to four times a year. They enable tutors to 'take stock' of student progress and provide formative feedback to students. The gateways are strongly centred on the student. Whilst they are themed according to level and some learning outcome requirements, the student is in most cases given a large amount of freedom to select and choose what they want to submit at the relevant Gateway. This requires the student to be more reflective and questioning about their skills and capabilities development and also allows them the opportunity to select the best of their work for presentation.

Bridging between the two: Uncertainty Threshold Diagram

Analysis

Problem Definition
The design task

Information Research
Data generation
Cultural context

Critique
Student feedback systems: The Buddy Technique (2 students recording – for one student during scheduled assessments)
Facility to support group Stereo viewing reviews for alias/bunkspeed designs – difficulty is in preparing suitable models rapidly to support.
Audio feedback to students – allows them to replay, capture emphasis, gain a more personalised set of comments.
PebblePad peer review activities.
PebblePad for stepping-stones for argument development and critical writing techniques.
Paper-based peer review activities: at levels one and two of course. To encourage reflection and critique by questioning and comparing other students work and personal work.

Face-to-face dialogue
Collaborative online projects across international boundaries

Student-student-expert
Portfolio surgeries
Client led/informed projects (Group projects with finalists)
Leonardo module development. Module set up to both be a tool for independent learning and directed and mentored with expert knowledge base.
Students come in to talk about their experiences.

Computer-mediated ideas sharing
Skype (Student projects – placement students)
Google Groups
Tanberg (Group conferencing – international staff collaboration
Facebook (Boat design students
Qube (Chinese students)
PebblePad (group work)

Synthesis

Design Studio Environment
Ownership of spaces – challenging in a mass-education culture – getting students to propose how to organise spaces for learning through client projects such as IKEA and in relation to finalists.
Portable projectors to enable practical demonstrations to be delivered to groups of students.

Creative Spaces
Design of the curriculum (introduction of periods of open play and discovery)
Adaptability of teaching spaces to shift from large group teaching spaces to small group teaching.

Playground for Visual Development
Clay heads to develop spatial understanding through sketching, modelling and freedom to develop form narratives – no prior constraint.
Digital form development projects – intensive 3D and digital animation input.
Workshop activities – making toys using laser cutting
Placement students engaging with learning about Motion capture
Development of new approaches to model making using technology e.g.
Tools provide a playground fro students across disciplines e.g. jewellery design students using rapid prototyping

Taking Risks
Wild Card projects that enable students to conduct a project and have the choice of whether they want to submit it for assessment
Holistic design of course allows more flexibility for 'risk taking' . Larger modules, more selection of activity, assessment focuses upon students selected work.
Gateway designs (each module has a set of Gateways that both allow students to select best work for presentation – enabling choice and focus on 'selection' and awareness of critical abilities.
Flexible course design – choices made in year two about specialist progression.

Challenge Conventions
New induction phase to ID course based on allowing students to take a highly explorative approach – a foundation to testing and trying out ideas
Highly conceptual phase to early learning – based on very individual and unconstrained briefs – unmarked.

Tactile Design Exploration
Clay heads and Trophy designs – students given freedom to engage with tactile form development with emphasis on hand sculpting.
Students are not allowed to progress their digital design exploration until they have engaged with the physical.
New course designed to emphasise the relationship between the tactile and the technological e.g. exploring form languages and methodologies emerging from the technology.
Example rapid prototyping to create new form possibilities and effects for jewellery design or for furniture construction.
Final year students make physical models in clay.

Figure 8: Bridging between the two: Uncertainty Threshold Diagram

CEPAD researchers observe that one of the best ways to increase student confidence is by nurturing them in an environment that is centred on professional engagement and cross-cultural experience. Students usually study with the goal of entering the professional community of practice, which is increasingly global in scope. The course has traditionally maintained good relationships with industry, but with shifts in industrial centres and the international perspective it is necessary to find opportunities beyond the placement as a means by which professional experiences are gained. To this end, school internships, international exchanges, cross-cultural collaborative projects have been reinforced within the curriculum. An ongoing example is a student collaborative project between Coventry industrial design students and students at EAFIT in Colombia (Atkinson, 2009). This enabled students to engage with different cultural approaches to designing, language and time-zone differences, collaborative project management over a distance. The culmination of the second year of this project was an exhibition in the Coventry Transport Museum. This useful exercise has supported our comparison of approaches in different countries and cultures to developing design capability (Osmond, 2010).

The curriculum design embraces a range of digital tools for communication and designing. To enhance and facilitate the analytical part of the design conversation we developed a number of communication techniques. Tools such as VOIP video conferencing, social networking tools such as Skype and Facebook have been adopted to support responsive and flexible communication.

The technology to facilitate the synthesis part of the conversation has been located in studios and creative spaces. To support spatial learning plentiful seats of Alias, Rhino, and Maya are available as well as physical tools such as rapid-prototyping, milling, laser-cutting and large scale printing. These enable students to work with digital visualisation as part of the processes of designing as well as at the representation stages. The integration of technology into the curriculum is organised around the philosophy of exploration and discovery. The aim is that technology can help to represent and review solutions as they develop such as by using the live projection of Alias models in 3D stereo. In addition teaching staff are encouraged to develop and engage with digital tools such as Cintiq to demonstrate sketch techniques to large groups of students.

Conclusion

This review of an analysis of spatial intelligence highlighted that there was a need to give greater attention to the Threshold of Design Uncertainty within the industrial design curriculum. It was observed that spatial design intelligence is a baseline capability that is hard to measure but a required attribute of applicants. Spatial intelligence itself is not specifically a measure of design capability, but a necessary component of it. However, the 'nurturing' of spatial understanding can be accommodated effectively in a dual-processing activity or 'conversation' that brings together analytical and synthetic approaches (See fig. 8). This is the process by which the Threshold of Design Uncertainty can be addressed effectively within the design curriculum. This can be challenging for students but they need to be able to develop confidence to take risks, deal with 'wicked' or 'ill-defined' problems and be solution-focused, even when they do not have all the information necessary to complete a solution. As a result of the findings made by CEPAD researchers a number of curriculum recommendations have been developed which incorporate the techniques which have been found to support effectively both parts of the design conversation. These include evaluative communication techniques and solutioning activities which centre on risk taking, playfulness in personalised, holistic and flexible study environments. Our first feedback from the implementation of these interventions is positive and encouraging.

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Author Biographies

Professor Michael Tovey

A graduate of the RCA, Professor Mike Tovey was in industrial design practice prior to entering education. In 1973 he joined the institution which was to become Coventry University, as a lecturer in industrial design. He was appointed to Head of Industrial Design in 1985 and in 1989 was made Dean of the Coventry School of Art and Design. In 2007, he changed position to take on the University-wide post of Director for Design. Professor Tovey is responsible for developing courses and applied research in design across the University and is Director of the Centre of Excellence in Product and Automotive Design (CEPAD).

Dr Karen Bull

Dr Karen Bull is Deputy Director, Centre of Excellence in Product and Automotive Design at Coventry University. This centre focuses on evaluating spatial design understanding and identifying the transformative threshold concepts associated with students entering the Global community of practice for industrial design. Her expertise is in industrial design theory, design analysis and design context. Her background is in product design and her PhD is titled Advanced Personal Telecommunications Products and Industrial Design'. She has continued to research pedagogy in relation Art and Design and is especially interested in the area of critical and reflective learning, e-teaching and learning and e-portfolio.

Joinedupdesign for Academies: Enhancing Design learning through complexity

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Friedemann Schaber, University of Northampton, United Kingdom

Abstract

This paper reports on research undertaken on the Sorrell Foundation's *Joinedupdesign* for Academies programme, a pilot scheme with four universities in the United Kingdom (UK) aiming to inform the transition of 'failing' secondary (11-18) schools into academies (involving substantial re-designs and re-building). From the authors' university, 12 undergraduate Design students participated in *Joinedupdesign* for Academies, in partnership with two secondary schools in the Midlands region of England. Like other universities in the UK, it has well-established links with local schools and programmes of community engagement, corresponding with reported US experiences (Lerner & Simon, 1998). The Sorrell Foundation model is an example of university design departments working in multiple partnerships in order to align with government initiatives (such as the Labour policy *Building Schools for the Future* to rebuild or renew nearly every secondary school in England over a 20 year period). By embedding the pedagogy of live projects, there is potential to impact significantly on local regeneration.

The aim of the study was to investigate *Joinedupdesign* for Academies as a new model of off-campus learning. In order to do this, we explored: the impact on student learning for employability; the effectiveness of undergraduate learning with pupils as clients, and the challenge of working with multiple partners in a complex environment. In terms of Design education, this provided a rare and timely exposure to the complex demands of the kind of regenerative, publicly-funded work on a large scale which will be providing opportunities for designers in the UK over the next decade.

Keywords

Design pedagogy; Live client collaboration; Multiple partnerships; Community regeneration; Employability Skills

Recent drivers of government policy in the UK following the Education Act of 2002 (Working Together, 2004; Cox, 2005; Leitch, 2006) have prompted a new impetus to Design education and the importance of educational partnerships. This has led to a number of funded initiatives including *Creative Partnerships* and *Building Schools for the Future*. One prominent example emerging from these drivers is the Sorrell Foundation's *Young Design Programme* (YDP), (The Sorrell Foundation, 2005), which aims to enhance the scope of design education at secondary school and university (and in so doing, dovetails with government policy to raise standards in education). Research indicates (Butcher, 2009) that undergraduate Design students on the YDP benefitted significantly from enhanced employability skills, and in return make an impact on the community (Rudd, Marshall and Marson-Smith, 2008). In this study, the authors will relate enhancement in student learning to the complexity inherent in the sister programme *Joinedupdesign* for Academies.

Contextual factors

Design pedagogy

In university Design studies, live client projects are enhancing the curriculum and challenging undergraduate students with outside constraints and deliverables, furthering their knowledge. In return, the community benefits from university links on various levels. 'Service Learning', which involves matching a community need with academic goals, is becoming increasingly important in Higher Education (HE). Student assignments are developed in consultation with academics and external partners requesting input from students to solve a particular problem. These live client collaborations are run as problem-based equivalents to traditional theoretical studio based design assignments. As such they deviate from the more common models of work placements and learning through work programmes, in which the learning is supposed to be integrated into the work experience. This definition of a live client project is described by Viljoen and Hoskyns (2007), who further review current practice in UK HE and relate these to research in Learning and Teaching. We argue in this paper that involving design students in regeneration projects has the potential to impact on the communities in a real way. In focusing on design pedagogy, we explore the impact on undergraduate learning, in particular the enhancement of skills through live client engagement.

Widening Participation/Outreach

From our UK university perspective, engagement with the *Joinedupdesign* for Academies programme offered a new form of community outreach work, in a collaborative partnership which was different to the prevailing agenda of *Widening Participation* (WP) which has driven UK HE policy for over 15 years. WP (HEFCE, 2001) can be represented as a range of policies and funding streams designed to: target groups disengaged from HE; remove barriers to HE; and increase the proportion of citizens with university level qualifications. For Design education in HE, WP has often been 'one-way', through portfolio advice/enhanced curriculum projects in schools or external pre-16 and post-16 aspiration-raising summer schools, (at its worst, 'selling HE to kids'). In contrast, *Joinedupdesign* for Academies has offered a very different conceptualisation of a community partnership, with schools and particularly their pupils serving as clients for the Design students, and industry mentors advising in the context of authentic live briefs. This has been a much more dynamic, two-way learning process, although the Sorrell Foundation's original impetus, to empower the pupil voice in the design of schools, has ensured the WP mission to raise pupil aspirations as part of a social justice agenda, has not been lost.

The Young Design Programme as a national initiative

The YDP is externally coordinated as part of a national initiative, with ten universities and thirty-five schools involved in 2009. It is managed systematically as a regular and continuous part of the curriculum at the participating universities. YDP aims to promote collaboration between design students and secondary school pupils, by asking the latter: "what they want to improve in their schools?" (The Sorrell Foundation, 2008) This programme informs the process of regeneration of school campuses and surrounding community. The approach, established in 2000, follows UK policy initiatives (see above) and *Creative Partnerships*, a creative learning initiative fostering long-term partnerships between schools and creative professionals, including architects, scientists, multimedia developers and artists.

Crucial to the conceptualization of YDP is that, with the support of Head teachers and staff, pupils should take ownership of their brief and present it to as many audiences as possible.

Joinedupdesign for Academies

This approach is refined still further in the *Joinedupdesign* for Academies development, a pilot project undertaken by the Sorrell Foundation with design students at four UK universities. Undergraduate design students from the authors' university worked with school pupils whilst being supported by the *Joinedupdesign* for Academies team and industry-based mentors. These, a practicing designer and a chartered architect had a significant effect on the students' work, concerned with visualisation and building technicalities.

The pupil client team was a group of children from five schools (the two 11-18 secondaries and three 'feeder' 7-11 middle schools), representing the views of the existing school community in formulating a pupil brief informing the master plan for their new academy to engage architects, sponsors and local authorities in what pupils want their academies to be like. This involvement was represented in the subsequent rebuild of the school campuses. Pupils attended a number of sessions throughout the spring term 2009, with the undergraduate designers facilitating (The Sorrell Foundation, 2009).

The university's Design staff, having attended an explanatory talk at a launch event at the London headquarters of the organization, developed a student assignment and mapped this onto the curriculum. Twelve students (four male, eight female) worked with two Academies (with representatives from their feeder schools) in three teams of four students grouped to share skill sets, deliberately cross-disciplinary in order to provide them with the experience of working with people from different subject specialisms: Product and Interior Design. At the university's 'Challenge Day' the pupil client teams met the student design teams for the first time and were tasked to work out what design problem they would like solved. For many, this would have been the first time they had ever entered a higher education environment (Smith, 2008). During this meeting, design teams showed their clients around the college and the client teams presented their design problems; these included school communal and reception areas, outdoor spaces, toilets and specialist classrooms.

Following these initial meetings and throughout the project lifespan, the student design teams attended meetings at the schools to gather background information, develop ideas, show progress and get feedback from their clients. This whole process is described as "the conversation" and included meetings organised by the University Design tutors at creative destinations in London. These visits were arranged to help the pupils reflect on their school environment in comparison to contemporary "designed" spaces. Sponsors met the student designers to discuss their vision for the Academy. They explained to the students why the Academy's specialisms had been chosen, and analysed its proposed relationship with the local community, before addressing issues of design and sustainability. The stakeholders discussed the local issues and the students described early discussions relating to the pupils' priorities.

The pupil clients presented the information they had collected to their local authority representatives, project managers, sponsors, teachers and Design students. They showed them the brief boards they had created for the top three common issues, and explained why they thought it was crucial to resolve these issues. The brief for the student design team was to prepare concepts for a dinner hall and social space. In three subsequent meetings at the school, the students presented design ideas through sketchbooks, colour drawings, material samples and 3D models, and the pupils offered feedback and further suggestions. The student designers developed and refined their ideas with the support of other students and their tutors. Upon completion of this project the finished design concept was presented to the client team for feedback and was separately assessed by course tutors at the university.

At the beginning of June, the teams gathered for a local celebration of their work on the *Joinedupdesign* for Academies project at the university, where they received certificates for their contribution to the project. They travelled to London the following week to join pupils from the other academy projects. Here, the pupil and design teams discussed their work with stakeholders and sponsors in a special marketplace. Their work was exhibited in the Sorrell Foundation's exhibition *What's Next for Schools?* and the event culminated in the presentation of the finished Pupils' Brief for each academy (See below Fig. 1).

Figure 1 The Pupils' Brief, documenting young peoples' participation in school redevelopment programmes

Methods

In order to gain evidence to address our research question, data was collected in a series of exploratory stages. The researchers monitored each interaction between undergraduate designers and school pupils through field notes. Multiple evaluations were conducted via a range of structured questionnaire and a reflective student group report. Triangulation came from industry mentors, school pupil and teacher feedback. At the end of the project, two focus groups were conducted with the undergraduates to elicit their perception of learning from the project. Findings were compared with a national evaluation (Rudd et al, 2008) and with previous 'live client' engagements conducted within the university sector as mapped in the literature (Viljoen and Hoskyns, 2007).

Analysis was undertaken drawing on an inductive framework informed by educational case study research (Bassey, 1995). In this, indexicality, in which meaning is elicited by coding and categorising from statements shared by participants through grounded theory approaches, allowed themes to emerge.This was iteratively informed by the authors' ongoing review of the programme structure and design in terms of pedagogical principles; the effectiveness was assessed through (a) student oral and written feedback, (b) client engagement and oral feedback, and (c) summative student assessment through presentations and multi-angled feedback by staff and peers, recorded through a scribe and documented with audio visual footage for inclusion in the students' Personal Development Portfolio. The captured participants' perceptions align with the Pilot Evaluation of the Young Design Programme 2005-2008 concludes that the "*the client-centred model encouraging 'real life' experience of the cycle of a design project, has been extremely effective in bringing institutions and individuals together*". (Rudd et al, 2008)

Student learning

In this *Joinedupdesign* for Academies case study, students were extensively briefed by the client team and group work and plenary sessions identified problems leading up to the design brief being finalised. The *YDP* structure enabled students from differing design subject backgrounds to work together and share a range of learning outcomes such as:

- developing support structures within and between teams
- university design student teams engaging with clients
- developing clear mechanisms to communicate one's message and ideas to others

Throughout the term-long project, work was monitored by means of individual and group tutorials and practical demonstrations. The student design teams presented the newly designed environments back to the school children giving them the opportunity to gain an insight into the design industry and university design study process. Just as with previous presentations to professional clients, the undergraduate students took this seriously, preparing elaborate physical and computer generated models, supporting their proposals with well-prepared powerpoint presentations. The researchers noted a high level of nervousness prior to the final presentations, suggesting an authentic engagement with pupils as clients. The school children themselves gained much from the experience and regarded the students as professionals, which bolstered their confidence and helped them to adjust to working with different client groups. This was captured in pupil comments:

It was fun working with real architects; they could transfer our visions for the new Academy into proper designs that looked amazing, we can't wait to see the final designs. (quoted in Schaber, 2009)

The students' feedback, sampled through questionnaires, suggests that this project has been useful to all members of the student design teams involved. A student reported that it *"had allowed all of us to gain valuable experience, and develop skills, which we would have been unable to do through a typical university lead design project. In particular I have been able to develop better time management, which will be of great value in the future. This project also allowed me to improve my communication skills, and has enabled me to work younger aged group of clients than a typical design project, which further helped to develop communication and presentation skills."* Students addressed the problems concerning the organizer's communication and programme management: *"Overall this has been a useful and enjoyable project, however at times it could have been better organised, and … more advanced notice of the event would have allowed us to better prepare for the boardroom meeting with the sponsors, which would have made to event more useful in terms of the information extracted from the meeting."*

As reported in previous research on its sister programme, the Sorrell *Young Design Programme* (Butcher, 2009), undergraduate student learning from *Joinedupdesign* for Academies was both wide and deep, although less about developing specific Design skills (as perceived by the students) than broader interpersonal skills (which of course are integral to Design planning). Some self-reported evidence did include the acquisition of design skills in: *using a laser cutter… in model-making… in photographing work for presentations, improving my computer skills in Photoshop… I am more confident knowing I've got that skill… designing for different types of clients and thinking about the needs of disabled pupils… working with other design disciplines… learning how Product Designers draw products… sketching in CAD.*

However, this acquisition of new design skills was viewed by undergraduates as a by-product of their involvement in the programme, rather than a core learning experience. The greatest evidence of perceived enhancement of their learning came in the ‘softer’, interdisciplinary skills related to employability. In this, the bulk of feedback was around: team work; problem-solving; time management; working with clients, and in relation to future employment.

Learning in teams

For example, when asked in the focus groups about working in a mixed team, a number of students commented on the enhancement gained from sharing strengths across different design disciplines and collaborating on a shared problem:

You’ve got to be able to see the difference between our skills and their skills… we had a product designer in our team, she was more knowledgeable in material areas whereas I’m not, but there were also some areas where I could help her… I remembered she had better knowledge in materials than me so I went back to her and asked for help.

Working in a team makes you understand more about your strengths and weaknesses as a designer… so you can work on your weaknesses… Learned to appreciate one another’s skills, and compromising, as you can’t have it all your own way.

So students recognised this innovative learning experience had ‘forced them’ to reflect on their own skills, to learn experientially how to compromise and negotiate, and to gain insights into the different design skills of others in a project team. This high level of reflection resulted from being put in a situation in which peer communication (especially between students who had not previously worked together) became a vital component of success:

Communication with different disciplines in our team, with any discipline, is what I’ve learned… being able to explain what you’re doing, being able to listen to what they’re doing too, and collaborating with each other… keeping in touch with each other, meeting regularly to exchange ideas.

While this was not an easy experience for most students (as evidenced by the body language during the focus groups), the authentic live brief, though complex in its demands, pushed students to see themselves as operating in a more ‘professional’ environment when they had to deal with real clients:

You just get things done, it’s professionalism… you just don’t want to let the rest of the team down.

When you work with a team that you’re not normally used to working with, you find different ways of doing things rather than the way you’ve been taught to do things… sometimes they’re better, as working with other people helps you discover better things when designing from your point of view… even if there is a ‘collision’ with others!

This element of working in a mixed team was reported as a critical learning enhancement, especially considering students perceived themselves not really used to working in a team.

Learning through problem-solving

The focus of the team's work together was also an important aspect of the learning, exemplifying problems to solve. One problem in particular was accommodating different design ideas from the team members (and the clients) into a final 'pitch'.

It made me realise how important it is to learn how to take the views of others into consideration and be able to put them together to find a solution rather than just taking one person's… it's quite a learning curve to know how to put them all together… everybody has really different opinions… it's difficult to mesh them all into one design.

Individual students were able to develop a strategy to address that problem, which they represented as taking a professional approach to others' ideas – something they had not had to do on their degree course previously. This problem-solving was an important aspect of personal learning as perceived by individual students:

Learning your own strengths and weaknesses through the timescale, and trying to get things done in a group… you can recognise what you're not so good at.

The 'problem' of over-enthusiastic pupils as clients also had to be sensitively dealt with:

Our client team wanted a juice bar but it had to be a reception so we had to dissuade them by encouraging their other ideas.

Students were thus in a position to utilise their novice designer personas to find a creative way to shift a preoccupation with a single (in this example, inappropriate) design idea. Our commitment to the importance of teaching visual communication is confirmed, as oral presentation skills have to be refined when presenting to live clients, often at community and board level, with direct implication on employability.

Learning time management

Interestingly, the opportunity to learn time management skills was linked to the challenge of operating as an effective team in a way which could enhance problem-solving. This became a particular feature of the way this project was structured, in that students operated semi-autonomously, and recognised:

We had to ensure we kept the lines of communication open… if you were with a 'difficult' group it made it harder, some members were willing to come in earlier… communication had to be strong between members of the group to ensure we got that extra time.

This resulted in further personal learning:

I prioritised this work over other projects… worked a lot of hours outside college time.

It also enabled key roles to emerge in relation to the challenges faced:

At the beginning everyone was on an equal footing, but towards the end there were two of us that had to become leaders, to take a leadership role to ensure the group even stayed together.

Learning from pupil clients

However, the most strikingly innovative aspect of the *joinedupesign* for Academies programme was the crucial involvement of pupils (aged between 10 and 14) as clients, in the context of planning the rebuild of their own schools. For them, this was not an abstract exercise, and they brought a lot of passion to discussions of what they wanted their new school to look like. In working with clients, our design students learned a great deal, much of it unanticipated:

You need to think what you are going to say a bit more… we were describing a particular part of our model, we had to explain to them that you can physically build glass walls… they thought it was easily smashed, they thought vandalism would be a problem and it would break… technically we understood that, but we had to find a different way to explain it.

We had a double skin on ours (a roof, then another roof). Trying to explain that without a model was quite difficult – until we managed to sort out a computer-generated image… it was the visual aid that helped rather than relying on explaining it through words.

Figure 2 Client conversation aided by physical and digital models

These 'language clashes' were evidence of communicative dissonance which prompted our undergraduate design students to find creative solutions to overcome their initial reliance on 'taken-for-granted' technical language. This learning experience was reflected on as a positive one, in forcing recognition of client needs:

From the first visit we learnt that just describing something was not enough… the best way to communicate was to show, because they had showed us around the school… the enthusiasm came from them saying 'look at this', running ahead to point something out… images were the way forward.

It also opened up an important insight into the needs of different partners:

I really enjoyed working with children, communicating with different age ranges… I was excited working with them rather than school governors, who were only interested in money, not in our designs.

Students were also able to articulate the benefits from working with this unusual client group:

It helps you to adapt… they can want something that will never work, but as a designer you can take it and mould it to what will work.

I didn't see it as unusual because you have to adapt to your client… but they're going to have slightly different views, they haven't seen much of the world yet.

So the learning was coming from a sense of empathy and insight with the fact that all clients will be different, and the pupils merely offered one step on the client continuum. This authentic client undoubtedly added to the students' learning experiences:

Working with an external client outside the university was quite exciting.

It gave me a sense of professionalism…we knew we had to present properly to proper clients, rather than imagining a client.

Learning for employability

The complexity of the project (involving our design students working with pupils, teachers and governors, academy sponsors, Sorrell Foundation staff and industry mentors) led to a number of important personal insights into individuals' intended career paths. For some, the innovative link with pupils and schools was timely:

It made me think more about teaching design… I really wanted to work with children – their imaginations are incredible and limitless… adults have the realities of practicalities - like costings.

I thought it was cool working with the kids because you might not work with them otherwise as a designer… you wouldn't normally go back to work in a school… and they were so enthusiastic.

For others, it confirmed different paths:

Working with a school was useful, I wanted to work in a commercial environment rather than domestic…and it was great to have more scope for a wider range of design ideas.

Even though I enjoyed working with my group, when it comes to employment I will consider working for myself now rather than for a company… as such it was a (negative) learning experience.

Discussion

Complexity of multiple partnerships

Complexity in Design has been outlined by Alexiou, Johnson and Zamenopoulos (2005). They conceptualise Design as an interactive process taking place in a social environment requiring cooperation and the exploration and construction of common knowledge. In this study, complexity was apparent in the multiplicity of partnerships, and to some extent in the 'measure of ignorance' (Alexiou et al, 2005 p.91) between the partners. Thackara (2006) focuses on the changing role of design in a complex world, and the need to reform learning in design, which is part of that. Correspondingly, for some students, the reflection was deeper, about the nature of complex learning:

It was interesting that so many different groups wanted to get so many different things out of the project…there were competing agendas between the children as clients, the Sorrell Programme idea of what should happen, and what we wanted. It helped me understand you need to know what you want from a project…we had to go at the project from all perspectives.

We suggest the complexity inherent in the *joinedupdesign* for Academies project comes from its origins as a 'social innovation', in which collaboration between individuals (pupils, teachers, Design students), organisations (schools, governors, sponsors, education authorities) and environment ('failing schools' and a well-resourced government school rebuilding programme) is the focus. Complexity is represented as a top-down intervention to engage bottom-up participative aspiration in order to improve pupils' lives, driven by those pupils as 'agents of change'. The premise is that another way (of designing schools) is possible.

As a result of the complexity, there were inevitably advantages and disadvantages. Although student debriefing was facilitated through the feedback and interview sessions, the continuation of the relationship was not built into the programme. Interestingly, some of the students involved exchanged business cards in the hope to gain placement opportunity once the architects are appointed to execute the planned new-builds, but it is uncertain that students identified the various stakeholders' intentions during the session the Sorrell Foundation facilitated at an event in London. There, they had opportunity to query the sponsors, local authority representatives and teachers.

The applied research undertaken by academic staff in the context of the case studies provides up-to-date understanding of multilayered communication and managerial skills and the awareness to planning issues, publicity strategies and manufacturing processes, which can be fed back into teaching. Also, the experience confirmed that *"community organizations, agencies and government bodies each have rules, procedures and practices that either facilitate or inhibit collaborations"*. (Todd, Ebasta and Hughes, 1998)

Benefits for academia and community

The relationship between community, local schools and academic institutions is likely to produce more than short-term gains, and provides insights and networking opportunities to benefit the parties involved.

Through the university's involvement with *the joinedupdesign* for Academies project, the students have worked with what were 'failing schools', known in the communities as 'sink' learning environments. These schools are, by their nature, unlikely to send many pupils to study design at Higher Education level. Whilst engaged in programmes stimulating social regeneration within the community, it has to be asked whether or not it has galvanised the pupils' thinking and challenged them beyond conventional design considerations. In their feedback, our undergraduate students cherished *"the opportunity to work with the school children"* with one of their colleagues stating that "*I am considering working with schools."* A student remarked that the most important point of the brief was *"to create an environment that both pupil and staff can be proud of, and provide all users of the school including visitors with a sense of belonging."* Good design builds reputation and identity in a place and the community at large, and could be "a way of showing they are proud of their school" (Sorrell, 2008).

Most importantly, from the viewpoint of the Sorrell Foundation, *"pupils work in client teams to debate each common issue, noting what it is like in their school now, and proposing how things could be improved in the future. This information produces the Pupils' Brief, a publication informing architects, head teachers and the local authority about the pupils' ideas"* (Sorrell, 2008). Through this, the students, in turn, contribute to the process of urban regeneration. Furthermore, the students impact upon the clients by being positive role models and raised "ambition" in the pupils. One of the children said: *"I liked working with proper architects and as a result of this experience I would like to train to be an architect myself, they made it look really easy".*

Conclusion

This pilot of *joinedupdesign* for Academies ran concurrently to the much larger YDP, but had distinctive characteristics which we were reminded of at the major launch event: a depth of rigour (through keeping closely aligned with the dates set out in the process guidance's and funding (with the Sorrell team double manning all sessions, recording all student-pupil interaction, and providing direction when appropriate). In addition a coordinator was placed at each school overseeing the transformation into an Academy (in one school there was an external consultant and also a member of an educational charity who will be a sponsor, responsible for the new school. The second school had the assistant head teacher facilitating. This differs from the YDP, which has to rely on an enthusiastic teaching staff, or champion of the engagement.

This innovative community partnership has provided an opportunity for powerful situated learning in Design, with the authentic brief offering HE Design students opportunities to: enhance their skills (through creative problem solving); develop their attributes (through preferences for learning through doing); and improve behaviours (by putting things together creatively). This learning was achieved in the context of a creative/social entrepreneurship model which, as collaboration, was more embedded in the Design curriculum than work experience, and more holistic in terms of facilitating employability skills than work-based learning.

Findings suggest the *Joinedupdesign* for Academies partnership is an effective approach to bringing various stakeholders in Design education together. However, compared to commercial live client projects, the complexity of the multiple sites and partners appeared to make this project markedly less efficient. Students highlighted the repetitive nature of some elements of the project and some felt ill-prepared to present at board level, and struggled to identify stakeholder intentions and underlying agendas. Facilitation from members of university staff was found to be highly demanding (a point acknowledged in the national feedback sessions by the project managers). In terms of undergraduate learning, a wide range of employability skills were demonstrated: community consultation; interpreting a master plan or survey; eliciting feedback from planners, pupils and local government; team work; time management; project planning; presentation to a panel; public/media relations. The authentic complexity of the tasks associated with the partnership project challenged the students to cope with co-learning (involving the merger of expertise in communities with expertise in universities), in a context of less-predictability.

Therefore, key outcomes for the Design students included in this *joinedupdesign* for academies project were positive. In relation to employability skills, their learning was enhanced by the experience of working in teams, of working with pupil clients and working to an authentic life brief. However, as a new model of off-campus learning, significant challenges emerged for tutors running the project, with the complex multiple partnerships requiring additional time and resources. The potential outcomes for pupils are less easy to measure, and will require further research of a longitudinal nature to see if impacts are sustained beyond the life of the programme.

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Design history education and the use of the design brief as an interpretative framework for sustainable practice

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Abstract

Over the last several years, designers, researchers and educators have been increasingly concerned with what effect design has had, and could have, on the current condition of unsustainability. If design has had a significant part in materializing unsustainability, then we must try to change its disciplinary parameters and relationships. How can we teach design history in order to engage students in this critical work?

This paper will document an ongoing experiment in the teaching of design history to undergraduate students in visual communication in two colleges of art and design. The course asks students to interpret images from the broad history of design through the lens of a common form of a “reverse design brief,” modified to engage the student in the task of pondering designs’ future effects. It is hoped that this pedagogical tool will not only allow the student to internalize this strategic tool of design practice, but as well allow them to understand the present-day consequential effects of designing. I will attempt to judge the success of the modified brief, from the standpoint of the qualitative insights of students into the ongoing designing effects of historical design objects.

This pedagogy raises questions regarding the uses of design history, the relationship between historical study and practice, the understanding of contemporary and historical frameworks and the engagement of an historical and ecological imagination. Can the design history classroom become a locus for a critically engaged, experimentalist pedagogy that can be experienced by the future designer as an essential tool in developing a sustainable practice?

Keywords

case study/studies; design brief; design history; pedagogy; practice; sustainability; unsustainability

Introduction

This paper will document an ongoing experiment in the teaching of design history to undergraduate students in visual communication in two colleges of art and design, which I began in 2002 and am still teaching today. Based on a common form of a “reverse design brief,” the course asks students to interpret images from the broad history of images, spanning epochs and cultural contexts. This pedagogical technique raises many questions, the most interesting among them for this researcher being the engagement of an historical and ecological imagination.

As Orr (2004) suggests:

> We will need schools, colleges, and universities motivated by the vision of a higher order of beauty than that evident in the industrial world….They must help expand our ecological imagination and forge the practical and intellectual competence in the rising generation that turns merely wishful thinking into hopefulness. (p. 185)

I start from the assumption that teaching is the most effective means of changing practice, at a time when fundamental changes in how design interacts with the world have become necessary (IPCC, 2007). If design has had a significant part in materializing unsustainability – which I define as a condition whereby the material impacts of a species within its ecological framework, when pursued over a finite length of time, result in the species’ extinction or its likelihood – then we must reframe our learning outcomes towards the end of creating future. Can the design history course become an essential tool for the future designer in developing a sustainable practice?

The discipline of graphic design history is rather short: the first North American history of graphic design course in a program of graphic design was begun in 1971 at California Institute of the Arts, and taught by practitioners—Keith Godard for one year, followed for the next 25 years by Louis

Danziger (Heller & Balance, 2001). The first symposium of graphic design history in the U.S. was held in 1983 at Rochester Institute of Technology, organized by Roger Remington (Twemlow, 2006). Until recently, its history was generally written and taught by practitioners or by scholars from other fields. In universities it is still not uncommon for it to be taught by a doctored art historian for reasons of academic accreditation or departmental politics.

I state this simply to call attention to its status as an open area of inquiry, where it is still possible to fiddle with its foundational assumptions. This is important, as design history grew out of the discipline of art history, also a young discipline, and has shared some of its assumptions (Calvelli, 2009). Design history is often taught as a history of artifacts, with an emphasis on authorship and historical movements, often following contemporaneous art movements. When social content is brought into design history, it is often done so in terms of its mirroring of an historical *zeitgeist.*

Thus, in the students' history of design course, the *agency* of design is displaced from the artifact and placed mostly in the hands of the designer. Concomitantly, in studio courses the assumption of agency is placed in the hands of the client. A more adequate understanding of agency would, following Anne-Marie Willis' discussion of ontological design, privilege neither designer, client nor designed artifact (Willis, 2006). Rather, it would open up the possibility of studying the *designing* effects of design in time (Fry, 1999), and allow us to pose the question of how design extends or limits our future.

Background

This first iteration of the course was developed for the Art Institute of Portland as their required history of design course for graphic design majors. The Art Institute is one of 46 colleges owned by the for-profit Educational Management Corporation. It calibrates its program and course outcomes carefully to the market through professional advisory committees of respected professionals in its community. Its defining metric of success is what percentage of its students is able to land jobs in their chosen field within six months after graduation (when I taught there during the recession following September 11, 2001, their metric was about 85%).

I brought some of the elements of this course to an upper-division seminar I developed, *Image and Ecology,* taught at the Pacific Northwest College of Art (also in Portland). PNCA is a private non-profit art college, traditionally based in the fine arts but with a small percentage of its students studying Communication Design. Many of the programs' students are as interested in or influenced by the surrounding educational environment of the fine arts. It views itself as experimental and conceptual and aims to graduate "boutique" designers to fill positions in prestigious studios or agencies. A case study of this course is included in the article cited above (Calvelli, 2009).

The most recent iteration of the course was taught in the fall semester of 2009 at the Alberta College of Art and Design (ACAD), one of the four provincial art colleges of the Canadian system of higher education. Like PNCA, it comes out of a fine art tradition, but their visual communication program has a strongly separate self-identity as a design-focused program. Students follow a highly structured sequence of courses; a particular methodology of solving communication design problems is reinforced throughout. The program views itself as international in their outlook, with a roster of alumni internationally, some of who contribute to current students' education through projects managed virtually over the Internet.

First iteration: Meaning and value in image-making

In 2002, I developed for the Art Institute of Portland the required survey course for majors in graphic design, using as my text the third edition of Philip Meggs' *A History of Graphic Design* (Meggs, 1998). To the traditional learning objectives of a survey course I brought two additional ones: first, to understand the history of graphic design within a broad framework of the history of image-making; and second, to be able to interpret this broad swath of images in terms of their meaning and value. This allowed me to foreground the strategic value of a wide diversity of images—from the Sistine Chapel to a Denny's lunch menu. Images typically associated with art history were examined in ways that brought to the fore parallels with contemporary design practice.

Fig. 1: Braun Citromatic de luxe citrus press, model MPZ22

Traditional and modern design images were analyzed in ways that removed them from the expediency of a commercial context in order to understand them as a cultural artifact.

The clear articulation of meaning and value is a challenge, and especially so in graphic design where the meaning of an image – what it communicates – is so closely correlated with its value – what the image *does*, its purpose for being created. A Braun fruit juicer (fig. 1), for example, might look like it is meant to juice fruit, and thus *communicate* its function; but this is only partly true: it also communicates, for example, modern efficiency and stylish classicism. Its function of squeezing juice out of fruit is more easily ascribed to its *value.* On the other hand, the value of a WPA poster for a dance (*fig. 2*) is intimately correlated with its meaning, the communication of the *what/where/when* of the event as well as its *why*, the joy of dancing.

Fig. 2: Charles Verschuren. *Dept of Parks water carnival: Music, dancing, singing*. 1936.

An image is an extremely efficient means of communicating complex information, which becomes apparent through the challenge of attempting to isolate and separate its meaning and value. We can read images in an instant, even though the effort to manage the communication on the part of the producer can be immense. A designer might achieve this effect not through an immense analytical effort, but rather through an extended synthetic mental process not dissimilar *in kind* to the mental process of a viewer. The ability to synthesize may be dependent – particularly in the case of a young student of design – on a repression of critical awareness of the strategic interests at stake in the image. The exercise of clearly separating the meaning from the value in an image, through the application of a *retrospective* critical analysis develops in the student a strategic understanding of how meanings are constructed for specific social purposes, in a variety of historical and cultural contexts.

Fig. 3: Lester Beall. *Radio*, from the series "Rural Electrification Administration," 1937.

For example, if we were to analyze the meaning and value of the *Radio* poster that Lester Beall designed for the Rural Electrification Administration, we might say its *meaning* is, simply, “Radio is coming to your home, courtesy of the Rural Electrification Administration.” Although it isn’t technically wrong to say the *value* consists at least in part of informing citizens that “Radio is coming to your home, courtesy of the Rural Electrification Administration,” this is both redundant and ignores other values, such as that the poster contributes to a feeling that the government is working to improve your life, or that it increases the chance that you might vote to re-elect FDR for a second term in the 1938 election later that year. Through this type of historical analysis, students begin to understand that the creative activity they engage in not only has the effect of communicating a message in an imaginative or instructive way, but is also implicated in a complex social and political equation of interests and value.

The Beall poster also lends itself to the examination of core meaning, as it is designed with such modern and effective simplicity (especially for America in the 1930s). Encapsulating the meaning of an image into a short statement requires of the student that they unpack both the overt and subtler messages in an image and synthesize them. This process is relatively straightforward in the case of the *Radio* poster: the strong white arrows, with the overprinted “RADIO” text leading to the house, signify “*radio is coming to your home.”* The foreground, in perspective, leads our eye to ”RURAL ELECTRIFICATION ADMINISTRATION,” suggesting “*from* (*or courtesy of*) *the Rural Electrification Administration.”* What’s missing from our analysis is the dominance of red white and blue, the colors of the American flag, and the *modern* design. This latter element might be missed if one didn’t know, through historical study, that it was unusual at the time. What we arrive at through the addition of these elements is the following meaning statement: “*The* modern technology of *radio is coming to your home, courtesy of* your government*.”*

A more complex image, such as the cover from the 1899 Sears catalog, presents a greater challenge. How do we articulate the totality of what is communicated to us here, in a simple statement? We are presented with a “cornucopia” of elements on the page, to wit: the title of the company, a globe, a goddess emerging from a cloud, a rural landscape, a tagline “Cheapest Supply House – Our trade reaches around the world,” a title “Consumers Guide,” and a literal cornucopia of overflowing consumer goods – among other elements. This requires a significant effort of synthesis.

The exercise of producing a meaning statement from a complex image (not only number of elements, but also subtexts, ironies, strategic positioning and the like) develops in the student an imaginative ability to put oneself *in the place of* a material artifact for the purpose on understanding the agency of design. “*If you were this image,* I ask them, how would communicate your meaning to me verbally?” I encourage them to use the first person: “I [Sear’s Roebuck] reach around the

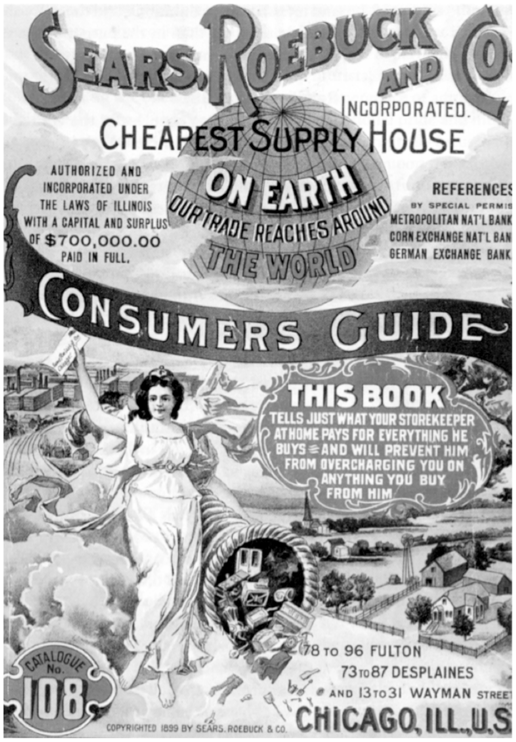

Fig. 4: Unknown. *Sears catalog cover*. 1899

world in order to magically bring to your remote hamlet an abundance of useful things to consume. Here is your guide to our riches."

Second iteration: Introduction to the reverse design brief

I introduced the reverse design brief to the course in 2003 and still use a modified form of it today. There were both pragmatic and pedagogical reasons for its introduction. I wanted to create a more relevant framework for students at the Art Institute of Portland, all of who had solid ambitions to enter industry. I also felt that the core concepts of meaning and value would be better understood within the more context sensitive design brief format.

The design brief I use is oriented towards visual communication practice, and consists of six questions: *What is the project?, Who is the client?, Who is the audience?, What is the core message?, What is the hoped-for outcome?, and What is the graphic strategy?* The core message and hoped-for outcome correlate closely with the meaning and value; the additional elements add the possibility for more analytical rigor as well as strengthen the tie to design practice.

For the purposes of this paper, I ask the reader to keep in mind a few points: first, although the form of the brief is quite simple, the reverse brief technique requires a considerable amount of practice on the part of the design student. Indeed, even after teaching this course over a dozen times, I still find much to discover through the dialogic analysis we engage in. It becomes both an analytical and synthetic exercise; the students' historical imagination is provoked, and the need for historical context is emphasized. More importantly, even though during this pedagogical iteration I wasn't yet emphasizing designs' future effects, the reverse brief technique squarely places the artifact in a conceptual space that foregrounds its *designing agency*, unlike courses based on a more traditional art historical model.

The following is an example I have used to introduce the format to the class, which analyzes a UPS logo from 1961 by Paul Rand, a designer who is often already known and respected by students before they take the history of design class. By citing this example, I intend only to demonstrate its basic organizing structure and use – how it works.

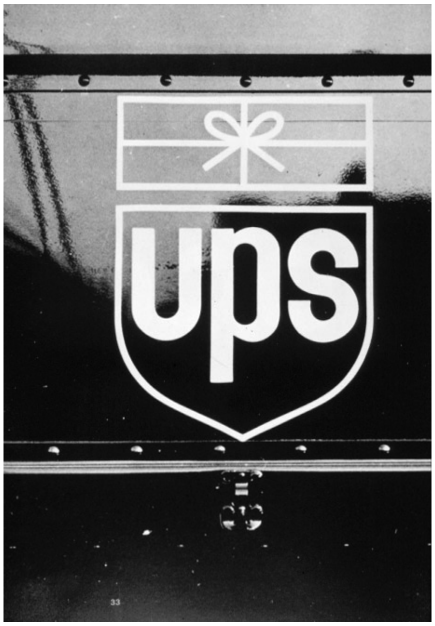

Fig. 5: Paul Rand. *UPS logo on truck*. 1961.

Reverse design brief as applied to the 1961 UPS logo designed by Paul Rand

1. **What is the project?** *Design a logo for UPS.*
   The project is defined as a denotative statement that clarifies the final image artifact. It is also an important entry point for students to imagine themselves as the designer with a project crossing their desk (in whatever historical era is being considered).

2. **Who is the client?** *UPS was the largest parcel delivery service in the United States at the time, competing with the US Postal Service.*
   The client is described in terms that add strategic value both to the brief and the resulting design. This encourages the students to examine their assumptions regarding the client. From an historical perspective, it is also an opportunity to examine the diverse institutional relationships (the "client" writ large) that exist between image producers and those they are answerable to, in whatever manner.

3. **Who is the audience(s)?** *Businesses that regularly ship or receive parcels; Families outside of large metropolitan areas who rely on the mail for deliveries.*
   There are also a wide variety of *types* of audiences, depending on the particular historical and social circumstances. Many students have only a vague sense of audience even in a contemporary context. This part of the brief allows them to see the work they do not in terms of a universal "other," but rather in relation to specific, historically based social bodies.

4. **What's the core message?** *"Your special package is safe with us."*
   "Core message" correlates with the term "meaning" used in the meaning/value analysis. The brief form allows the message to be isolated, disencumbered by extraneous information that fits better in other "buckets" of the brief.

5. **What's the hoped-for outcome?** *Potential customers would trust UPS for all kinds of packages from delicate equipment to Christmas gifts, and come to rely on its service.*
   This question and response correlates with "value" in the meaning/value analysis. In order to articulate the hoped-for outcome, the student needs to have an understanding of the values of the particular historical time and place for which the image was created, which requires not only research but also the beginnings of an historical imagination, an ability "to join the past, the present and the future" (Munslow, 2006).

6. **What's the graphic strategy?** *Paul Rand kept the logo simple so it was easily recognized. The color brown became associated with UPS and differentiated the company from the US flag colors of USPS. He designed it as a shield form in order to convey safety. The ribbon was used to suggest the anticipatory joy that comes from receiving a gift, which would become associated with using UPS.*
   The graphic strategy is an opportunity for the student to put himself or herself into the position of the designer solving the strategic design problem which, in general terms, can be defined as using visual communication to produce social value. They can imagine, each step of the image-makers' moves, and tie it to an existing element of the already-articulated design brief. Otherwise, they can focus on elements of the brief and figure out how the image-maker solved the problems encoded there.

Third iteration: Design history and designing effects

I was hired by the Liberal Studies department at the Alberta College of Art and Design in Calgary to teach their design history and theory courses beginning in the fall semester of 2009. The history course – *Critical Contexts in Modern and Contemporary Visual Communication Design* – is the major survey for Bachelor of Design students in the Visual Communication Design program.

In order to focus attention on the designing effects of design, I added an additional question:

7. **What are the designing effects?** *The brown logo-branded trucks would become ubiquitous on American streets as UPS became the only competitor to USPS. Consumer shopping became much easier and goods could be made farther from the consumer. This increased the use of fossil fuels for transportation.*

Note that the example imagines the designing effects of the simple logo and graphic identity within a reasonably grounded historical framework. A direct correlation between the logo and what is described is not assumed: in a complex relationship involving business, transportation, consumer behaviour and other factors, it would be impossible solely to isolate the role of design. Lorraine Code calls this "ecological thinking," which she observes "may indeed appear to restrict the range of justifiable, definitive knowledge claims, yet it maintains vigilance for irresponsible, careless, too-swift knowings that fail to do justice to their objects of study" (Code, 2006)

Elements of the traditional historical survey course were still present though weekly slide lectures and the use of the updated *Meggs' History of Graphic Design* (Meggs, 2006) as the required text.

It is a complex endeavour simply to adequately represent the history of design in a traditional chronological fashion. In addition to this objective, I also set myself the task of teaching the students to use the design brief to interpret historical images, and to foster an awareness of the "designing effects of design." By midterm, it was evident that I needed to find a way to increase depth of understanding while teaching to all of these objectives. To achieve this, I ceased reviewing students' reverse brief assignments during class, and instead used the time to engage the entire class with a dialogic analysis of a few images chosen for this purpose.

This had the effect of transforming the course into an in-depth, exploratory workshop in image analysis. It became a collaborative dialog of perspectives, relying both on analytical skills and imagination, with historical suppositions validated through on-the-fly online searches conducted by a few laptop-enabled students. Sometimes, the entire second half of the class would be devoted to the analysis of one image; we seldom were able to adequately analyze three images in the time allotted to us. Considered from this standpoint, the class was a success. In terms of an exit competency of being able to apply a course in design history to the task of creating future, we will have to rely on the modest evidence of written excerpts from the final assessment, for the purpose of this paper answering only the question: *what is the designing effect of* [*this*] *design?"*

Examples

For the final, I selected twenty images as a study guide, testing them on five, using the revised reverse design brief format. I emphasized that I would be expecting a thorough knowledge of historical context, and placing particular emphasis on their ability to analyze the images' designing effects. In the responses that follow, it should be kept in mind that the ones included do not represent the level of competence of the students as a whole. In teaching liberal studies courses to studio art and design students at three colleges of art and design, I have come to expect a wide variance of interest and ability in non-studio courses. Although it is important to reach the widest range of students when the purpose of the course is to affect practice, I did not find the responses of those students who have less interest or ability to succeed in the course to illuminate in what manner the pedagogy might have succeeded or failed. I will therefore not be sharing them. I will address some potential future revisions, however, in the findings.

Fig. 6: Wurlitzer Jukebox and Vending, Inc. *Wurlitzer One More Time CD jukebox*. 2006.
Based on the 1946 Model 1015 by Paul Fuller.

The Wurlitzer jukebox

The first image I presented to the students was a Wurlitzer jukebox – actually, a 2006 remake of the original version. As a faithful remake of the 1946 Model 1015, whose image was unavailable, I encouraged them to analyze it as if it were the original. I instructed them to pay close attention to its image design.

One student focused on copyright issues:

Jukeboxes, like every other advance in musical technology, created a stir among music rights owners (corporations, not artists), leading to lawsuits in the 40s and 50s. The recording industry lost, as it was judged that they had already been paid for the royalties of selling the storage media (like phono-records like vinyl and CDs that the jukebox used).

Another was more concerned with its effect on music production and technology:

It probably had a hand in shortening music to the 3- to 4-minute song we are used to today. By allowing the user to dictate the music and order, they jukebox became an early precursor to today's iPods or mp3 players, with their own personal collections and playlists.

This response notes the possible effects upon the musician:

Since live music had always been part of the social scene in all pubs and bars across every continent, a machine that replaced musicians could have been potentially damaging to their income. Freestyling in a small venue would be less common, as managers and owners of said venue would cut back continually.

The jukebox hasn't held such historical significance since Jack Kerouac wrote the introduction to Robert Frank's *The Americans*:

It is only a short step from soda pop culture to the revolution of the hippies: the jukebox opened the door to more cultural freedom.

One can see in these examples sensitivity to legal, technological, aesthetic, labor and cultural issues as an effect of the introduction of a designed artifact into the world.

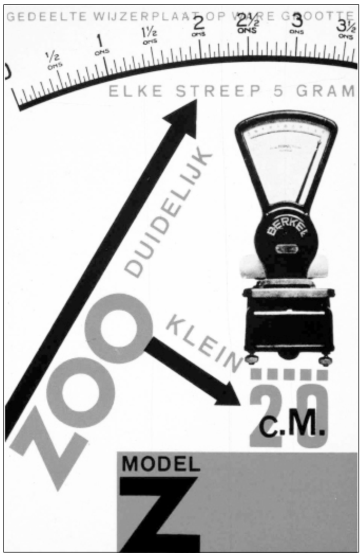

Fig. 7. Paul Schuitema. *Brochure cover for P. van Berkel Ltd.* Rotterdam, circa 1928

Brochure cover by early modern Dutch designer Paul Schuitema

Many students commented on the rise of efficiency and standardization arising from this promotional flyer for P. van Berkel Ltd., Rotterdam:

By the use of these scales, along with other products like automated slicers becoming widespread, a more accurate standardization in food purchases began to develop….This accuracy came to be expected, in the same way that we today expect our Starbucks triple-grande extra-hot caramel macchiato to taste exactly the same every time. Standardization!

It is interesting that the student is able to make a leap from a rather unconventional layout design (even in today's terms) to an effect of standardization. Would this insight have been made in a course that restricted itself to analysing the historical specificity and radical innovation of the phenomenon of Constructivist design, or its influence on future design movements?

Cranbrook Academy of Art recruitment poster by Katherine McCoy

The analysis of a Cranbrook Academy poster became an opportunity to reflect on the influence of the design profession itself, as can be seen in both these examples:

Work like this acts as an early bearer of the responsibility of bringing the digital method into general acceptance and to merge it with real life. If the designers – who are altering the experiential world of everyone else to a huge degree – begin to utilize a technology, it becomes ingrained in culture. The acceptance of computer technology owes as much to projects like these and to schools like [the] *Cranbrook Academy.*

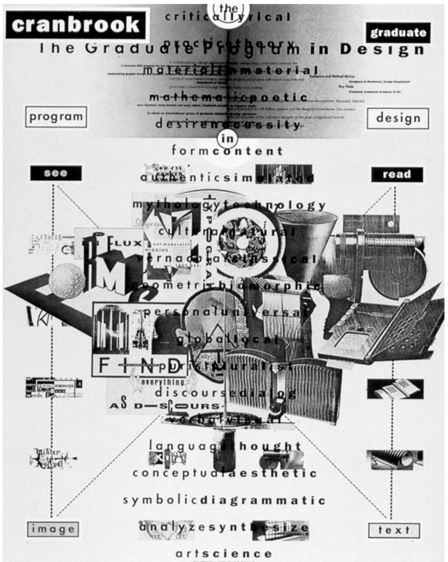

Fig. 8: Kathy McCoy. *Cranbrook recruitment poster.* c. 1988.

Another student commented:

According to New York Times in 1984, "the effect of Cranbrook and its graduates and faculty on the physical environment of this country has been profound."… Perhaps this has created a desensitivity in Americans, and all the developed world; that in being used to seeing innovative design around them all the time, they have stopped appreciating the beauty of images in favor of demanding things also be new?

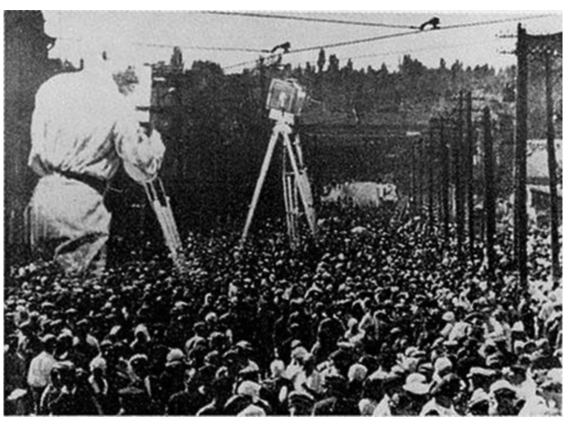

Fig. 9: Dziga Vertov. Still from *Man with a Movie Camera*. 1929

***Still from Dziga Vertov's* Man With a Movie Camera**

A few of these interpretations of this still from his seminal early Soviet film, *Man With a Movie Camera* might have stirred Vertov from his grave. The responses point to the limits of predicting the designing effects of design, as well as to the nature of design as always already co-opted.

(Student 1) Perhaps this did work to create a sense of pride and unity among people. Perhaps they worked a little harder for a while. Could this movie have assisted in lulling them into a sense of complacency, while Stalin's iron fist gripped them tighter and tighter?

(Student 2) He…in a large part foresaw the unobtrusiveness of cameras and the ability of a cameraman to go almost anywhere.

(Student 3) [*His*] *controversial documentary film led to the very beginning of the billion-dollar industry that is reality television. His ideas about not staging [a scene] yet [still staging it] behind-the-scenes are the very basis of most television today.*

Findings

As these last responses attest, a designer cannot fully predict the effect his work will have on the future. There is a good argument to be made that it is better to teach to the possible – how to solve a specific design problem located at a specific point in time and space – than to flirt with the impossible – how to take in account the enormous possibilities of permutation and perversion that comes with the releasing any artifact into the world to begin its work of designing over time.

But if we agree that our global society exists in a state of unsustainability (IPCC, 2007), and that this condition limits the time of human future, then we must develop ways of being in the world that have the capability of creating more future rather than less.

We cannot validate a claim that the knowledge gained from a course in the history of design will contribute to the creation of more future. The selected student responses to the question of the designing effects of design do exhibit sensitivity to the work of design in time, in ways that exhibit both insights and elisions characteristic of undergraduate work. I believe they *were* able to parse existing designed artifacts in ways that exhibit an ability to understand these artifacts in terms of their potential future effects – though more could be accomplished.

Additional class time could be spent in the analysis of images rather than in the presentation of chronological lectures. The recent publication of the *Design History Reader,* by Hazel Clark and David Brody presents, by its very publication, a compelling reason to abandon the survey textbook in favour of an approach that prioritizes a critical framework that has relevance to, but is not overdetermined by a chronological approach to history. Students easily become overwhelmed by the confusion of priorities that is caused when critical concepts, like futuring, conflict with expectations they bring with them from their art history survey course.

The reverse brief technique, adapted to emphasize futuring effects, has provided a context where both past and future have a relevance to present practice. It is not a necessary prop, however. It is useful only insofar as traditional design history pedagogy may be inverted into one that prioritizes future by re-contextualizing historical knowledge. Where once we emphasized the past for students without historical consciousness, now we can emphasize the future in order that our students may respect the past for its power either to limit or extend future.

The deciding questions would remain: does this awareness have the likelihood to be applied to practice and, if so, would it have better potential to create future compared with a practice not so informed? If internalized by practice throughout the course, the inclusion of a question concerning the designing effects of design within the format of a commonly used design brief makes its application to practice more likely. As to it’s potential to create future? *Time will tell.* Compared to a pedagogy that stresses the designed artifact more than the artifacts’ *effects,* it seems it would have a better chance.

Conclusion

At a time when the additive material extraction and cumulative environmental degradation exceeds our ability to sustain human life into the indefinite future, the context of our learning and our designing must change. Historical study then becomes the imaginative, practical and necessary challenge of our time.

Everyday People: Enabling User Expertise in Socially Responsible Design

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Abstract

This paper examines the contemporary relevance of interdisciplinary research practice specifically within the field of design for social need. Examining the complexity of current social problems using the concepts of Rittel & Webber's *wicked problems*, this paper looks at the potential for the application of co-design methods within an interdisciplinary framework. By proposing the use of a social model of design, it is argued that it is through co-design methods and the use of generative toolkits such as Liz Sanders' *MakeTools* and *IDEO's Human-Centered Design Toolkit* that the design process can be enhanced in the early stages. This paper argues for interdisciplinary practice by enabling user expertise so that the user can equally contribute to the design process. This paper also explores the changing role of the designer from researcher to facilitator, and how this can benefit communities dealing with complex problems. Finally, this paper looks at the benefits of active user involvement in socially responsible design through discussions on empathy, user empowerment and benefits to communities within design education.

Keywords:

Co-design; Participatory Design; Interdisciplinary; Socially Responsible Design; Design Research; Toolkits; User; Expertise

There has been increasing demand for a change in design thinking with regards to socially responsible design. In recent years a *call to action* has grown increasingly louder. Buzzwords around social action are widespread in contemporary media and political platforms, with issues surrounding environment, poverty, health, and education. The role of design must adapt in response to the effect of economic and social change on a population of nearly seven billion people. While design has been commonly associated with beautiful objects of desire or luxury, the significant change in design thinking lies in the belief that "If designers have begun to figure out how to design 'better experiences' for high-end consumers, what about improving the experiences of those who belong to the population segment that design activists have dubbed 'the other 90 percent?" (Berger, 2009, 185).

The call for socially responsible design is urgent, with leaders in the industry setting the pace. These initiatives have emerged as both a necessary and inevitable next step. The Cooper-Hewitt's touring exhibition *Design for the Other 90%* sparked knowledge about the radical difference in quality of life in which the majority of humankind find themselves. Design associations such as *Design for the Majority*, (a chapter of the *IDSA*) enlist members with a bold mission on this changing social climate stating "we as designers can either lead this shift, or we can follow" (*IDSA* website). In addition, initiatives by Denmark's *INDEX: Design to Improve Life* have also been undertaken to further international education by incorporating their socially conscious process model into national education. Most notably, *INDEX:* implemented the largest international design award, in recognition of designs that substantially improve the lives of people.

At the root of these initiatives lies the central belief that “design is fundamentally grounded in human dignity and human rights” (Buchanan, 2001 36), and that the designers need to respond conscientiously through responsible action. In other words, with human consideration during the design process. On new design thinking, *IDEO’s* Tim Brown jokes, “design is too important to be left to designers” (Brown, 2009). With the increasing recognition of human consequence to any design decision, designers will need to consider both interdisciplinary and participatory methods to further consider humans, or *users* as active participants in their own future.

The complexity of social design problems calls for interdisciplinary practice. By examining the role of the user within a participatory framework, this paper argues that participation in the design process is a critical success factor for increased benefits to the end result. However, it is only through exploring the means of involvement through co-design and the use of generative tools that the user can be viewed as an equal contributor– an “expert”– in the interdisciplinary design process.

1.1 Clarification of Terms

This a theoretical paper based on a literature review. As the field of design practice and research evolves, the terminology continues to evolve and expand as well. Some of the sources are initial publications on the subjects, so it is important to clarify the terms that may have changed. *User* will imply *humans whose lives are directly affected* and “who stand to have their activity and experience transformed” (Carroll & Rosson, 2007, p. 258). *Socially responsible design* refers to design within the realm of social need, and upheld by a definition where it is “grounded in human dignity and human rights” (Buchanan, 2001). This paper will take *Human-Centered Design* to mean a “design process specially focused on socially responsible design, with the end aim of responding to basic human need” (IDEO Toolkit, 2008). *Design Thinking* is inspired by a “process that endeavors to solve problems and create new possibilities, generally relying on empathic research […] combined with creative experimentation and extensive prototyping and refinement” (Berger, 2009, p. 302). The term *design* will be in the scope of socially responsible design.

2. Socially Responsible Design

2.1 New Design Thinking

As social problems of the world change, so does the role of the designer. It can be argued that earlier definitions of design do not effectively cover the wide range of theory, knowledge, and methods used in new design thinking. The role of the designer, once viewed as a profession based on principles of aesthetics, and creation of beautiful artifacts “has expanded into a more thorough and diverse interpretation of the physical, psychological, social, and cultural relationships between products and human beings” (Buchanan, 1992, p. 9). Until recently, it seemed suitable to pigeonhole designers into specific subcategories; graphic, industrial, urban design, with each designer approaching individual problems with their own unique knowledge. However, the increasing complexity of social problems has, as a result, made solving them increasingly difficult. Because of this, “the boundaries around these problem areas have begun to collapse […] As a result, old divisions of design practice now appear increasingly inadequate and ineffectual” (Margolin, 1996, p. 23).

The role of the designer is now, more than ever, about adhering to a new way of thinking about problems, one that incorporates a broader research approach in order to fully understand problems as systems, rather than individual parts. By expanding their knowledge designers can then contribute a well-informed solution, matching the complexity of the problem. Evolving far beyond the principles of aesthetics and basic form and function, design thinking is now focused on “form and content,” fundamentally rooted in humanity (Buchanan, 2001, p. 35). Designers must cross multiple disciplines to expand their scopes of knowledge and this approach can now be considered a tool, not solely a profession. Only through this new form of thinking can designers really be able to face current social problems.

2.2 Rittel & Webber’s Wicked Problems

The complexity of problems faced by designers can be best characterized by Rittel & Webber’s formulation of w*icked problems*; those that are far too unique and complex that do not have logical or concrete solutions. The properties of wicked problems are detailed in Table 1. As such, these problems must be looked at more expansively. As social problems tend to be interrelated, they must be looked at it in a bigger context, which “tends to run counter to the more conventional method of trying to simplify problems to boil them down in an attempt to come up with ‘the answer’” (Berger, 2009, p. 206). When a problem is *wicked* it is impossible to fully solve in the way that a mathematician might solve a puzzle. Social problems can never be solved. (Rittel & Webber, 1972, p. 160), and often any one solution may actually “solve one aspect of the larger problem while making another part worse” (Berger, 2009, p. 207). In an example of a current water contamination problem, it is argued that designing a filter is just a quick solution and only identifies one part of the issue. Designers hold responsibility to carefully examine the system as a whole. Only by understanding consequences and impacts such as local culture, water sources, health issues, and cost of implementation, can a solution to a problem as complex as water contamination be approached (Berger, 2009, p. 206).

1	There is no definitive formulation of a wicked problem	The information needed to understand a wicked problem depends on one’s idea for solving it
2	Wicked problems have no stopping rules	There can never be an end to a problem when there are no definitive solutions
3	Solutions to wicked problems are not true-or-false, but good-or-bad	There is no criteria to determine this when there are no definitive solutions
4	There is no immediate and no ultimate test of a solution to a wicked problem	There is no on-the-spot test because it could take years to implement a variety of solutions
5	Every solution is a “one shot operation”	There is consequence to every decision, so there is no room to learn by trial-and-error
6	Wicked problems do not have an enumerable set of potential solutions	There are not only infinite numbers of solutions but infinite combinations of possible solutions

7	Every wicked problem is essentially unique	They can often be similar, but never the same because of individual context
8	Every wicked problem can be considered to be a symptom of another problem	Every problem is interrelated
9	The existence of a discrepancy representing a wicked problem can be explained in numerous ways	Especially in interdisciplinary work, everyone's understanding of a problem will be different.
10	The problem-solver has no right to be wrong	The aim is not to solve, but to improve the problem, so a hypothesis must be given regardless

Table 1. The ten properties of *wicked problems* (Rittel & Webber, 1973).

Put bluntly, these ten properties stress "the social reality of designing" (Buchanan, 1992, p. 16). The concept of *wicked problems* translates to a variety of issues faced in new design thinking because of the "fundamental indeterminacy," of them; that is, lack of answers and infinite combinations of solutions (Buchanan, 1992, p. 16). While problems might not be readily definable, the role of the designer should continue to identify "the actions that might effectively narrow the gap between what-is and what-ought-to-be" (Rittel & Webber, 1973, p. 159). This must first be accomplished by examining social problems as systems, and by following a social model of design.

2.3. A Social Model Of Design

As new design thinking must deal with interrelated and complex social problems, an interdisciplinary practice must be used. Margolin & Margolin propose a social model of design practice specifically for designers, based on the literature of interdisciplinary process used by social workers. Such a model calls for joint projects within disciplines, with the end product designed to satisfy a human need– a six step problem-solving process working "in a collaborative manner with the client system" (Margolin & Margolin, 2002, p. 24). Following this social model, new design thinking can look more holistically at a problem and enlist theory and knowledge from other disciplines. 'Design' as a subject matter "is potentially universal in scope, because design thinking may be applied to any area of human experience" (Buchanan, 1992, p. 16). The magnitude of knowledge needed to formulate strategies when dealing with *wicked problems* is impossible for one designer alone as "individual intelligence is insufficient to our tasks" (Rittel & Webber, 1973, p. 160). Through collaboration, designers can expand the field of knowledge surrounding a problem to ensure that every possible aspect of a system is addressed.

Approaching social problems using an interdisciplinary framework is necessary, as "without integrative disciplines of understanding, communication, and action, there is little hope of sensibly extending knowledge beyond the library or laboratory in order to serve the purpose of enriching human life" (Buchanan, 1992, p. 6). With the primary aim of synthesizing knowledge, interdisciplinary practice is in use by respected organizations, institutions, and design leaders in the field of socially responsible design. Danish organization *INDEX: Design to Improve Life* has implemented cross-disciplinary approaches in their process models and included it in their overall mission statement. Design and innovation firm *IDEO's* roster of multi-disciplinary team members is evidence of new design thinking, and the *Cooper-Hewitt's* affirmation of the need for designers "working directly with end users of their products, emphasizing co-creation to respond to their needs" (Retrieved from the Cooper Hewitt's Design for the Other 90% website, 2009). While these forerunners of design practice set the pace for other designers to adopt a social model for design, the new focus on the human-centeredness of design thinking brings into question the role of the 'user' in the design process.

3. Enter the User: from Participant to Expert

If the consideration of humans at the core of the design process is the "the major tenet of new design thinking" (Buchanan, 2001, p. 37), then what is the role of a particular 'human' in the design process when they are the one(s) potentially affected by the end result? The following sections will examine the application of participatory design practice and explore how users can be effectively involved in order to fully maximize the potential for viable interdisciplinary design practice following a social model.

3.1 Origins of Participatory Design

Participatory design is fundamentally rooted in early Greek Civilization, "where perhaps the first formal citizen forums were held" (Beheshti, 1986, p. 122). While the meaning of the term 'participation' has evolved considerably over the last few decades, participatory methods are founded in the basic tenets of democracy. The egalitarian principles such as freedom of speech, public assembly, and equal representation fed the energy of activism for democracy in the 1960s, and inspired a stronger community consciousness in the early 1970s (Beheshti, 1986, p. 122). These political and social trends were instrumental in growing demands for citizens to have influence in decisions of their communities. Politically, *participatory democracy*, or "collective decision-making" (Sanoff, 2006), has the aim of organizing a society in which "individuals share in those social decisions which determine the quality and direction of their lives" (Beheshti, 1986, p. 122).

Including the perspectives of users in a design project was initiated in Scandinavia in the 1970s. One of the first participatory design projects, using a "Collective Resource Approach," (Sanders, 2008, p. 3) came out of a project where union workers were actively engaged in the development of systems designed to make their workplaces more efficient. This collaboration allowed the computer professionals designing the systems to fully understand the worker's needs and day-to-day issues from the perspective of those "whose work was to be impacted by the change" (Sanders, 2008, p. 4). This realization of the users' intimate understanding of the problem emphasized the potential for active knowledge sharing and mutual benefits by involving people directly affected by the results. In addition, participation research expanded through the writings of Cross, Beheshti, and Sanoff, who supported a model referred to as the *Design Coalition Team*, "simply defined as all those who are involved in, affected by or can exert influence on the process of designing the built environment" (Beheshti, 1986, p.124). This meant equal say from all participants, including users. These writings and initial participatory projects were central in design practice and furthered considerations of user involvement during the design process.

Although participation has been increasingly incorporated into practice, there is still a great divide between the roles of *designer* and *user.* Most recent research methods are conducted through ethnographies, interviews, and surveys. This information is then interpreted by the designer or researcher, who is thought to have an "expert understanding of users of artifacts" (Reich, Konda, Monarch, Levy, & Subrahmanian, 1996, p. 169). While this type of participation in the development process definitely moves the role of the user closer to the designer, the user is still not really a part of the team, but "spoken for by the researcher" (Sanders, 2002), and still through interpretation by the designer. The user is regarded as a *subject*, with little to no involvement further along during the design process. Further participation methods can bridge the designer/ user gap, by involving the user in "ideating, and conceptualizing activities in the early design phases" (Sanders & Stappers, 2008, p. 1), referred to by Sanders and others as the "fuzzy front end" of a design problem. Increased contributions and involvement can possibly shift the view from *user as subject*, to *user as expert*. This can suggest that there must be opportunities for further inclusion of the user throughout the entire design development process.

3.2 Co-Design

Co-design, the "collective creativity of collaborating designers" (Sanders & Stappers, 2008, p. 2), upholds the idea of interdisciplinary practice within the social model. A large part of its potential, especially in socially responsible design, lies in the conviction that everyone is inherently creative, and knowledgeable about their own experiences. With complex social problems, it is necessary to think beyond the obvious solutions, and engage every team member through their skills and expertise. Co-design makes a case for user expertise by enabling the user's active involvement through the design process, who is then able to equally contribute to the solutions.

In co-design, the boundaries of roles between designer and user become blurry, and the user, "who will eventually be served through the design process is given the position of 'expert of his/her experience'"(Sanders, 2002). This is a significant shift in perception from user as *subject* to user as *expert,* now assumed to have an equally valid say in the design process. If expertise is defined as those with "access to special knowledge of a subject which supposedly raises that individual's awareness above that which is obvious" (Sanoff, 1985, p. 180), it can be argued that a user's perception of a problem through personal experiences and memories is in itself a unique knowledge, and therefore an expertise. Because new design thinking is about approaching a problem from every possible perspective, then the experience-based insights from the user are invaluable to interdisciplinary teams.

Users (as co-designers) cannot always clearly articulate their experiences, needs, or desires to relay their expertise. This is referred to as a user's *tacit knowledge,* that knowledge which is implicit, or inherently understood, but may not be able to be expressed through words (Polanyi, 1964). Therefore, it is not enough to simply *involve* users– they must be *enabled* to access and reveal this knowledge in order to "harness the collective and infinitely expanding set of ideas" (Sanders, 1999). Tools are needed to enhance this collaborative communication, in ways that allow people to visually express themselves through tangible means. This paper will focus on two particular generative toolkits.

3.3 Generative Toolkits

There has been much research development in tools for co-designing. To guide communication during the co-design process, the designer must assume the role of *facilitator* (Sanders & Stappers, 2008, p. 11), who can create appropriate tools to enable users to generate tangible, experience-based ideas. It has been established that “people cannot tell you in words about their unmet needs” (Sanders, 1999), so in this sense, by enabling user expression, toolkits can be considered a form of common language through which designers, users and other co-designers can communicate. This language is “built upon aesthetics of experience rather than an aesthetics of form” (Sanders, 1999). Sanders’ *Say-Do-Make* design process model is shown in Figure 1, illustrating that it is through *making* that the tacit knowledge can be made explicit.

Figure 1. Design process model: What people say, do and make. (Sanders, 2002)

These toolkits can be physical materials with which to create tangible artifacts, as in the case of Sanders’ *MakeTools*. Many varieties of toolkits exist, some eliciting cognitive or emotional experiences, stimulated by statements or thought provoking questions. Co-designers express themselves with the materials provided, often able to rearranged and built into artifacts with Velcro or stickers, and refined with pens or markers. Often their created artifacts are in the shapes of words, image collages, prototypes, concept maps or storyboards (Sanders, 2000), from which desires, needs, and “new, experientially-defined categories” emerge (Sanders, 2000). These artifacts reveals users’ clear personal experiences about ideal scenarios, which would probably not have been revealed without the necessary tools.

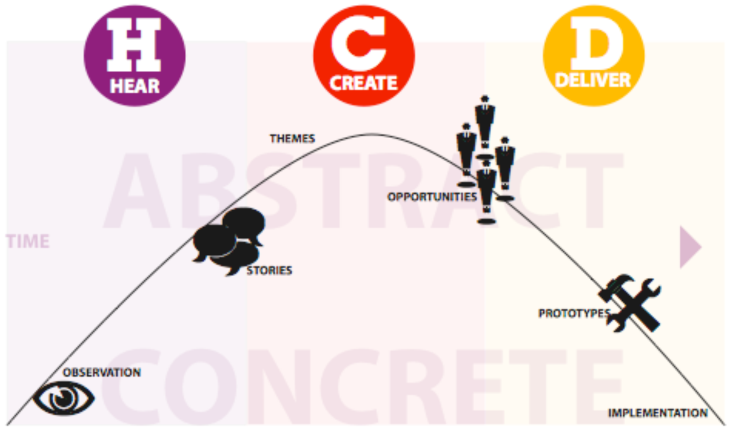

Figure 2. Design process model “Hear – Create – Deliver” (*IDEO Toolkit*, 2nd *Edition*)

IDEO’s *Human-Centered Design (HCD) Toolkit,* and accompanying *Field Guide* were created for particular use for socially responsible design for NGO’s and others, and parallels of the *HCD Toolkit* design process model, shown in Figure 2, can be drawn to Sanders’ design process model in that both aim to generate experience-based ideas through co-design. Both empower users by enabling their expertise. The *HCD Toolkit* guides facilitators through community participation and visual expression. An example of a co-creation workshop from the toolkit is seen in Figure 3. By including notes for the facilitator, and templates from which to build, the kit includes guides for role-playing workshops, storytelling sessions, scenario drawing, and prototyping, this process gives “voice to communities and allows their desires to guide the creation and implementation of solutions” (*IDEO HCD Toolkit*, 2nd *Edition*). This enables their unique expertise in the situation. The toolkit itself functions as much as a facilitator, illustrating how to select participants, and providing ways to deal with differences of culture, gender, hierarchy, and class systems, as shown in Figure 4. These are the same principles underlining interdisciplinary collaboration, as the toolkit reinforces the approach that “one cannot understand the problem without understanding it’s context,” (Rittel & Webber, 1973, p. 162). By enabling co-designers to create a tangible representation of their everyday life, these tools empower community members.

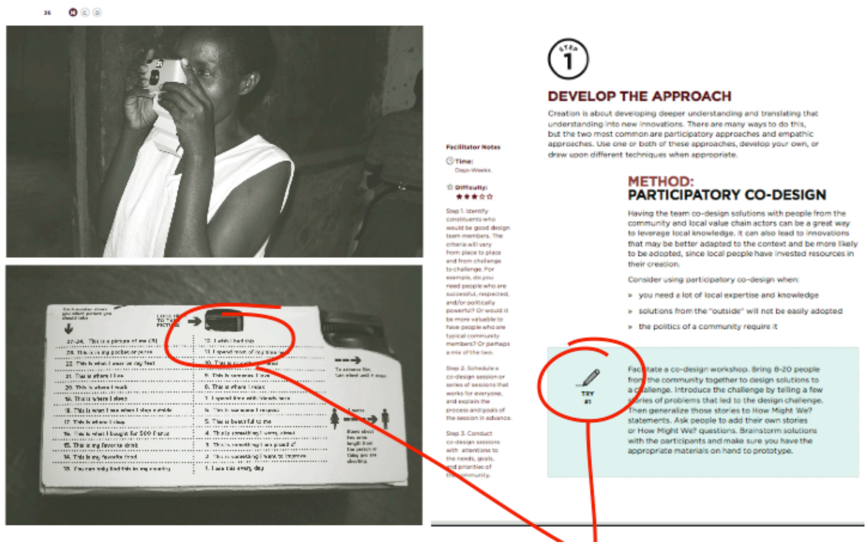

Figure 3. On the right, an example of tips outlined for facilitators to lead the workshops. On the left, co-designers create photographic storyboards using self-documentation and following a list of suggested guidelines– phrases such as *I do this every day* or *This is something I worry about.* (*IDEO HCD Toolkit*, 2nd Edition)

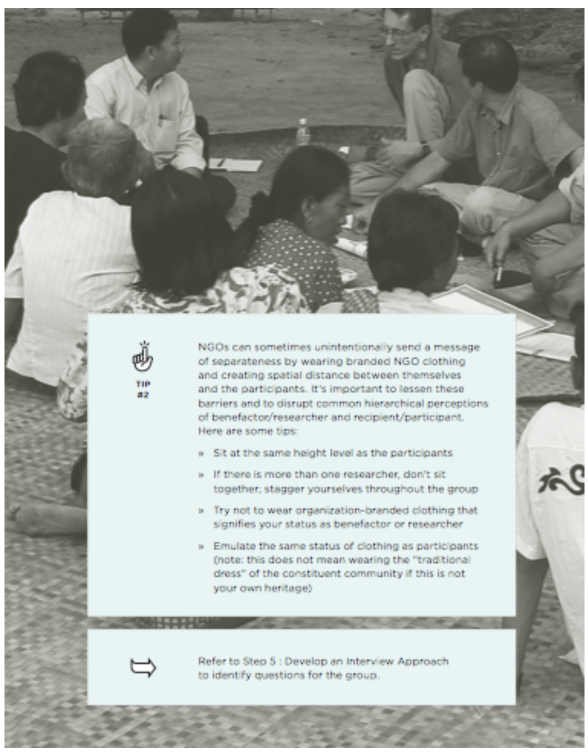

Figure 4. The toolkit explains certain techniques to enable the participant through sitting at the same height, and by not wearing clothing that sets facilitators apart or "separate" from the team, upholding the egalitarian principles of participatory methods (*IDEO HCD Toolkit*, 2nd Edition).

4. Implications on Design Process

Sanders & Stappers write that participatory design has the potential “to arrest the escalating problems of the man-made world” (2008, p. 5). By enabling user expertise through participatory methods, interdisciplinary design teams have a much stronger wealth of knowledge to face problems in the social arena. The benefits and implications of this collaboration are discussed below, as interpreted in Figure 5.

Figure 5. Benefits to co-design practice in socially responsible design

4.1 Empathy

Socially responsible design is especially relevant because of the direct impact it has on quality of life. Because of this, it is the moral responsibility of designers to consider the active involvement of the user in the design process as it determines the quality of *their* life, which the designer has the power to transform. If human rights are at the center of new design thinking, then user participation must be viewed as “a *prima facia* right of all people potentially affected by a design” (Reich et al, 1996, p. 162). The users direct involvement, personal history and unique experiences with the cause suggest a moral obligation for interdisciplinary teams to enable the user’s expertise. There should also be respect for the fact that it is the user whose life stands to be changed the most by the result. Caroll & Rosson aruge for a user’s direct say and meaningful role because users “are morally entitled to have a say in anything that might change everything (2007, p. 243).

Empathy emerges as a success factor in socially responsible design as a result of active user involvement during the design process. Expertise is exchanged between designer and user through co-design as a result of the shared experiences. The user learns design thinking, while the designer gains a deeper understanding of the user experience. Because of this, the designer is able to empathize with the user and greater care can be taken to consider all outcomes. This empathy strengthens the project, as the "awareness of the consequences of the decisions that are taken" (Sanoff, 1985, p. 178) is reinforced. This empathy for the impact on quality of life adds a greater sense of responsibility and consideration to the project. Ideas are developed thoroughly with the shared expertise.

In a case study by IDEO, in collaboration with a VisionSpring team, the tool of role-playing was integral in implementing a solution for eye-screening tests in a rural village in India, where children were terrified of the actual tests. Through role reversal, the team was able to empathize with the children's fear. In the spirit of childhood make-believe games, the team turned it into a game by having the children first conduct the tests themselves on their teachers. By "thinking from the perspective of […] users, and doing everything […] to feel and understand what they are experiencing" (*IDEO HCD Toolkit, 2nd Edition*), the team enhanced the experience by placing the child in a position of authority, thereby making the process playful and the children in control of their lives.

4.2 Empowerment

Co-design toolkits enable users to express their experiences so that within an interdisciplinary framework, they can be perceived as experts, and equally able to contribute to a solution. When the user is actively involved in the design process, "the major source of satisfaction is not so much the degree to which the individual needs have been met but the feeling of having influenced the decisions" (Sanoff, 1985, p. 178). By not only relaying, but also realizing one's own expertise and harnessing it through tools, this new sense of *empowerment* for the user is a critical success factor to the future of collaborative design. Empowerment gives a sense of accomplishment, a sense of pride, and the realization that one has the power to affect change. Most importantly, it gives them the feeling of control over their life and within their community.

In a case study from Africa, a designer worked collaboratively with Ugandan bicycle couriers (called Boda-Bodas) to design and implement low cost utility bicycles that would enable them to carry passengers and supplies to nearby towns. The study examines the design process and experiences of designing with the ten Boda-Bodas. Central to the study is that "including Africans into the design process not only enriched the design but also encouraged the community of their importance" (Morris, 2008, p. 7). Not only did it enable them to participate in their future, their significant contribution to the design process empowered them. There is potential for a much larger impact on social change through community empowerment. By acknowledging that community members have the power to affect change, an interdisciplinary framework could allow members of communities to work together, each of them being experts on local problems.

4.3 Education

Perhaps the shift from *designer* to *researcher* to *facilitator* can continue to transition into *educator*. As co-design continues to evolve as an emerging practice, "participants learn from their engagement in the process" (Sanoff, 2007, p. 214). This implies that there is enormous potential for community action to evolve separately from facilitation of the designer. Empowering community members, toolkits can enable users to recognize their own individual expertise through the design process, which they can then implement through interdisciplinary practice with other members of their community. This would mean that not only is the project "strengthened by the wealth of input, but the user group is strengthened as well by learning more about itself (Sanoff, 1988, 3). Given the proper tools, this could address front-end design problems within their communities and possibly prevent problems from becoming more complex further along.

Designer Bruce Mau refers to "distributed possibility," which is "the widespread dissemination of design tools, useful knowledge, and expanded capabilities- all being downloaded and passed around as never before." (Bruce Mau, queried in Berger, 2009, p. 203) What is noteworthy about IDEO's *Human Centered Design (HCD) Toolkit* is that it is open source, readily available and free access for anyone to facilitate a project. This brings into question the possibility of further refinement of such toolkits so that perhaps users can facilitate their own techniques for working towards solutions in their own contexts. Further discussion on toolkit criteria can include elements specific to certain cultures, or enlisting community facilitators to guide their own co-design practice within their own community.

5. Conclusion

Sanders writes of a "world made up of the dreams of everyday people" (Sanders, 2000). The face of design is changing in consideration of the rights of users and in the face of social problems that are far too complex. The scope of such problems are often interrelated, and because of this, interdisciplinary research methods need to be applied in order to ensure that proper knowledge and expertise from multiple disciplines can be distributed in order to shape solutions for *systems,* not just single parts of the problem. Designers have a responsibility to involve the user in the design process as they are ultimately affected by the end result and are the most knowledgeable about their own individual experiences. This will further enhance the interdisciplinary design process in socially responsible design through the combination of experts working together on a common goal. Using tools and techniques to facilitate the user through the design process, there is much potential for research into how to further involve the user in the whole process. The effect of applying co-design techniques within socially responsible design can have substantial impact on *empathy*, which increases the value of design, *empowerment* of communities through co-design and expertise, and *education* by designers to further empower communities. Perhaps a world made up of human dreams isn't entirely far off.

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From ontologies to folksonomies. A design-driven approach from complex information to bottom-up knowledge

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Abstract

This paper explores the social challenge posed by the complex environments in relation to knowledge management in which contemporary society and all its activities are immersed. The main question addressed is how information design can contribute to the construction of hybrid, bottom-up and collective ontologies-in-progress and dialogue with the complexity of the practices around the construction of digital knowledge.

We argue that it is necessary for information design strategies to deepen its understanding of the semantic web and the new forms of creation of ontologies. This research seeks to broaden the analysis of the role of information design in this moment of change so that design can find a concrete space of agency in such a scenario.

Information design can develop an essential role in developing more suitable prostheses, more versatile instruments and simpler technologies. That is a great responsibility and a great opportunity. A new design approach is required to dialog with the strategies of a web-based culture, as an example of a complex phaenomenon (Lewin, 1992), among which we can find hybrid, bottom-up and collective ontologies, built *in itinere* with the contribution of users that trace definitions, associations and variations, in a kind of defective semantics, founded on co-tagging, mash-up and syndication.

Design has the possibility to establish a rhetorical of project in order to create a dialogue between the social and the technical tissues. This means not only to produce a toolkit to support new scenarios with sustainable models, but also to suggest a vision of a different cultural apparatus, to offer a new way to online interaction, and new points of access to the knowledge.

Keywords

Design and society; cross, trans, inter, multi-disciplinarity; bottom-up knowledge; creativity.

Introduction: approaching knowledge in web culture

According to Lewin (1992) the web culture can be understood as an example of a complex phenomenon. A system is complex when it displays features like non-linearity (there is no direct relationship between cause and effect), emergence and self-organization, among others. They are open, dynamic, non-mechanical systems that are continuously interweaving and interacting with their surroundings. Although they rarely display long-term periods of stability, they are resilient scale-free network systems. A group directed by Albert-Laszlo Barabasi mapped the connectedness of the Web and found out that the structure of the Web connectivity map conformed to what they called "scale-free network" instead of the more popular model of random connectivity. This approach presents also some features present in fractals and other fields.

> Systems as diverse as genetic networks or the World Wide Web are best described as networks with complex topology. A common property of many large networks is that the vertex connectivities follow a scale-free power-law distribution. This feature is found to be a consequence of the two generic mechanisms that networks expand continuously by the addition of new vertices, and new vertices attach preferentially to already well-connected sites. A model based on these two ingredients reproduces the observed stationary scale-free distributions, indicating that the development of large networks is governed by robust self-organizing phenomena that go beyond the particulars of the individual systems (Barabasi, A. and Reka, A., 1999).

The approach of Barabasi is especially noticeable in the way the propagation and constant growth of the World Wide Web have triggered the development of complex systems to control and manage information. The hierarchical features and ethno-classifications that dominated the first phases in the history of online knowledge are being increasingly substituted by non-linear popular taxonomies (folksonomy) that have been emerging without default relationships among elements nor precise points of departure.

By means of these complex taxonomies social actors self-organize themselves to produce definitions, associations and variations, developing a kind of defective semantics founded on practices such as co-tagging, mash-up and syndication. These practices enable social actors to develop different spontaneous and collaborative forms of "bottom-up" classification (Tapscot and Williams, 2007) according to their own conceptual model.

Among multiple perspectives of innovation and development that sprouted in the last years in relation to that flexible and effective codification of online information there are two perspectives that we would like to highlight. These perspectives (correlated but with independent variables) are the semantic web (Berners-Lee, 2002) and the creation of ontologies (Davies, J.; Fensel, D. and Frank van Harmelen, 2003).

Approaching these concepts, the aim of the paper is to explore the social challenge posed by the complex scenarios in relation to knowledge management in which contemporary society and all its activities are immersed. In this direction the research addresses the question of how information design can contribute to the construction of hybrid, bottom-up and collective ontologies-in-progress and dialogue with the complexity of the practices around the construction of digital knowledge.

Emerging strategies in emergent complexity

Complex systems demand a different attitude that is contrary to the reductionist way that we have been traditionally working within disciplinary borders, by breaking reality into separated parts.

Thus, the emerging strategies in digital reality and the exponential development of the web-based culture, call for a different design approach regarding the spaces of communication, relation and interaction. This implies to listen to different rules in order to create and share information and knowledge that is sensitive to the nature of the system that is complex.

Information design has always tried to deal with this complex field and, as such, should be one of the most flexible and transversal disciplines to respond both to the needs and features of the field, that is to say, to the need of collaboration, creation and sharing of knowledge and the trends in the complex organization of information in the society of knowledge.

This research argues that it is necessary for information design to develop new kind of strategies to deepen its understanding and its approach to the semantic web and to new forms of ontologies definition. The arguments that support this assertion are various. On one hand, the semantic web offers an environment in which all traceable information (pages, files, images, links…) can be associated to specific metadata able to individualize the context and to construct a network of multi-pertinence for each piece of information. On the other hand, ontologies are the structures able to maintain all entities in perfect hierarchical relation (Nirenburg and Raskin, 2004). Both arguments directly relate to the core of design strategies. On the one hand, information design faces the same complex situations that are experienced by the rest of social sectors. Thus it is challenged to broaden its capacity of translating complex information structures and hierarchies into a bottom-up approach to knowledge. This challenge is mostly addressed specially to the areas of conceptual planning and technical implementation. In so doing, information design could transform actual hierarchical structures present in the very categories and relations used in traditional ontologies into flexible bottom-up forms of data classification able to contaminate the whole system, redistributing itself and remapping its own schemas and questions.

Such bottom-up approach supposes a change from a scenario dominated by ontologies into one in which non-linear folksonomies are central and social actors and society shape and classify knowledge.

Semantics and ontologies: a bottom-up design-driven approach

As a result of this research we seek to broaden the analysis of the role of information design in this moment of change so that design can find a concrete space of agency in such a scenario.

We see two basic roles emerging. The first is a role of mediator between the emerging scenario and society. It implies translating the social trend of bottom-up articulation of knowledge into information frameworks that facilitate it and enable social collaboration to increase strongly.

The way information design can do that is by establishing a project's rhetoric that fosters the dialogue between social and technical tissues. That means not only to be able to produce toolkits to support new scenarios with sustainable models, but also to reveal the possibility of a different cultural apparatus, to offer a new way to develop online interaction and to create new points of access to knowledge.

This research aims at showing that information design can be essential in this early phase of a process that sprouted from a communication necessity but turned into a central question in relation to knowledge. Information design can play an essential role in developing more suitable prostheses, more versatile instruments and simpler technologies to improve the possibilities to sustain and support social processes. This is possible to be done in relation to specific practices that consider people as active users or actors in knowledge processes. Processes such as these should be supported by tools, which are designed to enable people not only to define and share personal contents but also the grids that connect (meta-define) information itself.

A design-driven transit from complex information to bottom-up knowledge must consider the different features of the actual scenario that are: (1) people are feeling like being "immersed" in the information flow and not like being only "in front" of it, (2) societies take active part in the process of construction of knowledge and are not limited to the role of receptors of information; (3) all can be "tagged"; not only messages (contents) but also objects (media) and all elements involved in different processes of information construction can deliver contents.

Considering these points social actors/societies change from the passive role of data receivers into the role of active propellers, promoters of information in the net according to social relational ties.

Before exploring how this change could occur, and how the current paradigm enables this variation, it is pertinent to analyse the dynamics of the semantic web and ontologies that make it possible, then to consider the transition towards a bottom-up logic.

Together these two sources of knowledge management are currently the most advanced systems for analysis, creation and distribution of data, but their own structural ideas are based on a monolithic view of organizational hierarchy. This structure should be challenged to provoke a change based on the fact that there are increasingly more possibilities of social interconnection, high-speed feedback, feedback in relation to actions and choices of users and, specially, bottom up management of data classification performed by communities that select, classify and manipulate information.

Semantics is a discipline that, according to various criteria and different approaches, demarcates the parameters of a language, and the conceptual and paradigmatic behaviours of a system. It sketches the formal aspects, but also anticipates the inconsistencies, the displacement field and the extensions of a specific reference domain. In relation to complex scenarios, it reduces the factors to be analyzed by breaking them down and looks for links that constitute the fabric of formal learning. In relation to the world of the Web, and taking into consideration its dimension, it should be noted that the successful implementation of a semantic analysis (and often semiotics) derives, in part, from the fact that the latter practice is concentrated in specific environments[1].

Semantics allows for the understanding of systems and their translation into formal codes that abstracts the fundamental character of their relations, developments and the nature of their behaviour. Serving as a tool it helps spot the merits and logic of a method and also the possible epistemological and systemic misuses of application.

Let's consider the case of semantic web applied to systems like Amazon or e-commerce websites, where each question about a product returns as suggestions relating other similar products that may be of interest to the customer to purchase[2]. There are also cases of search engines that are based on the semantic filtering of information (i.e. Mooter, in Figure 1).

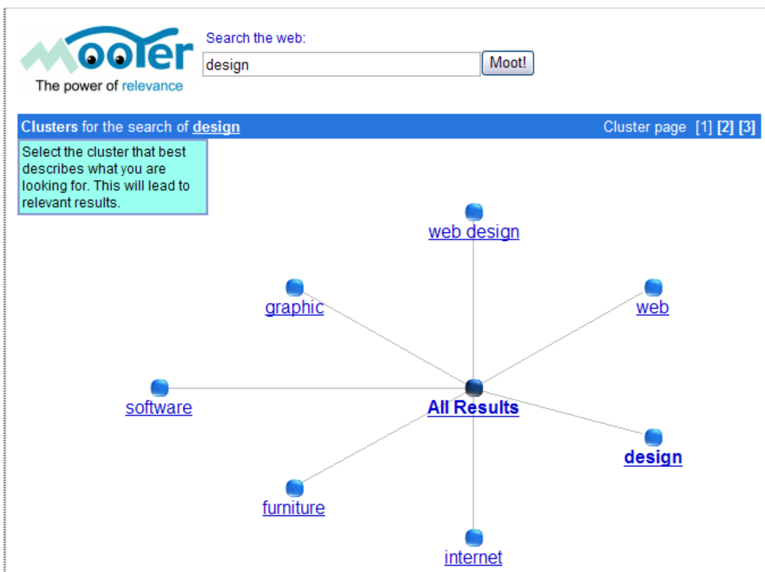

Figure 1. Homepage of Mooter Search Engine, a Website based on an engine for semantic search and content rating.

Thus, when semantics is given the task of outlining the complex linguistic expressions that define the typical or significant features specific to a particular area, it will also mark the content in relation

[1] Cfr. Davies, J., Fensel, D., Van Harmelen, F., *Towards the Semantic Web*, Chichester, John Wiley & Sons, 2003, *passim*.

[2] Do not consider here a similar comparison made by other users and compared with a hypothetical product, but how those products are labelled due to semantic similarities, and how they can be classified and made available to every database query by simply "playing" the characteristics of similarities, themes, quantities, etc.

to which these features are linked, so that they can be associated to "labels" (tags[3]), that are as close as possible to the reality they represent.

The semantic Web, based on the electrical classification of information, thus becomes an environment where information and traceability (pages, files, images, links, etc.) might be associated with metadata[4] that specify the context and build a network of objects that belong to distinct areas.

That process requires a structure able to store and maintain all entities, identified and appropriately "labelled", in perfectly hierarchical relationships. This structure should also provide an exhaustive and rigorous conceptual framework with which to manage relationships, rules, dependencies, symmetries and the specific different domain for which the structure was established.

The configuration logic and substance of a specific domain is called ontology. Although it is a term borrowed from Philosophy[5], in relation to the Web its meaning is no longer focused on the essence and significance of things, but on a particular form of description and classification, which opens and lays out the patterns by means of which things can be incorporated and information reconfigured.

Both ontologies and Semantic Web constitute a unique framework, considered as a complex organism in which information, and the logic that governs information retrieval and archiving, are inseparably united and inter-connected. There are different types of ontologies, all oriented to cover specific needs including some which are constitutive (or higher), disconnected of any application domain, and extended to describe entities in general[6].

What emerges from the consideration of these constructs is the dimension within which they are created, the frame of reference for information management and the very nature of how ontologies have an "embedded" hierarchical scheme developed specifically for self-inclusion. An example of this is the *W3C Semantic Web Layer Cake*, which is not only one of the most popular patterns on the Semantic Web, but also one of the most criticized for having a highly complex and rigorous structure (Figure 2).

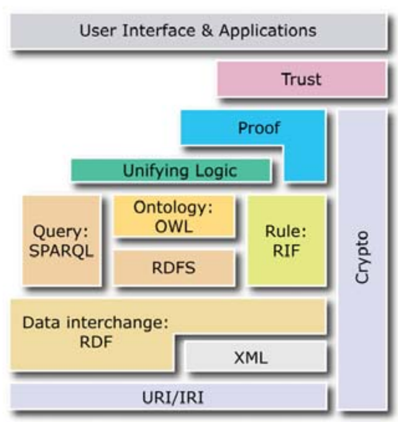

Figure 2. This figure represents the W3C Semantic Web Layer Cake, a very effective scheme based on a rigorous structure for ontologies.

[3] A "tag" is literally a particular label that can be attributed to any item to qualify and create a description outlining the characteristics that distinguish it.

[4] Metadata is literally information about information (*meta*-data, as well as data) used to describe its characteristics. Labels (tags) allow you to identify, locate, filter and get more specific details about a particular item of any type (words, content clusters, files, documents, etc.).

[5] In Philosophy the term ontology (lit. "speech about being") is the study about being as such; for the Web, the term has a branch that involves the construction of an exhaustive and rigorous conceptual framework within a specific domain: a definition that describes with precision the "essence" of a system using the classification and measurement of its key constructs.

[6] Among the most common ontologies is sufficient to recall Cyc, a proprietary system developed as early as 1985 that consists of a constitutive ontology and several specialized domain ontologies; WordNet, a database designed as a semantic network based on the principles of psycholinguistics; SUMO (Suggested Upper Merged Ontology), a project of ontology deployment, which tends to reserve certain words and their meaning for all systems based on the same standard (P1600.1), in the same way that a general ontology (in the philosophical sense) defines "what exists", implying that a hierarchy can be accepted rather than a basic choice.

On the one hand, firstly, the construction of these hierarchical systems ensured the beginning of knowledge formalization in the Web. On the other, different forms of information management appeared: popular taxonomies (folksonomies[7]) allow the development of spontaneous and collaborative forms of "bottom-up" knowledge classification reflecting the conceptual model of users. This is a model free of predefined relationships between elements or specific pre-organized structures.

Redesigning the scenario: towards hybrid ontologies

Considering the idea of the Semantic Web as unattainable, some experts celebrated its death when bottom-up systems of social classification started growing. In fact, the detractors of Web 2.0 are used to consider exhausted the concept of the Semantic Web: the perspective previously outlined shows that the "semantic" approach might be somehow incompatible with the kind of content building process that was considered the original centre of the project.

However, the criticism in relation to the Web 2.0 is not the end of the semantic dimension of information in the network. If fact, it represents the beginning of a challenge related to the re-articulation of the bonds that had been attributed to a "pre-instructed" system of ontologies in order to construct flexible hierarchies, within the limits of specific domains of knowledge.

The change of perspective rests precisely on the imperfect nature of these bonds, which are based on a fluidity that hierarchical systems cannot sustain. This fluidity constantly shapes, defines and translates knowledge processes and practices that occur in social systems of information sharing and has the power to reconfigure the network itself.

Even previous to the assumption of a "collective intelligence"[8], this kind of tag-enabled knowledge management is based on subjective value criteria that reveal the connective[9] shape of people's thinking. That process builds an ontological open form in continuous alteration and semantically flawed.

Information connections, together with the kind of connections typical in social networks, offer a view of how knowledge systems are being organized in the Web: which tools, challenges, drivers and with which forms of technology we are dealing to achieve specific results in empirical applications.

Nova Spivack[10] showed how the current landscape in the Web is not characterized by the decline of the Semantic Web or of an information regimen proper of the system. Spivack says that the Semantic Web is a project to be followed inspired by the position of a society that is aligned with the Web 2.0 but freed from the Semantic Web. It implies a project that points towards a scene in which the systems of semantic search, semantic database, etc., form part of the social web. This is a moment in which we are redefining participation, information and classification tools, and passing from the monolithic and hierarchic system of Web 1.0 to include social networks, media sharing, mash-up, weblog, wiki and all that is redefining the role of the user in the very nucleus of information.

Another element that underlines the role of ontologies in the prospective of "folksonomies" is the actual information management system: designing a process to manage data growth with bottom-up classification methods that reconfigure data without any hierarchies of flow is a natural point of disarticulation between "quantity" and "quality" of information that individuals and groups have to

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[7] The term folksonomy is derived from the words folk (people) and taxonomy and indicates both a collaborative, popular (bottom-up) mode to classify information using keywords (tags), that emerges from the movement of groups that cooperate spontaneously to organize distributed information in the web. It is also a form of ethno-classification or demo-classification (classification people-driven).

[8] Levy, P. 1994, *L'intelligence collective. Pour une antropologie du cyberspace*, Paris: La Découverte.pp. 205-221.

[9] De Kerckhove, D. 1997, *Connected intelligence*, Toronto: Somerville House Publishing, pp. 73-90.

[10] Nova Spivack is is considered one of the leading voices on the next-generation of search, social media, and the Web. Spivack has founded numerous ventures including Twine.com, EarthWeb (now called Dice.com), and Live Matrix (in stealth). He worked with technology ventures like Kurzweil, Individual Inc., and Thinking Machines in the late 1980's and early 1990's. He speaks widely on the future and has co-authored several books on Internet strategy, collective intelligence, and technology.

manage. This means that with the advent of a truly semantic, ontology-based and bottom-up web, able to process information using a folksonomy-driven approach for classification, we will no longer need to use large amounts of data to obtain better information. Rather we will exploit the most suitable data (qualitatively more weighed, marked and labelled) to obtain a result more aligned to what we want.

Let's consider one of the largest existing search engines, Google. No doubt that if you submit a non-precise search without clear filters, it is difficult to get results without being overwhelmed by dozens of pages, among which it is impossible to navigate clearly for lack of a "policy" guide. They are generated and arranged in precise sequences supported by a structure of referrals. Following a realistic process of development, in this situation it is very difficult to bring what we want to focus.

In the near future, the construction of knowledge in the network -either from the viewpoint of conceptual design or the point of view of technical implementation- should take into consideration the arrangements, structures and social dynamics present in the Web. Having more strategies and recombinant grids to share knowledge empower the way people can contribute and beneficiate of knowledge itself.

This implies to align the current hierarchical structure and the bottom-up processes of data classification, making possible the same categories and relations that are present in traditional ontological systems. This means coming to postulate and implement "hybrid" ontologies based on arbitrary starting structures, according to the domain in which they serve, and incorporating users.

The process of collaborative tagging as a turning point: towards hybrid ontologies

The construction of software systems has always required the adoption of specific programming languages consisting in re-defined or pre-arranged codes. The Web galaxy is no exception to that when considered as a complex environment based on different kinds of software that operates by means of its own codes. However, unlike a programming language, in order to participate in the construction of information in the actual Web galaxy it is not essential neither to build specific processes and to manage and elaborate different languages, nor to have particular technical skills and competencies. There are open-platforms, social software, aggregators, user-generated systems, etc., which allow communities to self-organize in relation to information simply by (re)arranging the structure of pages to be displayed on screens and the relationship between (self-generated) contents.

The uniqueness of this organization, introduced firstly related to a basic language like HTML and then, in the late nineties, radically changed by the social approach to the Web, is to use "labels", known as tags. Tags describe each component on a page, giving it a formal role, functionality or value. From these initial steps related to the dawn of the World Wide Web, many steps forward emerged. In addition to evolution of codes there has been a gradual evolution of classification systems and labelling means, until a change of perspective was brought by the introduction of a new coding language like XML.

The concept of tags, a simple but effective system, not only allowed a profound evolution in programme languages for the Web, but are also emerging as social tools for defining bottom-up information.

In fact, due to its potential, tagging is challenging the traditional channels and methods of construction of knowledge in the network, by making "liquid architectures" of which has always been based on the hierarchy and the predetermination of their own apparatus of incorporation. In fact, these hierarchies are weaker because, by the tagging of one or more elements, people can potentially classify any content. It is possible to create layers between elements and then, meta-layers, and meta-meta-layers, and so on, until the tagging completely re-ontologize the system.

This process suggests another special feature of the labels, namely their strong ability to adapt to contexts of application. In fact, in the Web, with the evolution of the connective participation of users, a tag has a significance that goes beyond simple keywords and page-code structures: labels are directly exploited by users to sort and classify their contents and those of others, without following any hierarchical or scientific rule, but simply by referring to their needs and to an idiographic modus operandi.

Folksonomy, as a method of classifying, refers to communities but is completely personal and customizable. It expresses a form of digital identity of individuals, who, as members of a group (broad or narrow), contribute to shape it according to self-organizing rules, which emerge spontaneously during the connective process of the tagging itself.

Regarding that, David Weinberger[11] offers s a very eloquent example. Weinenberg underlines that if we are in a supermarket, the possible relations between a product and another may be multiple and different for everyone but, because of the fundamental bond of physicality, the products may be placed on one, or a maximum two similar shelves. On the Web, using a tag, and thanks to digital contents, each object can relate to a multitude of others, according to an order that is customizable and scalable.

This characteristic clearly shows how each individual is free to manage and organize information, creating relationships between them and the external sphere of possible links of information. It is interesting to note that categories and hierarchies loose strength and consensus in a social apparatus that tends to overcome them. This self-organizing bottom-up approach to knowledge destabilises the grids of information architectures and substitutes them with liquid forms of relation and different layers of meta-information which are able to create their own order through disorder and emergency.

In fact, different people classify resources in different ways and make different use of them. In addition, similar concepts can be represented with different labels, in many languages and with different kinds of approach.

This property clearly shows that there are languages that can evolve and be structured by the simple phenomenon of tagging, allowing each individual to spontaneously define anything by means of his/her (but shared) language model. The moment this happens all denoted meaning may collapse or evolve, changing the dimension of meaning and significant according to a dynamic logic based on bottom-up understanding, tolerance and trends. In fact, it is enough if a group considers that a new label, or a particular tag is reliable for a specific term to be adopted as common language in the Web.

These considerations suggest that bottom-up classifications are usually successful only when a large number of users tag the same information. The “mass” (*folk*) decides about the most representative and credible keyword and about content in a spontaneous democratic and transparent way, according to a natural and direct principle of self-elimination or collective dismissal.

Thanks to these assumptions, folksonomies are transformed into a fast, distributed and scalable form of information classification, in which the process of indexing not only enables users to produce new forms of aggregation but also questions the validity of any hierarchical ontology. This approach also introduces a change in the method of finding information, -deconstructed and reassembled into descriptive metadata- that goes beyond the original value of a unique and arbitrary classification model. This is changing not only in terms of meaning and significant, but also in relation to the mechanisms of access: social tagging exploits a mechanism of “browsing” that is based on the identification of content through keywords, rather than by index scan, which is established in the “finding” procedure, common to many systems for mapping, tracking and retrieving data network.

The same is valid in relation to information and interaction processes that enable discovery, and possible further classification of information. These processes bring a change in the game of communication which not only alters the message contents but also the paradigm relating to management and meaning, impacting all actors involved.

This change has introduced new forms of visualization and interface, promoting the development of innovative graphical models such as tag-cloud, a visual presentation of labels, which uses a recursion of terms that is measured by the size of a tag-source for determining the level of importance.

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[11] Weinberger, D. 2007, *Everything is miscellaneous*, New York: Time Books, *passim*.

Another effect of this change has been the phenomenon of serendipity, or the ability to discover something unexpected in the process of looking for something else. This peculiarity shows that tagging is becoming an increasingly essential component of the Web. In fact, the dissemination of folksonomies in various social networks inevitably leads to a different variation of tags in relation to proxemics[12], or distance of interaction.

This means, for example, that the search for a video in a system like Youtube, when we use one or more keywords, may often not give the desired result but is more likely to simultaneously provide a certain number of clips. This process suggests that the very tags trigger greater cross-fertilization and completeness levels in data search, through the variables of relevance, redundancy and recurrence.

In this scenario, contents are enjoyed in a scalable multiple level manner, thanks to the dynamism of bottom-up processes, which are curiously aligned to complex adaptive systems. That means that the structure and connections in the Web display a behaviour that is similar to complex systems. The analysis of folksonomies-in-process can determine and describe this behaviour and processes of change.

Tagging, as noted, has successfully been adapted to the realm of the network and the digital world, and it is important to stress the weight it occupies in everyday life. This process, firstly related to the Web, is now being extended to any process of reality: RFID systems label everyday world, making it possible to identify, through radio frequencies, the objects equipped with RFID-tags. In this way, objects can be recognized and tracked according to position changes. Right now, although RFID-tags are not widely employed they have a great potentiality to be used in marketing and integration. In fact, they represent both the best channel for user profiles and the most effective one for communication between objects (or systems software).

Therefore, it is inevitable to note that labels, whatever the form, are playing a major, if not a decisive role, in the development and creation of new software, hardware, and in new processes in information and knowledge construction.

Conclusion. Design open rules for information: tag mash-up for an “imperfect semantic”

The multiple challenges posed by the successes and failures of the Semantic Web trigger a need to take a new step towards a different approach in relation to online information and its “liquid” shape: it is necessary to facilitate and, in some cases, to provoke a paradigm shift in relation to the hierarchical structure of the system, leading users to a new dimension in the social construction of knowledge.

Based on an user-centered definition of innovation, it is clear that the Semantic Web project -as it is outlined in the manifesto of its inventor Tim Berners-Lee-, brought a gradual change in the concept of knowledge management, especially when it comes to make available and distributed online information.

The development of this new social form of use of the Web seems to result from the permeation of the network’s capillary level, fostered by the distribution of open-source code, the employment of systems that allow for the sharing of any type of resource and a social attitude to create and manage relations by means of online tools. These factors led users to be able to regain possession of a heritage that is theirs by right.

This was not the case in relation to the question of content, but rather in relation to what kind of media and platforms are made available in the phenomenon of social software: everything starts from a need to communicate, not from the subject of knowledge, and then people exploit the most suitable prosthesis, the most versatile tools and the most available technologies to define which tools can be used in the process of knowledge sharing.

The consequences, or the beginnings, of this phenomenon constitute the currently scenery:

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[12] The term proxemics was created by Edward T. Hall to describe a set of measurable distances between people as they interact (Hall, E.T., *The hidden dimension*, Garden City, N.Y., Doubleday, 1966).

- People are feeling “immersed” in the information flow and not just “in front” of it;
- Users became active parts in the process of knowledge construction, apart from being receptors and distributers (users became actors);
- Not only contents but also all entities and things are involved in the information process (i.e. objects, environments, etc.);
- Unique conceptual hierarchies and classifications can no longer be enough to describe a reality that is constantly changing.

By analysing the implications of that scale phenomena we see that users became not only a patron but also an active propeller in the information network, updating the first forms of co-authoring in the age of hypertext.

This oversized semantic shapes a new way of knowledge building that can no longer rest only on language dimension, semiosis, structural constraints or revived special structural data ties, but should also take into consideration the trends and drivers that have led to specific results, or to evaluate certain goals.

In this moment of indefinite proliferation of groups, which aggregate and separate according to complex and non measurable phases, links built between statements, terms, concepts and data clusters are born and die when the collective attention is focused on them and reconfigure their scope, contents and their very labels. Unstable information links result from these “bottom-up labels” that reflect how online communities accept and determine values. This produces proliferation of metadata and the redefinition of contents according to their cognitive matrix.

The result of all these processes is a form of semantics declined according to the impulses, attractions and polarities that happen between users that reconfigure the very network, since no hierarchical structure can control a process that falls within its same patterns of demarcation and classification.

An imperfect unstructured semantic emerges. It is a kind of semantic that is longer based on models of heuristics and linguistic processes, but on a mash-up of tags and syndication, that characterizes the dynamics of a projective and unpredictable mass collective action based on communities of users on the network.

It is necessary for information design to understand both, the processes present in the semantic web -as an environment in which all traceable information (pages, files, images, links…) can be associated to specific metadata able to individualize context and to construct a network of multipertinence for each piece of information- and the new forms of creation of ontologies, understood as structures able to maintain all entities in hierarchical relation (Nirenburg and Raskin, 2004).

Both dimensions directly relate to the core of design strategies. On the one hand, because information design faces the same complex situations that are experienced by the rest of social sectors and thus is challenged to broaden its capacity of translating complex information structures and hierarchies into a bottom-up approach to knowledge. This challenge is mostly addressed specially to the areas of conceptual planning and technical implementation. In so doing information design could transform actual hierarchical structures, present in the very categories and relations used in traditional ontologies, into flexible bottom-up forms of data classification able to contaminate the whole system, redistributing itself and remapping its own schemas and questions.

In synthesis, such bottom-up approach supposes a change from a paradigm dominated by ontologies into one in which non-lineal folksonomies are central and social actors and society shape and classify knowledge. In this scenario information design can find a concrete space of agency, in special, assuming the role of mediator between that emerging social media and society. This implies translating the social trends into information frameworks to improve social collaboration.

That can be achieved by (1) establishing a project’s rhetoric that fosters the dialogue between social and technical tissues. This requires to develop research that is focused on the articulation of social-technological dimensions; (2) developing more suitable prostheses, more versatile instruments and simpler technologies; (3) being aware of the responsibility that is in the hand of information design to define and discriminate what can start any grid of the shareable knowledge; (4) learning to listen and to be supportive of social processes.

That is a moment of great responsibility and extraordinary opportunity to perform the transit between different conceptions of social information and knowledge. Information design should consider at least these three different dimensions of the actual scenario: (1) how people feel in relation to knowledge (immersed)"; (2) how knowledge is constructed (bottom-up), and (3) what can be included in the process of electronic knowledge (contents, objects, environments, products, etc.).

This challenge can help society to find new ways to create information online: it can redefine systems in order to serve society to create social deals and offer a totally bottom-up knowledge toolkit to empower people.

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Dynamique des ambiances lumineuses par relevés vidéo d'espaces de transition

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Abstract

Natural light characterizes architecture in a complex manner, especially when considering its fluctuations and variations whenever we experience a transition or passage from a space to another. It also influences the comfort and the well-being of its occupants. This visual adaptation appears in a process that is translated into a spatio-temporal dynamics implying body movement from space to space. The literature review recognizes the lack of knowledge in the relation light-space-time. This research proposes to study this spatio-temporal relation existing between light and architectural space, to qualify an architectural *promenade*. It proposes to reconsider the design of transitional spaces by the spatio-temporal analysis of light, through *in situ* experimentation including filmic segments. The studied variables of this research take into account the qualitative and quantitative aspects of light such as luminance, time, contrast and brightness. It combines the use of a luminance-meter, a camcorder and the analysis of numerical images as a starting point for the assessment of spatio-temporal qualities of light. The resulting analysis, as well as the visualization of the dynamic experience of visual ambiances, will allow a classification of luminous transitional experiences. The architectural *promenade* is analyzed according to the diversity and relative intensity of luminous ambiances in relation to time, which allows the development of a descriptive analysis of visual perceptions through spatial transitions. This method of analysis and dynamic representation offers a potential to favour the design of spaces while encouraging and applying principles of luminous diversity in architecture.

Keywords

Transitional spaces, contrast, video, images analysis, visual adaptation, Light, daylighting

Résumé

La lumière naturelle dans un bâtiment avec ses fluctuations et ses variations lors du passage d'un espace à un autre, caractérise de manière complexe, mais importante le design d'un bâtiment. Elle influe sur le confort et le bien-être de ses occupants. Cette adaptation visuelle s'inscrit dans un processus qui se traduit par une dynamique spatio-temporelle impliquant le mouvement du corps d'un espace à un autre. La littérature fait état du peu de connaissances en ce qui a trait à la relation lumière-espace-temps. Cette recherche propose donc d'étudier cette relation spatio-temporelle existant entre la lumière et l'espace architectural, afin de qualifier un parcours architectural. Elle propose de reconsidérer le design des espaces transitions, par l'analyse spatio-temporelle de la lumière, au moyen d'une expérimentation en milieu *in situ* et de segments filmiques. Les variables étudiées lors de cette recherche prennent en compte les aspects qualitatifs et quantitatifs de la lumière tels que la luminance, le temps, le contraste et la brillance. Elle combine l'utilisation d'un luminance-mètre, d'une caméra vidéo et d'une méthode d'analyse d'images numériques comme point de départ pour l'évaluation des qualités spatio-temporelles de la lumière. L'analyse résultante ainsi que la visualisation dynamique des ambiances lumineuses permettent une classification des ambiances lumineuses. Le parcours architectural est analysé en fonction de la diversité et de l'intensité des ambiances lumineuses en fonction du temps, ce qui permet de développer une analyse descriptive des perceptions visuelles d'espaces transitions. Cette méthode d'analyse et de représentation dynamique offre donc un potentiel aux concepteurs désireux d'enrichir le design d'espaces en favorisant la diversité lumineuse dans l'expérience architecturale.

Mots clefs

Espaces transitions, contraste, vidéo, analyse d'images, adaptation visuelle, Lumière, éclairage

Le design d'un espace éclairé naturellement tient à la fois compte de la performance énergétique du bâtiment, mais considère également de la recherche de confort visuel pour ses occupants. Par contre, le design en relation à la lumière naturelle demeure l'un des champs de recherche les moins développés en ce qui a trait à l'analyse qualitative de l'environnement intérieur en relation à des données quantitatives. Par exemple, le facteur lumière du jour (FLJ), largement utilisé pour caractériser les espaces éclairés naturellement, est maintenant reconnu comme mesure déficiente autant d'un point de vue qualitatif que quantitatif [1]. Les défis reliés au design de bâtiments éclairés naturellement dépendent donc de la capacité des architectes à optimiser la performance et le confort visuel des espaces. Cette optimisation doit prendre en considération que la perception de l'architecture se vit notamment par la dimension spatio-temporelle de la lumière naturelle impliquant le mouvement. En ce sens, les espaces de transition sont des lieux privilégiés en architecture puisqu'ils permettent d'expérimenter la diversité de la lumière lors de transitions lumineuses, permettant l'adaptation visuelle des usagers. En effet, s'ils sont bien conçus, ces espaces transitions servent à expérimenter les seuils de caractéristiques lumineuses particulières et provoquer des situations complexes et visuellement stimulantes de diversité environnementale. Les espaces de transition peuvent prendre plusieurs formes et accueillir plusieurs usages, tels foyers, lobbies, atriums, corridors et tous les autres espaces où les gens circulent entre l'intérieur et l'extérieur [2]. Le seuil entre deux espaces devient donc un élément fondamental dans le potentiel expérientiel, car il peut s'exprimer de façon graduelle ou soudaine, rendant la transition plus ou moins confortable. Ce type d'endroit constitue un lieu d'étude important afin de comprendre le processus de perception et d'adaptation visuelles. Si celui-ci est fortement étudié en relation à la notion de temps, peu de recherches ont été développées afin d'étudier le comportement lumineux de manière dynamique. Alors que la photographie, le film, l'architecture et les arts ont toujours reconnu la nature dynamique de la lumière et ses qualités, la communauté scientifique a tenté de simplifier cette relation, en n'arrivant toutefois à aucun modèle suffisant pour supporter l'analyse dynamique de la lumière en architecture. Cette recherche se veut donc une nouvelle approche dans l'analyse de la lumière naturelle, reconnaissant sa nature dynamique dans le contexte d'un parcours architectural, et ciblant de manière expériencielle l'analyse de l'environnement visuel d'un occupant. Les auteurs proposent la mise au point d'un outil d'analyse vidéo qui permettra d'évaluer et de caractériser la qualité lumineuse de façon dynamique des espaces de transitions, et ce, dans le but d'alimenter le processus décisionnel en phase préliminaire de design. Elle s'inscrit dans une volonté d'approfondir les connaissances sur la dynamique des ambiances lumineuses architecturales, un domaine encore peu étudié puisque les paramètres impliqués dans les phénomènes de transition, de perception et de lumière naturelle sont multiples. À cet égard, la méthode digitale proposée permet de simplifier le processus d'analyse et de représentation de ce phénomène complexe.

Lumière, architecture et mouvement

Lorsque nous regardons le monde qui nous entoure, la lumière qui entre par la pupille passe au travers une série de processus mentaux qui convertissent le patron visuel en une perception du monde comme nous le connaissons [3]. Ainsi, ce patron visuel n'est pas statique, mais il est continuellement en mouvement [4]. En fait, Arnheim [5] décrit l'architecture dynamique par : "The visitor experiences not only a sequence of sights but the constant gradual transformation created by perspective and lighting in every wall and constellation of elements" (Arnheim,R.,1974, p.11). L'architecture dépend donc littéralement de la lumière, qui révèle la forme, l'espace, et simultanément dévoile le sens et les intentions qu'ont imaginés les architectes lors de la conception. La lumière peut améliorer l'expérience de l'architecture, en dévoilant la structure, les matériaux, les textures afin de permettre l'orientation, le focus et l'expérience du temps. Le résultat d'une interaction entre une ou des lumières, un individu, un espace et un usage peut ainsi être décrit comme une ambiance lumineuse [6]. Cette interaction influence momentanément ou durablement la perception du lieu éclairé [6]. La caractérisation d'une ambiance lumineuse est complexe, car elle fait intervenir divers paramètres physiologiques, psychologiques et culturels. L'éclairage à l'origine de ces diverses ambiances lumineuses se mesure grâce aux valeurs photométriques (intensité lumineuse, éclairement, luminance, uniformité, contraste). Par contre, la mesure des ambiances lumineuses fait intervenir des éléments de perceptions plus subjectifs qui font appel à l'appréciation individuelle [6].

Afin de qualifier et quantifier cette perception lumineuse, il est généralement admis d'utiliser une sonde photométrique qui mesure la luminance à certains points de l'espace [7,8]. Ces types de mesures statiques constituent un frein à une compréhension de la lumière comme phénomène dynamique, car elles ne permettent pas une visualisation de l'interaction de la lumière avec l'espace. Déjà en 1980, Derrick Kendrick énonçait l'importance de considérer le rôle prépondérant de la nature dynamique de la lumière naturelle dans un bâtiment [9]. Alors qu'en 1997, Fontoynont soulignait que nous atteindrions les limites des représentations statiques en lien avec la nécessité de représenter l'usager en interaction avec son environnement [10]. En ce sens, la lumière naturelle est une lumière très variable qui peut atteindre sur la façade d'un bâtiment, 100 000 lux par journée ensoleillée et diminuer à quelques centaines de lux lorsque le ciel est couvert [11]. Généralement, lorsque la fréquence et l'écart entre les changements de stimulus dans la distribution lumineuse sont trop élevés, l'œil ne suffit pas et s'en suit une confusion dans l'analyse de l'espace. Ceci peut causer : l'échauffement et l'écoulement des yeux, des douleurs, des maux de tête, des migraines, de la confusion perceptuelle et des étourdissements [7,12]. La présence de la lumière naturelle dans un bâtiment avec ses fluctuations et ses variations lors du passage d'un espace à un autre caractérise le design d'un bâtiment ainsi que le confort et le bien-être de ses occupants. Dans un parcours architectural, les variations temporelles et visuellement perceptibles de la lumière qui sont dépendantes du design du bâtiment sont considérées dans le cadre de cet article comme étant des dynamiques lumineuses. Dans ce contexte, les architectes doivent être conscients du rôle qu'ils occupent dans la conception d'espaces qui sont soumis à cette dynamique lumineuse [7].

Il paraît alors improbable d'arriver à une définition d'un espace durable d'un point de vue de la qualité lumineuse en utilisant des facteurs mathématiques qui ne tiennent pas en compte la perception de l'espace. L'adaptation visuelle peut être définie comme étant le changement de sensibilité à un patron lumineux résultant d'une exposition prolongée à ce même patron [13]. Par conséquent, l'habileté avec laquelle les individus s'adaptent aux conditions dynamiques de la lumière est très importante [7,13]. En fait, nous nous basons principalement sur la perception visuelle de l'espace lorsque nous nous déplaçons dans un environnement, car, le système visuel est plus sensible aux changements qu'aux conditions stables [14]. Le mouvement et la vitesse sont des paramètres qui influencent grandement notre perception de l'environnement. Ceci est observable, non seulement selon des caractères spatiaux, mais aussi selon le temps [15]. La vidéo constitue de nos jours, une méthode de représentation des espaces qui se rapproche le plus de la réalité perceptuelle des usagers. En effet, elle permet de comprendre l'espace dans son ensemble, d'avoir une représentation des textures, des luminances (horizontales et verticales), des contrastes, et ce, modulé dans le temps. L'analyse de la vidéo, comme outils de représentation et d'analyse de la lumière, permet ainsi une simplification de la représentation et de l'analyse. De plus, contrairement à la photographie, ce médium offre l'avantage d'un continuum de prises de vue (30 images par secondes), et ce, sans interventions manuelles du cameraman sur les paramètres d'une scène (ouvertures, temps d'exposition, etc.). Ces paramètres automatisés par la caméra, donnent la possibilité d'enregistrer de façon presque impersonnelle une progression dans un espace. La prise de relevés vidéo suggère aussi la potentialité d'aborder la problématique selon une approche d'analyse spatiale différente qui tient compte des aspects qualitatifs (l'image) et des aspects quantitatifs (les valeurs numériques des pixels).

Cette recherche, propose l'intégration des variables qualitatives par l'analyse numérique d'images vidéo et des variables quantitatives qui peuvent y être extraites par la corrélation avec la luminance, le temps, le contraste et la brillance.

Méthode

Le développement des technologies numériques, de nos connaissances sur les espaces transitions ainsi que l'utilisation maintenant courante de la vidéo numérique rendent la création d'une interface d'analyse de l'image en mouvement possible. La méthodologie la plus appropriée pour étudier un phénomène complexe, comme le sont les ambiances lumineuses dans les espaces transitions, est une évaluation impliquant un relevé in situ [16]. Fondamentalement, la méthode consiste à utiliser la caméra vidéo digitale, de filmer un parcours *in situ* et d'en étudier les images calibrées résultantes afin d'en faire un schéma des caractéristiques lumineuses.

Le bâtiment à l'étude est le séminaire de Québec, situé en plein cœur du quartier historique de la ville de Québec. Il est considéré comme l'un des plus anciens en Amérique du Nord et comporte des caractéristiques spatiales particulières. En effet, il est constitué d'une façade possédant un albédo très élevé, des murs très épais (0,75 m.

à 1 m.), une variété élevée de types d'ambiances lumineuses, un hall d'entrée complètement fermé avec peu d'ouvertures ainsi qu'une fenestration répétée qui rythme la façade. Les relevés, présentés aux figures 2 et 3, ont eu lieu le 27 septembre 2009, à 12h00, par une journée de ciel complètement dégagée, afin d'éliminer les variabilités occasionnées par des passages nuageux. Cette date correspond, à la journée la plus près de l'équinoxe d'automne, soit lorsque le centre du Soleil est exactement à la verticale d'un point de l'équateur de la Terre. Cette évaluation *in situ* comporte trois grandes étapes décrites subséquemment, soient :

— Repérage (Prise de données quantitatives)
— Tournage de la Séquence filmique (Prise de données qualitatives)
— Analyse des données

Le repérage (Prise de données quantitatives)

Cette étape consiste principalement à établir un parcours architectural qui débute à l'extérieur du bâtiment à l'étude, se poursuit dans l'espace transition, pour se terminer à l'intérieur du bâtiment. Ce parcours est établi dans le but d'obtenir le plus de variabilité d'ambiances lumineuses. Les figures 2 et 3 démontrent le parcours établi dans le cadre de cette étude entre le point A, situé à l'extérieur du bâtiment et le point F, situé à l'intérieur du bâtiment.

Une fois ce parcours établi, il est alors possible de déterminer les endroits de faible et de forte luminance tout au long du parcours. Cette étape fait intervenir l'utilisation d'un luminance-mètre afin de calibrer ultérieurement les images vidéo en fonction de leurs luminances, une donnée qui permettra de quantifier les brillances relatives dans le champ visuel des images. La luminance d'une source est le rapport entre l'intensité lumineuse émise dans une direction et la surface apparente de la source lumineuse dans la direction considérée, cette mesure s'exprime en candélas par mètre carré (cd/m^2) [17]. Les données de brillance des images seront utilisées pour mesurer le contraste entre des éléments du champ visuel, ainsi que le contraste globalement perçu entre deux espaces. Il s'agit de sélectionner dans la scène, deux zones, une sombre et une seconde plus brillante, tel qu'il est illustré par la figure 1. Il est important de choisir ces zones de tailles raisonnables, d'une luminance constante, utiles et facilement identifiables au sein de l'image. Il s'agit de prendre la luminance de ces zones, les enregistrer et de noter l'endroit exact de la prise de mesure.

Tournage de la Séquence filmique (Prise de données qualitatives)

La seconde étape consiste à filmer le parcours architectural à l'aide d'une caméra vidéo numérique. Cette étape est relativement simple, mais nécessite tout de même une grande rigueur dans sa planification. En effet, bien que la majorité des caméras numériques soient dotées de stabilisateurs d'images intégrés, il est important d'optimiser la stabilité de la caméra, afin d'obtenir une image de plus grande qualité [18]. De plus, le tournage doit s'effectuer avec un pas régulier et standard d'environ 1m/sec [19], afin de représenter le déplacement de la majorité des usagers. Puisque cette recherche se veut également quantitative, le réglage d'exposition automatique intégré à la caméra sera utilisé pour effectuer la prise de données et l'interprétation de la brillance. La brillance d'une image correspond à la luminosité d'une scène qui est un attribut d'une sensation visuelle selon lequel une surface paraît émettre plus ou moins de lumière [20]. À cet égard, il est important de rappeler que l'œil humain possède un temps d'adaptation visuel différent de celui du système numérique utilisé. En effet, dans le diaphragme mécanique, le temps d'adaptation à la lumière pour rendre efficacement une scène s'établit en fractions de secondes comparativement au système rétinien qui prend plus de temps à effectuer le même travail. L'adaptation complète de l'œil passant de la lumière du soleil à des luminances intérieures cent fois plus faible demande environ 20-30 minutes, bien que 70% de l'adaptation soient réalisés après 90 secondes [21]. Mais si l'espace intérieur est éclairé naturellement, l'adaptation y est deux fois plus rapide. De plus, le temps d'adaptation varie d'un individu à un autre [13-21]. Il est aussi possible d'établir que chaque caméra numérique possède un système de capteurs de la lumière différent. Dans le cadre de cette recherche, les auteurs énoncent l'hypothèse que la caméra vidéo représente un système d'adaptation lumineux parmi ceux de l'œil humain.

Analyses des données

Bien que la brillance d'une image soit un phénomène à première vue subjectif, il est par contre possible d'établir une relation entre la luminosité d'une image et la luminance qui elle, est quantifiable [22]. Cette recherche se base principalement sur une méthode qui intègre le contraste et la luminosité afin de permettre un classement lumineux qualitatif et quantitatif de la vidéo. Pour ce faire, la vidéo est alors traitée à l'aide du logiciel ImageGrab41fr. Ce logiciel permet d'extraire des images d'une vidéo tout en conservant les propriétés de luminosité et de contrastes. L'expérimentation requiert l'extraction d'une image toutes les secondes, ce qui équivaut à 1 mètre de distance parcourue, la vitesse de marche étant de 1 mètre par seconde. Une fois ces images obtenues, elles sont alors traitées par automatisation à l'aide de la fonction traitement par lots dans le logiciel Photoshop. Cette automatisation consiste en un changement de la dimension des images à 320(w) x 240(h), la transformation de l'image à l'aide de la fonction isohélie en 5 tons de gris puis finalement de sauvegarder l'image en format RAW. La transformation d'une image en cinq (5) tons de gris permet une décomposition en cinq (5) zones (0 %,25 %,50 %,75 % et 100 %) de la luminosité. Ceci a pour effet d'abstraire une certaine réalité perceptible pour se concentrer sur la composition lumineuse de l'image [22]. L'ensemble des images est par la suite, modifié en utilisant le logiciel Rascal, qui permet l'extraction des valeurs de chaque pixel en valeurs numériques. L'ensemble des valeurs numériques des images est alors analysé par le tableur Excel Culplite qui permet d'attribuer une valeur de luminance à une valeur numérique d'un pixel [23]. L'utilisation de ce processus permet donc l'établissement d'un rapport entre la luminosité d'une image et la luminance mesurée en milieu réel à l'aide du luminance-mètre. L'image résultante est donc calibrée en fonction de la luminance.

Cette série d'images est alors évaluée en fonction des valeurs de la moyenne et de l'écart-type des valeurs des pixels extraites des images. Ce type d'évaluation de l'image est possible en regardant l'évolution de l'histogramme d'une image. La mesure du contraste, qui correspond à une évaluation de la différence de deux ou plusieurs parties du champ observé, peut être extrapolée en utilisant les valeurs de l'écart-type dans cet histogramme alors que la moyenne des pixels d'une image représente la luminosité [24-25]. Les données obtenues par le biais du logiciel Adobe Photoshop et celles de l'analyse des images faite par Culplite sont utilisées pour générer la valeur correspondante à la valeur de la moyenne de l'image (brillance) et celle de l'écart-type (contraste) en cd/m². L'ensemble de ces données est compilé sous forme d'un graphique (voir figure 1), qui exprime l'évolution de la brillance (luminance) et du contraste d'un parcours architectural en fonction du temps.

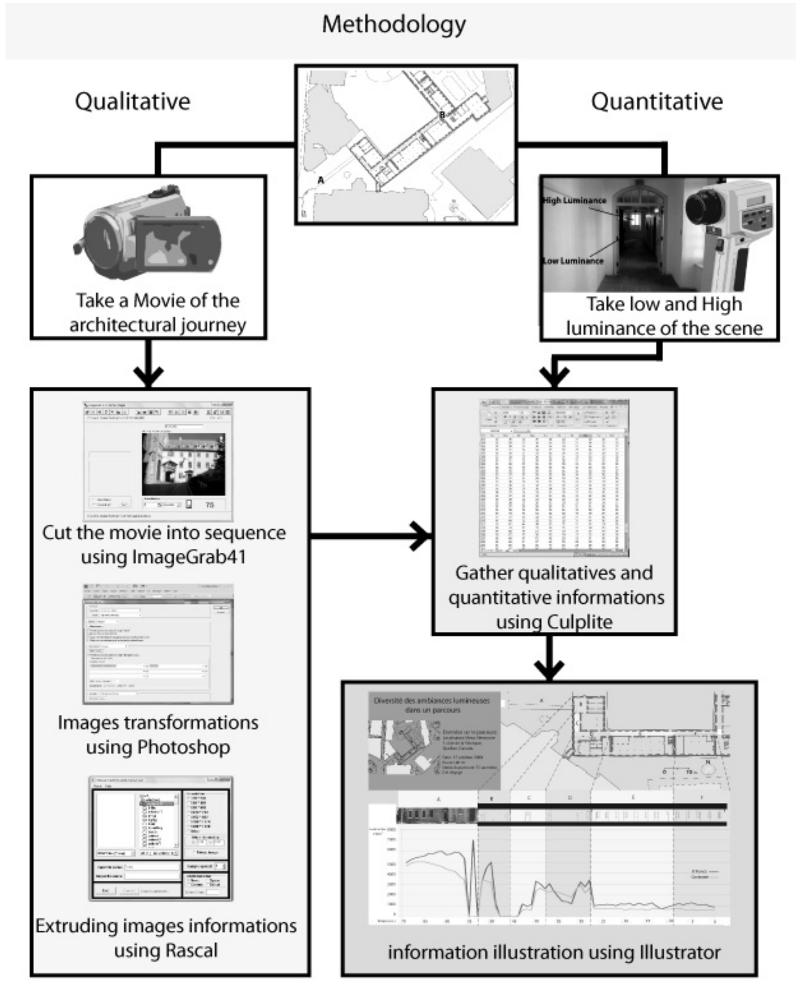

Figure 1 : Méthode d'acquisition de la dynamique des ambiances lumineuse.

Analyse des résultats

La figure 2 illustre la variabilité des ambiances lumineuses dans le parcours architectural effectué de l'extérieur vers l'intérieur, entre le point A et le point F alors que la figure 3 représente un parcours en sens inverse, soit de F vers A. Le parcours a été effectué dans les deux sens afin de comparer la perception lumineuse d'un même espace, mais avec une orientation différente.

L'évolution des valeurs de brillance et de contraste dans la section A, B et C des figures 2 et 3, permet de représenter la relation intérieure-extérieure de manière graphique et offre une analyse globale du phénomène complexe de transitions-espace-lumière. En effet, ces sections du parcours représentent la principale zone d'adaptation lumineuse lors d'un passage entre l'extérieur et l'intérieur. Ces portions du parcours démontrent une plus grande variation dans l'évolution des valeurs de brillance et de contraste, comparativement à la suite du parcours. Si on se réfère à la définition de l'adaptation, laquelle indique un changement de sensibilité à un patron lumineux résultant d'une exposition prolongée à ce même patron [13], l'œil devrait donc s'adapter, dans cette section du parcours, à un grand écart de luminosité et de contraste.

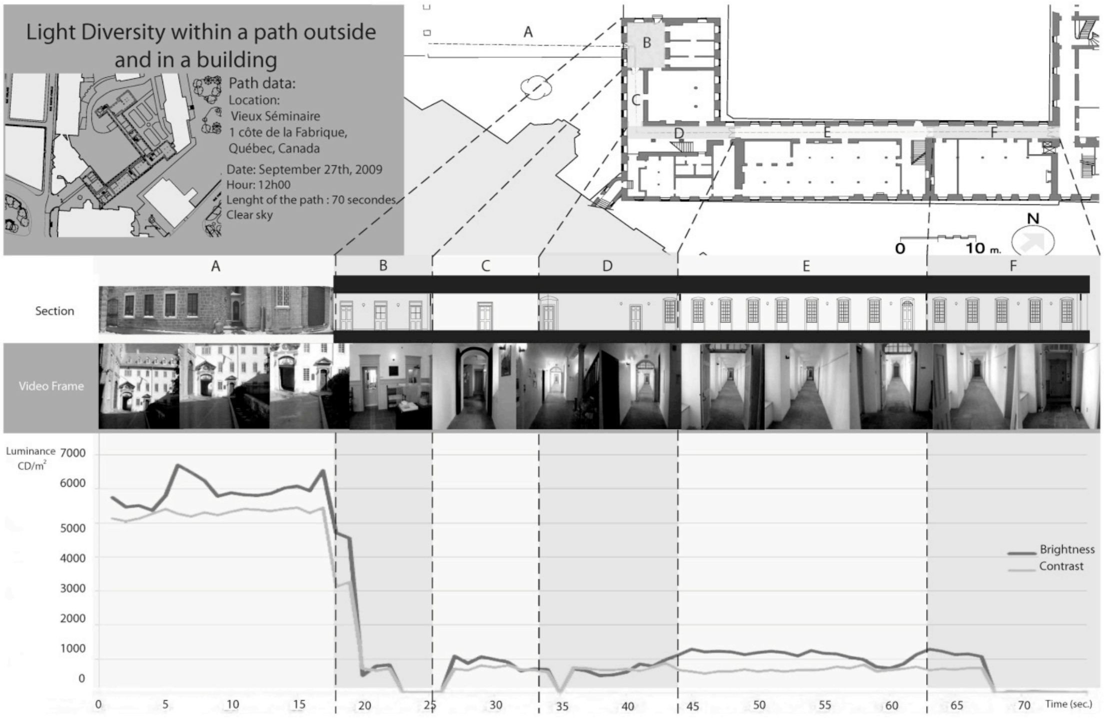

Figure 2 : Distribution de la luminosité et du contraste selon le temps dans un parcours architectural de A vers F.

Les figures 2 et 3 démontrent également que la brillance et le contraste dans les images du parcours varient en fonction du temps. En effet, dans la figure 2, on peut apercevoir que dans l'espace A, bien que nous circulons dans un même espace, nous observons une variation de la brillance et du contraste dans le temps. Les valeurs des moyennes de la brillance des images varient de 6490 cd/m² à 7 secondes, 5800 cd/m² à 11 secondes, à 6555 cd/m² à 17 secondes et 4720 cd/m² à 18 secondes. Ces variations sont trop importantes pour qualifier qu'une seule ambiance lumineuse. On peut donc avancer l'hypothèse que cet espace pourrait contenir 4 ambiances lumineuses différentes. Celles-ci correspondent aux deux pointes, à 7 secondes et 18 secondes, de la courbe de la brillance en fonction du temps dans la section A de la figure 2 et aux deux plateaux qui sont observés respectivement entre 1 et 7 secondes et entre 8 et 18 secondes. Les données précédentes démontrent donc que la variabilité des ambiances lumineuses dans un même espace est importante et qu'elles sont modulées et réparties dans le temps. On peut observer également ces variations avec des intensités et des durées variables dans l'ensemble des autres espaces (B,C,D,E,F) des figures 2 et 3.

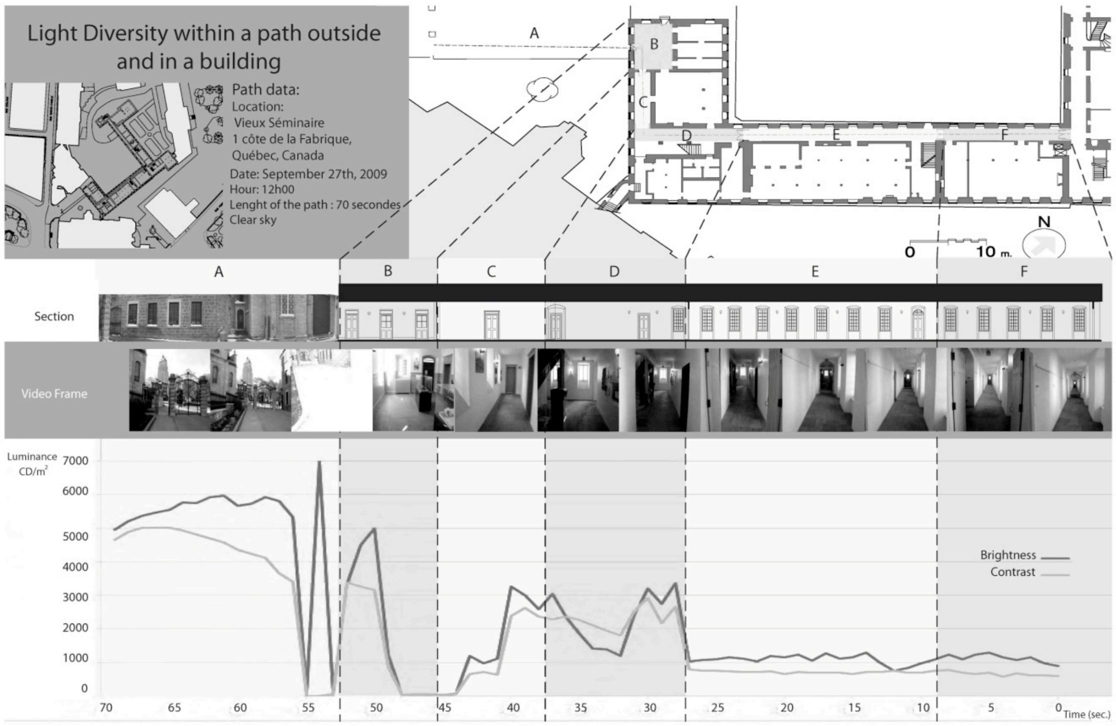

Figure 3 : Distribution de la luminosité et du contraste selon le temps dans un parcours architectural de F vers A.

Dans le relevé présenté, cette adaptation est vécue différemment que l'on sorte (figure 4) d'un bâtiment ou que l'on y entre (figure 5). Ce phénomène peut s'expliquer en étudiant les limites du système visuel lorsqu'il est soumis à des différences de luminosités et des contrastes élevés [7, 21]. Ces situations ont tendance à être plus fréquentes lors de l'entrée et la sortie d'un bâtiment [7,21]. Il semble y avoir un consensus dans la communauté scientifique sur le fait que le processus d'adaptation de l'œil fait intervenir des cellules spécialisées distinctes en conditions de faible et de haute luminosité [21]. Les cônes sont constitués des cellules sollicitées par des luminances élevées alors que les bâtonnets le sont lors de luminances faibles. Cette distinction physiologique amène une discrimination importante dans la perception de l'espace [21]. De par leur évolution, les cônes procurent un meilleur rendement visuel, tant à ce qui a trait aux luminosités, qu'aux contrastes et aux perceptions de l'espace [12-26]. Par contre, les bâtonnets sont plus limités dans la perception des couleurs, des nuances de contrastes et offrent un rendu de l'espace moins performant [21]. La figure 2 illustre que le passage d'un environnement où les luminances moyennes enregistrées sont de l'ordre de 6560 cd/m² à 17 secondes, à un environnement où celles-ci sont de 22 cd/m² à 22 secondes, implique un ratio correspondant à 1 :300 ce qui est drastique. Lors de cette transition, l'œil doit faire le relai entre l'utilisation des cônes, qui sont sollicités à l'extérieur, vers les bâtonnets qui sont utilisés en luminance faible [21]. Ce phénomène amène la perte momentanée d'informations spatiales, qui se traduit par un *black-out*.

On parle alors d'effet de *black-out,* c'est-à-dire d'une perte d'informations dans la lecture spatiale de l'environnement créée par un effet d'éblouissement qui se traduit par la perception d'un environnement beaucoup plus sombre que la réalité. La figure 4 représente l'effet du *black-out* qui a lieu lors de l'entrée dans le bâtiment. La première image représente la façade du bâtiment avec un albédo élevé et où l'œil offre un rendu convenable de la scène alors qu'à la lecture de la seconde image, la scène semble être inexistante dans la partie de droite de l'image. L'image démontre une faible luminosité ainsi qu'un faible contraste (image tirant sur le noir). Il s'en suit une perte de la lecture de l'espace qui est retrouvée par un rendu convenable de l'espace dans la dernière image.

Figure 4 : Images représentant la séquence d'entrée du bâtiment et l'effet *black-out.* 4 a) extérieur au t = 17 secondes et avec une luminance moyenne de 65600 cd/m², 4 b) phénomène du *black-out au t = 20 secondes* et avec une luminance moyenne de 740 cd/m², 4 c) espace transition constitué par le hall d'entrée au t = 22 secondes et avec une luminance moyenne de 22 cd/m².

À l'inverse, la figure 3 illustre le passage d'un environnement où les luminances moyennes enregistrées sont faibles (41 cd/m² à 54 secondes), à un environnement où celles-ci sont dites élevées (5300 cd/m² à 57 secondes). Lors de cette transition, le système d'adaptation de l'œil passe donc du système utilisant les bâtonnets au système utilisant les cônes ce qui génère la perte momentanée d'informations spatiales. On parle alors d'effet de *white-out,* c'est-à-dire d'une perte d'informations dans la lecture spatiale de l'environnement créée par un effet d'éblouissement qui se traduit par la perception d'un environnement beaucoup plus brillant que la réalité. La figure 5 illustre l'effet de *white-out*, qui se traduit par une surexposition de la luminosité et une perte du contraste dans l'image (image tirant sur le blanc). Ces phénomènes sont donc attribuables aux trop grandes différences de luminosité et de contraste qu'il y a entre l'intérieur et l'extérieur. Dans ce cas précis, la différence énorme provoque un éblouissement et une perte de la lecture de l'information architecturale pendant quelques instants (figure 5).

Figure 5 : Images représentant la séquence de sortie du bâtiment et l'effet white-out 4 a) intérieur au t = 52 secondes et avec une luminance moyenne de 1000 cd/m² 4 b) phénomène du white-out au t= 55 et avec une luminance moyenne de 7000 cd/m² 4 c) extérieur au t =57 et avec une luminance moyenne 5300 cd/m².

La figure 5a) représente l'étape initiale de l'effet d'éblouissement, où on peut bien comprendre la perte de la lecture d'information de la configuration spatiale dans la section de droite de l'image. La figure 5b), représente l'effet de la surexposition de l'image vidéo et de la grande brillance, rendant l'environnement avec une perception extrêmement lumineuse. Finalement, la figure 5c), illustre l'espace A, soit, l'extérieur du bâtiment.

La conception d'un espace de transition entre l'intérieur et l'extérieur pourrait donc traiter architecturalement ce type de seuil en ce qui a trait à la luminosité. On peut remarquer une variation importante de la luminosité aux limites des environnements terminés par des ouvrants, soient les portes. Ainsi, à la limite des zones A et B ainsi que B et C, des figures 2 et 3, il est possible de constater une variation importante dans la luminosité et le contraste suite à ces frontières spatiales. Cet effet est amplifié par le fait que l'espace transition est très opaque et ne possède que peu de continuité visuelle avec l'extérieur. Ce phénomène serait moins apparent, éclairage moins contrasté, si l'espace de transition comportait une plus grande continuité visuelle avec l'extérieur, c'est-à-dire plus de transparence dans l'espace de transition.

En comparant, la section D (figure 2 et 3) dans les deux parcours, il est possible de constater une différence dans les variations de la luminosité et du contraste. La façon de percevoir cet espace lors de la migration de A vers F section D (figure 2) semble moins soumise aux variations dans la luminosité et le contraste que lorsque nous effectuons la migration inverse de F vers A section D (figure 3). Ce phénomène peut être aperçu à la figure 6 et s'explique par le champ visuel et la nature de la scène filmée. En effet, lors de la progression de F vers A section D (figure 3), il y a présence, au centre du champ visuel, d'un élément de transparence, une fenêtre, qui est absente du champ visuel lors de la progression de A vers F section D (figure 2). La moyenne de la brillance des images de la section D de la figure 3 est de 2200 cd/m² alors que celle de la section D de la figure 2 est de 664 cd/m². Le même espace est donc perçu avec une brillance de plus de 3 fois supérieures dans le parcours fait à la figure 3 que celui effectué dans le cadre de la figure 2. On peut conclure que la perception de brillance est dépendante des variables lumineuses présentes dans le champ de l'observateur en mouvement et qu'elle pourrait être étudiée architecturalement en modifiant la disposition des éléments de transparence pour minimiser l'inconfort visuel créé par une transition trop brusque entre deux espaces.

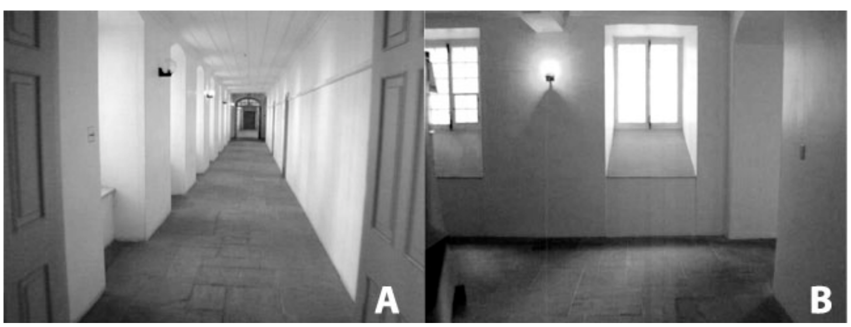

Figure 6 : Images représentant le champ visuel lors dans l'espace D. 6 A) lors de la migration de A vers F de la figure 2; 6 B) lors de la migration de F vers A de la figure 3.

Conclusion

Fondamentalement, la méthode utilisée dans le cadre de cette recherche consiste à utiliser la caméra vidéo digitale, de filmer un parcours *in situ* et d'en étudier les images résultantes afin d'en réaliser une représentation graphique des caractéristiques lumineuses. Les résultats indiquent que la diversité des ambiances lumineuses dans un parcours linéaire relativement « simple » est grandement supérieure au nombre d'espaces traversés. L'exemple présenté dans la section A de la figure 2 démontre, en effet, que 4 variations importantes de la brillance dans le temps ont été enregistrées dans 1 seul espace. De plus, la recherche illustre que l'adaptation lumineuse, lors du passage intérieur-extérieur d'un bâtiment, est vécue différemment que l'on y sorte (figure 4) d'un bâtiment ou que l'on y entre (figure 5). Ces variations dans la perception des ambiances lumineuses sont caractérisées par deux phénomènes, le black-out et le white-out. Ces deux phénomènes, démontrés aux figures 4 et 5, sont le résultat d'une grande différence dans la brillance des images successives et impliquent un ratio de brillance de l'ordre de 1 :300.

La comparaison entre la section D de la figure 3 et la section D de la figure 2 a permis de conclure que la perception de brillance est dépendante des variables lumineuses présentes dans le champ de l'observateur en mouvement. De plus, cette analyse a permis de constater que la perception lumineuse d'un même espace peut être expérimentée différemment selon la direction avec laquelle il est traversé. Il est alors promulgué qu'un même espace peut provoquer des perceptions différentes selon la position du champ de vision de l'observateur. Les auteurs sont conscients que le choix d'un autre bâtiment procurerait une expérience lumineuse différente. Dans cette optique, il serait alors possible d'étudier les transitions lumineuses dans un certain nombre de bâtiments afin d'en comparer les ambiances lumineuses lors de promenades architecturales planifiées en fonction du mouvement des usagers.

La relation de la brillance avec l'espace est proéminente quand il est question d'étudier les ambiances lumineuses. Le mouvement et la vitesse constituent des paramètres qui influencent grandement notre perception de l'environnement. En ce sens, l'utilisation de la vidéo implique non seulement la notion de temps, mais également la relation entre la représentation graphique et l'analyse. La lumière ne possédant aucune échelle, la méthode expérimentée *in situ* pourrait s'avérer très efficace dans le cadre d'une utilisation avec une maquette analogique, permettant de contribuer plus explicitement à la définition des ambiances dynamiques des espaces de transition.

Cette recherche vient appuyer le fait que l'expérience de l'architecture fait partie intégrante de la transformation constante et graduelle, créée par la perspective et la lumière sur un ensemble complexe de variables. Finalement, la création d'un espace devrait impliquer le mouvement des usagers, générant des espaces transitions adaptés à la complexité des ambiances lumineuses. Cette étude établit qu'il est dorénavant possible de qualifier et quantifier le caractère dynamique des ambiances lumineuses pour une promenade architecturale.

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Consumption experience in running: how design influences this phenomenon

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Abstract
The studies on consumption experience have gained force not only in the Marketing field but also in relation to the impact that design can have in the construction of those experiences. This paper discusses the role that Design can play in the construction of experiences perceived in road running activities. In order to do so, an exploratory study was conducted through the use of multiple techniques of data collection (in-depth interviews, desk research, and ethnographic essay). The results indicate that the experience generated by the running activity is strongly dependent on external agents, like sport consultancy services and competitions, being Design as an important factor to the promotion of sports practice and the constitution of consumption experience.

Keywords
Experience design; running; tribes.

The road running market[1] is a global phenomenon. Millions of runners practice this physical activity in parks, squares, and streets in big cities all over the world. More than a sport activity accessible to a great public for several reasons (easy to practice, no specific equipment required or no need for other participants), running has gained strength as the fastest growing sport in the world with very expressive figures in Brazil, too.

Practicing alone or in groups, runners have motivated the creation of an expressive number of competitions, from short distances (5km and 10km) to higher challenges (21,097km and 42, 195 km – half-marathon and marathon), or ultra-marathons as the Comrades in South Africa, with 89 km.

The evolution of the practice can be noticed by the impressive figures of the New York Marathon, with more than 100 thousand applications for 43 thousand allowed participants (AIMS, 2009). Marathons as Tokyo, Chicago, Berlin and Paris are big events that attract thousands of tourists and athletes, representing important dates on their tourist calendars. But, why does it happen?

We can speculate on some reasons for this trend, such as the increasing concern with sedentary life style and stress, typical of post-modern societies, or the search for a perfect body and the consequent elevation of self-esteem. However, which factors are really responsible for such figures?

In the 70s, there was a booming in jogging all over the world influenced by the work of Dr Kenneth Cooper and by the beginning of the increasing status of running as a healthy sport. In the USA, there were about 100,000 runners at that time, increasing to 30 million nowadays. In Brazil there is an estimative of 3 million daily basis runners[2], placing it as the second most popular sport in the country's biggest cities (São Paulo and Rio de Janeiro), being soccer the first one.

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[1] According to the International Association of Atletics Federations (2009), road races are disputed in streets, avenues and roads with official distances varying between 5 to 100km.

[2] Daily basis runner is considered the one who practices this physical activity at least 3 times per week for 30 minute-lenght period.

Sports goods companies have invested huge amounts of money in the development and launching of shoes and accessories for running, focusing on lighter, more resistant to different kinds of ground and weather, and customized products for each type of runner, taking into consideration, for instance, their weight or the way they step and move when running. At the same time, the events organization related to running have multiplied and professionalized. In São Paulo, the biggest Brazilian city, there were 11 official competitions in 2001. In 2009, 174 competitions were carried out, or 3 competitions every weekend (Corpore, 2009).

Once it is realized the relevance of this sportive and social phenomenon, some inevitable questions come to mind: The increasing number of people practicing running is something spontaneous or created? What makes a strenuous and little stimulating activity into something attractive and capable of mobilizing crowds?

The discussion proposed by this paper is guided by these questions: is the experience of running something designed by others or is it something constructed by the user; how can Design influence the practice or the consumption of running; can the racing practice phenomenon be explained by the formation of a subculture proper of this kind of individuals that are sometimes organized in tribes; is the formation of tribes the result of projected actions by market agents? In order to discuss these points, it was defined as research goal the evaluation of experience design influence on consumer behavior of road runners in Porto Alegre, as well as on the tribe's formation process in this market.

The scope of Design action has been broadened since the original conception of product projecting to the constitution of offer and value to the user. Mitchell (1993) used to say that Design should not project only objects butalso functions, contexts of use, systems and environments. This conception is materialized through experience design, which has as its purpose not only in product development but also creating conditions to generate satisfactory experiences for the user.

Recent studies have tried to analyze the role of Design in the development of consuming experiences (Forlizzi, Di Salvo e Hanington, 2003; Freire, 2009), however, there are innumerous theory gaps in the area. In the next section the concepts of experience design will be detailed.

Experience Design

The experience theme has gained relevance in the field of consumer behavior since Holbrook and Hirschman's study (1982). Until then, the discussion about consume wouldn't explicitly consider the role of hedonistic and symbolic elements that products and services had on consumer perception. The authors highlight that there was a flow of fantasies, feelings and fun around consuming processes so far underestimated by organizations in the development of their offers and even when designing their products. Personal experiences would be the result of individual events, full of emotional meanings resulting from the interaction between user and a set of stimuli, either related to products, services, or communication.

Pine and Gilmore (1998) pointed out that the consuming in XXI century would be within the "experience economy", that is, the XIX century industrial revolution that attempted to implement standardization and mass production would be replaced by mass customization (products/services increasingly more adapted to individual needs and desires) which, in its turn, can be characterized by the search for individual immersion in consumer experiences instead of simply buying products or services.

In economies increasingly more dependant on services, the concern is to generate experiences based on the creation of environments capable of absorbing clients in a pleasant, memorable, and unique way, with services working as stages and products as supports (Pine e Gilmore, 1998; Schmitt, 2003). Lusch and Vargo (2006) point out that the dominant logic of services in national economies lead to a new consumer role in the purchasing and consumption process. A passive posture loses space to an individual in search of co-authorship in the creation of consuming value. There is no value in offers until they are used, and the experience is fundamental in determining it. Experience, in that sense, is not an accessory element to the consuming process anymore and it plays a leading role in the construction of value organizations. The consequence of this process is the change in the role of Design that in this new context is not an ability focused only at designing artifacts but to develop user experiences. The challenge is to be capable of generate not just everyday and satisfactory experiences, but outstanding ones. The cognitive psychologist Mihaly Csikszentmihaly says that activities that are intrinsically motivating[3] for the individual, that give pleasure in their accomplishment and take the user to a deep state of involvement and personal joy generate a state of mental flow and are essential for the constitution of outstanding experiences. When in this state, the feelings of pleasure and satisfaction are considered unique and can contribute for a bigger engagement in the continuous realization of a certain activity. The figure 1 shows the conditions for generating flow, which occurs when there is a higher level of challenge to be faced, demanding a higher degree of skill to be accomplished.

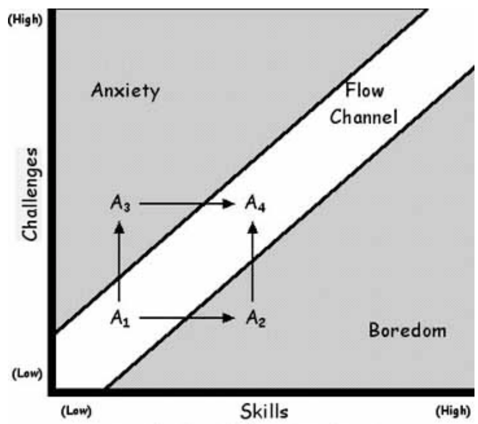

Figure 1. Conditions for the generation of Flow

Source: Csikszentmihaly and Csikszentmihaly, 1988.

Many authors have discussed the nature of consumption experience. Pullman and Gross (2004, p.551) indicate that the experiences are "inherently emotional and personal", and are dependant on individual factors like cultural background, previous experiences, mood and personality traits. Forlizzi, Disalvo and Hanington (2003) as well as Hekkert and McDonagh (2003) point out that experiences are unique, made of small experiences related to contexts, products and people, and the experiences themselves cannot be projected, only the situations of interaction with users.

Caru and Cova (2007) classify consuming experiences within a continuum, according to those responsible for their construction, as visualized in figure 2. There are, on one side, experiences oriented by consumers, which are organized by users and tend to be the result of everyday services and products sold by companies through traditional marketing approaches. On the other hand, there are experiences oriented by companies conceiving all the details of the projected experience, characterized by specific organizational efforts to generate immersion consuming contexts.

[3] Intrinsic motivation can be described for not be focused on the rewards from some activity, but as consequence of its involvement and effort. Extrinsic motivation occurs when an activity is just the way to reach some goal, generating more tension and stress for its achievement (Cszikszentmihaly and Csikszentmihaly 1988).

Fig 2. Continuum of Experience Consumption

Source: Caru and Cova, 2007.

The intermediate position in this context relates to experiences dependable on the construction by companies of an experiential platform as well as on the user's active participation in the development of his/her own experience. Therefore, the results of the projected experience are the outcome of co-authorship between organization and consumer. Playful activities like adventure tourism and cultural events are typically co-driven experiences.

According to McLellan (2000), experience design is intended to "orchestrate" experiences that are functional, engaging, attractive and memorable. It demands designing all the details of content and context for the user, seeking to generate emotional fulfillment and pleasure in use that enhance one's perceived experience (Kurtgozu, 2003). The scope of experience design is beyond the materialization of a service or a product; it is in the set of planning activities of processes and systems that support the occurrence of the experience, besides the earlier stages of its construction, like the full understanding of clients and production contexts.

Method

The study presented here sets out from a phenomenological approach and presents an exploratory character. To generate understanding about the road running market phenomenon it is used data triangulation by employing different approaches of data collecting. The development of a desk research about the running world, either from market data or studies from other academic research fields like Physical Education, Tourism, Marketing and Psychology was the starting point.. Secondary data collecting was carried out at running related institutions like Association of International Marathons and Distance Races (AIMS), International Association of Athletics Federations (IAAF), Corpore (Paulista Road Runners United), Associação dos Treinadores de Corrida de Rua de São Paulo (São Paulo Road Runners Instructors Association), as well as a large research in the different running specialized medias like magazines, sites and blogs.[4]

Primary data was collected through a set of audio recorded in-depth interviews based on semi-structured scripts with agents from this industry.

1. Corpore general manager: the biggest running group (9850 athletes) and the biggest competition organizer in Brazil.
2. Two directors from the biggest running training groups in the country (Run & Fun and MPR, with 1400 and 1300 enrolled athletes respectively).
3. Marketing directors from the two leading sports brands in the running world market.
4. Members from the media specialized in running (Runners World Brazil magazine, and Sprint Final newspaper).

[4] It's important to highlight that the data was collected in two Brazilian cities (Porto Alegre and São Paulo) due to the expressiveness of São Paulo market in the context of road running, being considered the city with the highest number of runners and running races in Latin America.

An ethnographic essay with one of the authors of a sports consultancy service company was developed in parallel, in which he was submitted to three training sessions of 60 minutes each, three times a week for 7 months. The criterions for choosing this company were the number of athletes participating (120 runners) and its structure level in relation to other groups in Porto Alegre. Besides the training, the researcher also took part in 5 annual competitions in the city, with distances of 5 and 10km, as well as of social activities with members of the running group. Notes were taken in field diaries throughout the study and photos were taken during the activities.

Data analysis was performed by the transcriptions of in-depth-interviews, and a content analysis was carried out about the collected material, that was evaluated in conjunction with other obtained data.

Results

The results of this study are presented in two parts: the description of the main agents in the running market, followed by the analysis of the influence of experience design over the consuming behaviour of road runners.

The market of road running in Brazil is made up by the following agents:

1. Runners
2. Sporting goods brands
3. Events organizers (private companies, running clubs, public sector)
4. Sport consultants or training groups
5. Specialized media
6. Business opportunity seekers
7. General public and family members

Unquestionably, the main agent of this process is the one that runs. For many reasons that will further be dealt in this paper, runners get interested in the running activity and in most cases start playing the sport independently. Running, just like walking, is the most accessible sport activity because it can be carried out alone, anywhere, and initially requires little investments. Some studies point out the factors that motivate people to choose running as a physical activity. According to Silva (2009), running improves the physical conditions of athletes (better fitness, less risk of cardiac diseases, weigh control and breathing capacity), the emotional and cognitive balance (stress reduction, better mood, higher self-confidence, enhanced learning, concentration and abstract reasoning), and the social skills (the need to belong to a group, make new friends etc.).

Although it takes little investments to go running, the role of sporting goods labels is more important than it seems. Brands like Nike, Asics, Mizuno and Adidas have noticed that the market of running has a high annual growth rate and that runners look for products that allow higher performance, regardless of their own performance level. Products range from foot wear, with improved technology to bring comfort, cushioning, resistance and stability, to training apparel crafted with smart fabrics that are light and moisture-wicking, and also accessories like heart monitors that measure speed, distance, calorie expenditure, with GPS sensors and other performance display features.

Running shoes are the flagship of brands. They have an outstanding role in the market since there are annual collections being launched globally that bring on technological advancements and are widely advertised in the specialized media (most of them publish running shoes profiles comparing brands, models and performance tests), as well as in the outlets and races sponsored by the labels.

A particular issue from the Brazilian running market is the relevance of the running groups or sport training consultancy services for influencing the runner behavior. There is no recent statistics of the share of runners market which hires this kind of service, but it's an important element to leverage the sport growth in the country. The running training groups, distinctively from the runners groups, are paid services which seek to become the sport experience more pleasure and comfortable. They are compound by training counseling before, during and after the exercise and races (including warm-up, stretching, massage, and hydration), customized training spreadsheets, tents and lounges for athletes in the race. The distribution of t-shirts for the members, the transportation for training in distant sites (most of the practices occur in parks and streets of the cities, according to a previously informed timetable), the race registration service, the web-based platform for communication between athletes and instructors, as well as the organization of running trips (especially for interesting races as prestigious marathons abroad) are extra services which differentiate the companies and the value perception of the runners (the basic cost for this services is US$ 80 per month).

Sports consultants (or running groups) offer services to two segments of the market: individual runners and corporations. Companies, with the objective of improving the health and lifestyle of their staff, have been hiring consultancy services to organize and assist their staff in running activities. Besides promoting fitness among the staff, this kind of initiative also improves corporative life.

The growth of Brazilian running market is due to an increasing number of races in a structured calendar, which can vary according to distances, courses and purposes. Competitions have been more professionally organized, which involves processes and services of advertising (mass and specialized media), application (mostly by the internet), the use of transponder timing systems (which are essential to measure the performance of athletes), the distribution of apparel sets (a numbered T-shirt is the basic item with a variation of accessories and toiletries), the setting of race courses, inspection, lightning, music etc. Application costs are also higher (ranging from US$ 20.00 to US$100.00 for each athlete), not only for restricting the number of participants but also for choosing a target public for the organizers. Races that are up to 13.1 miles have a number of participants that ranges from 2.000 to 15.000 in average.

Another interesting fact which regards to race events is that they are usually related to an issue, a project or a specific public. Besides being organized by their course length, races can be directed to females (Venus Circuit), Kids (Kids Run) or companies' running clubs (Corporate Run). They can be held in the evening, with a clubbing atmosphere (Fila Night Run, Poa Night Run), inside a factory around the assembly line (Volkswagen Run) or in fashion high streets. A common kind of race is the one in which athletes take turns allowing groups with different numbers of participants to run side by side, regardless the performance level of each runner.

Some elements that characterize the studied races are the great number of stands dedicated to sport consultants and running clubs. They usually provide support services to runners that take part in these clubs, like a place to keep their belongings, fruits and drinks. All participants of a running club wear the same apparel as a way of keeping unit, even when race organizers offer a specific T-shirt for the competition.

Analysis of Data and Findings

Considering the analysis of the context for the practice of road running, the guiding questions of this study about the role of Design (specifically experience design) in different forms of consuming associated to running can be discussed. The individuals who practice running were grouped in different segments according to their motivations. It became clear throughout the interviews with the specialized media and sport consultancy services that there are three runner profiles:

1. Group 1: formed by extremely competitive individuals seeking a superior performance. They participate of competition on a regular basis and are heavy users of related services and information.

2. Group 2: formed by individuals seeking a better quality of life. They participate of competitions for the pleasure of taking part in the event and, in some cases, for the challenge to improve performance. They often start practicing motivated by the possibility of being accepted in a social circle or because it is trendy, but as they get involved they realize it is an easy, pleasant and low cost activity.

3. Group 3: formed by individuals who are marginal to the market. They do not take part in competitions and are light users of products and services related to running.

The first group represents a very small percentage of the running population, but works as an aspiring element for the other participants, mainly for the second group. Group 2 has been responsible for market growth, influenced by the increasing number of runners in public places and by the growing number of competitions designed for beginners (5 to 10km).

Based on Csikszentmihaly's flow concept it is possible to notice that practicing running has distinct tones for each runner profile. For those who have as their aim the continuous improvement of performance, the imposed challenges demand the development of skills necessary to achieve their goals, forcing them to use all the necessary resources in order to be able to accomplish their goals. The use of sports advisory services, the constant search for information and the continuous investment in equipment and accessories to improve performance give support for the mental sate of pleasure to be eminent. Besides the elevation of challenge levels, diversity of stimuli has played a fundamental role for the designing of outstanding experiences. This can be confirmed by the constant innovation in the dynamics of competitions, either in racing circuits, services or available technologies for their occurrence. Another trend identified for competitive runners is the called *running tourism*, that is, competitions like the New York Marathon, or similar ones in Berlin, Buenos Aires, and Rio de Janeiro that have attracted tourists/runners willing to face new challenges and, at the same time, visit new places. Tourism agencies, hotels, and flying companies have designed services targeting these specific tourists who usually travel with other runners or with their families.

For individuals from group 2, the initial motivations for running are extrinsic, with goals not specifically related to the act of running. Because of the immersion in the running context, either inside of the structure of running clubs or advisory services or participation in competitions, the motivational nature is altered, and the pleasure and satisfaction with the activity comes naturally. The immersion process, according to Caru and Cova (2006), is not quickly or automatically established, it is progressive and can be accelerated according to the designing and management of services that compose the experience, either in terms of consultancy services or the organization of street competitions.

Running clubs play an important role in the promotion of the running practice because they are behavior inducers. When gathering people with different motivations, level of performance and different socio-cultural backgrounds but united around the same cause (running), the clubs produce positive reinforcements in the individual, like socialization, the necessary orientation for safely practicing the activity with less injury risks, comfort and support to allow for a carefree practice. It can be concluded that *flow* occurs in this context since consultancy services act as promoters of intrinsic motivation characteristics of this mental state and of extraordinary experiences.

Competitions, even if they are not common to all kinds of runners, play the role of generating constant challenges, which is essential for the arising of *flow*. Unlike other sports, road running is essentially a competition against ones own limits, not against other competitors. Competitions assume two responsibilities in relation to competitors: create opportunities to challenge their records and engage individuals in experience sharing communities, a central characteristic of consuming tribes (Cova and Cova, 2001).

There is evidence that runners who actively participate in the practice of running, either using consultancy services or taking part in competitions, tend to get a more significant involvement with sports practices. Stebbins (1992) reveals that the construction of a social identity is relevant for the individual because it creates a sense of fitting in, a valuable place in a social environment, a connection with others and a way to raise self-esteem. Shipway and Jones (2008), in a study on the experiences of the London Marathon participants, pointed out that only what is known as serious leisure can create a meaningful social identity. Since a social identity is created between runners, a new consuming tribe is constituted. According to criteria identified by Cova and Cova (2001), the four elements necessary to the constitution of a new tribe are: the everyday practice (regular training), locations (parks, streets), trends (increasing number of people practicing running) and gatherings (training sessions, competitions, social activities).

It is in this context that the formation of tribes occurs because, besides the natural obstacles to be overcome, the activities demand a high commitment and engagement. This is possible to notice on the structuring of the consultancy services with the institution of a standard uniform (usually a t-shirt), that reinforces the feeling of belonging to a group, sharing affinities and seeking common goals. The perception of the running competition itself is substantially altered when experienced independently and individually or in teams or groups sharing a minimally constituted identity. The group experience revealed itself as being more stimulating, promoting a longer involvement with the running practice (lower rates of quitters). Design can play an important role in the configuration of this projected experience, either in the constitution of services to stimulate the formation of groups or with tangible elements that reinforce the structuring of a collective identity (brand, uniform, communication, facilities).

When discussing the concept of experience design, it was possible to notice that the elements for its structuring, either for competitions or consultancy services, could be found in the constitution of content (central or auxiliary services offered by event organizers or teams), context (development of physical evidences) and processes (supporting systems that allow for advisory and competition operations). The challenge for the people responsible for it is the continuous generation of positive experiences. Not only this, but with an urge to continuously develop innovations that will characterize them as satisfactory and, if possible, extraordinary experiences.

Conclusion

It is possible to observe that the running activity is initially an independent, low-cost and an easy activity to practice by the participants. However, the construction of a more complex experience with the participation of other people and with specialized technical orientation from professionals of Physical Education and related areas brings other elements for the engagement with the sport. The formation of running clubs, with their own identification and sport consultancy service, as well as services like warming up, stretching, hydration, circuit definition, performance control, organization for collective participation in regional, national and international events, transform a consumer-driven experience into a co-driven one, that is, its fruition and development are equally dependent on the user and companies initiatives.

A good example of how organizations may constitute different experiences for a single runner is the realization of theme competitions in different formats, not only in the possibilities of participation (individual or teams) but also in terms of environments and possible external stimuli (Fashion Run, Corporate Run, Disney Marathon, Volkswagen Inside Run). More than just an event for runners, competitions are their goal because it is where they can break records, improve performance, socially interact and try new sceneries, like circuits, services and products offered by organizers and sponsors .

Initiatives in the developing of running related products reveal the efforts in the designing of experiences, like the partnership between Nike, the sporting goods manufacturer, and Apple in the launching of the Nike Plus system. The system integrates Nike running shoes and iPods, making it possible to monitor the runner’s performance, listen to music and participate in a Nike social network on the Web for athletes using the same technology, reinforcing the stimuli for the constitution of a community of users or sports practicing people with tribal characteristics (Cova, Kozinets and Shankar, 2007). Running is not an obstacle to be overcome and it acquires a social, entertaining and pleasurable character from products that free runners’ central activity from the fatigue, discomfort and sacrifice that they normally face.

This study made it possible to verify, from an approach of various perspectives of different participants in the industry, how the running consuming experience is constituted and the role design plays in the transformation of that experience into something more accessible to a common user, not restricting itself only to a performance athlete. The construction of consuming experiences less focused on the user sportive performance and more focused on the providing for their hedonic and functional needs is the fuel for the expressive growing of this market and highlights the importance of design in the constitution of services, experiences and products.

The study has focused on a minor portion of the running experience as consumption. Issues as runner perception process and its relationship with designed experience weren’t discussed on this article. These findings presented on this paper represent the first part of data analysis of this research project. Further data collection and analysis will be conducted focusing on the experience design methods and their application to the service industry.

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SCENARIO: The User profiles methods applied to Product Design

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Abstract

This paper presents SCENARIO (System of Speculative Conception of New Environments related to the Individual and the Object), developed in the Ph.D. thesis called "Design future-oriented, focused on the individual and trend analysis",(2005). SCENARIO is a project instrument created with the objective to help the designer to comprehend both the profile and the user necessities, so that the former is capable of designing more adequate objects to the contemporary context. The objective is also to create conditions that allow the verification and validation of the designer's project proposal through the use of metaphors built on trend analysis. The project is composed of three phases: Phase 1 – Identity; Phase 2 – Projections and simulations; Phase 3 – a possible history. Considering theory references from psychology and anthropology, it discusses methods of data collecting and treatment using phenomenological reduction techniques and participative living. The result can be applied to the conceiving of objects more adequate to the necessities of contemporary users.

This research is based on the assumption that the complexity presents today, after so many changes in all segments of society in recent years. Nowadays the user-individual must be considered the centre of the whole projetual process and Design must consider its vocation for innovation and for the future. The approach utilized in this paper considers the object in its scenario and the individual as a character in this story, to be told using multidisciplinary elements which have their origin in psychology, design, marketing, anthropology and sociology. The second assumption is that it will happen starting from the analysis of the social tendencies and the comprehension of the user/consumer's necessities. We believe that only from the understanding of the object's role in society and its participation in the construction of the individual's everyday life is possible to project new objects that will suit both necessities and expectations.

The theoretical framework is established from the summary tables, establishing relationships between areas of knowledge, the authors used and tool projetual proposal.

Keyword

Human-centred design; User-centred design; Phenomenology; Design process; Industrial Design

Designing for other people is a very difficult task, mostly when one does not know whom one is designing for. When commissioned to design a new object, one has the opportunity to meet its future owner, so it is possible to talk to the client and know his preferences. Thus it is possible to make a unique and personal project based on data provided by the subject himself.

Mass consumption opened a gap between the designer and the end user, firstly by mass production itself. When trying to get closer to the end user, the designer realizes how difficult it is to work for whom he does not know. For this reason companies invest on consumer and marketing research, trying to understand who these people are, creating data banks where their tastes, habits and customs, even manias, can be classified. But even then the designer is still left with the same problem described above: the knowledge from the subject obtained through indirect data, mediated by marketing, provides inaccurate information about the users and their necessities.

This present research is based on the hypothesis that, after so many changes in all segments of society in recent years, it is very difficult to continue designing new objects as it was done until the eighties. Nowadays the user-individual must be considered the centre of the whole projetual process and Design must consider its vocation for innovation and for the future. Therefore differently from Marketing, which strives to understand what the consumer wants to buy, the designer, on the other hand, should foresee the product conditions before, during and after the commercialization and ownership of it. For the designer, the commercialization is just one rapid moment in the process of the use of the object, which relates to just one part of the relations between the object and the individual. The approach utilized in this paper considers the object in its scenario and the individual as a character in this story, to be told using multidisciplinary elements which have their origin in psychology, design, marketing, anthropology and sociology.

We believe the development of new products in view to innovation will consider the socio-cultural aspects involved in its production. The second hypothesis is that it will happen starting from the analysis of the social tendencies and the comprehension of the user/consumer's necessities. We believe that only from the understanding of the object's role in society and its participation in the construction of the individual's everyday life is possible to project new objects that will suit both necessities and expectations. It is fundamental, bearing such an objective in mind, the use of adequate instruments that allow us to comprehend and to contextualize the product in its initial stage.

A new methodology for the creation of new products: searching for a new expertise

Baudrillard (1993) said at 1968 in his book *The system of objects* that it is not possible to describe the everyday system of the objects through a purely technological analysis. "*The system of the objects can only be described scientifically as we consider it, in the same movement, as resulting from the continuous interference of a system of practices on a system of techniques*" (Baudrillard, 1993, p.16). When new objects are designed, the classic methodologies consider them as elements isolated from the rest of the world, circumscribed to a briefing given by the client, as if it was absolutely autonomous. People forget that such an object has a complex symbolic function in post-industrial society and that its success will depend much more on its synergy with the society/culture than on its technological possibilities.

Savoia (in De Masi, 1999, p.361) says that

> So does the market change profoundly. The technological development determines the continuous flow of new products into the market and a strong increase in the consumption of similar and alternative goods; the potential users stratify much more than in the industrial economy. Limited and restricted personal choices, of the kind "either this or that one" and the uniform and standardized shopping behaviour which characterize the consumption for the whole post-war period until the mid 60s, gave place to a

> multiplicity of styles and orientations of strongly individualized choices. The consumer's universe is not an indistinct aggregate of society and publicity for the mass market, where few product choices satisfy few homogenous tastes, but a highly diverse system in which it is possible to identify segments of consumption behaviour, of rentability.

The consumer becomes a determining element in the market and a client, not an administered being anymore. In a market where the absolute rapidly becomes obsolete and where there is no time for deeper thinking, the discourse seems to be lagging behind action. This feeling comes in part from some analytical characteristics of design which have remained stable for a long period in modern history and which, differently from advertising or marketing, have not been adapted to the dynamics required to act in our contemporaneous society.

The requisites of a new methodology for the development of products that would consider the user as the centre of the projetual activity could be divided into two: attitudinal and technical necessities. By attitudinal necessities we understand the elements present in the projetual act or in the designer's posture before the problems that lie in the projetual process itself, generating an approach concerned with the way the professional stands before the new object and its context. By technical necessities we understand the instruments used to gather and to analyze the socio-cultural data and the user as well. Such instruments are to be used by the designers during the projetual process.

From the perspective of the concept of attitudinal design, the designer's posture during the project has great influence on the final result. Utilizing an analogy between the designer's relation with the user and of the psychologist with his patient, we can understand that some points proposed by psychology can help to design and to minimize many projetual problems. The main point refers to the distancing necessary to have a critical perspective on the problem to be solved. It is very common, and many authors, including Papanek, Wachsmann, and Munari, that the designer has a natural tendency to get too involved with the project, thus losing the necessary critical perspective to evaluate the solutions proposed, have already emphasized it. Wachsmann goes as far as to suggest, in his method *Team Work*, the change of teams in the different stages of the project, which would allow an external point-of-view on the problem.

Another very harmful tendency for the project is what we call "self-project", in other words, the tendency the designer has to design for himself. In this case, there are two preferable situations: the designer should either work in a segment where he is a designer and also a user or where he does not have any kind of involvement with the segment in question. In the first case, the involvement happens because of the nearness and knowledge of the object to be designed, which make the process of self-project easier. Thus, by a metonymical tendency, the designer ends up believing that what suits him will also suit everyone else. In the second case, the ignorance of the particular field will bring a desirable distance, but it is also a cause of lack of information and of involvement. Without an adequate research, one might be caught in the trap of working with distorted and stereotype information, be it from the common sense or from preconceptions so deeply rooted in the culture that one does not even realize he is using it. In this last example, there is a tendency to make a worse version of the self-project, because more than using mistaken information, one is inspired by the things he would do in that situation without a proper technique to approach the situation.

The elements referred to above indicate the necessity of finding a more adequate reference in theory, one that would permit to minimize such problems, facilitating an empathic attitude from the designer and reducing the problem of self-project. Psychology and Phenomenology have provided concepts and techniques to better understand the subject-user as a unique individual in the design process. How cans one work with the user-centred design if one continues to think about the user only in quantitative parameters? For the last sixty years ergonomics has contributed to enhance the relations between users and objects, their spaces and activities. However, this quantitative analysis has not shown itself adequate enough to describe the complex relations of the contemporary subject with his environment. The greater the number of options offered by the market and the more hedonistic the individual's attitude, the more it will be necessary to have adequate instruments to better understand his necessities.

We shall demonstrate the main concepts utilized to lay the groundwork for the proposal here presented. After the theoretical structuring, the objective will be to facilitate the use of it, translating the abstract concepts into operating praxis.

A multidisciplinary approach

Marketing was the first to study the user psychology, understood by it as the consumer, based on theory references from psychology. However, due to the nature of the discipline itself, the main focus of all the Marketing studies in the last forty years has been to establish behaviours that emphasize product consumption. Consequently, the adoption of concepts from Psychology has not always been the most adequate one concerning the thoughts of the theoreticians in psychology. Design, on the other hand, has studied the user according to his anthropometric and biomechanical relations, aiming at a better adequacy between the objects and the human body in the exercise of its functions. In this case, Psychology has not become adequately present in such activity. However, more than just perform tasks, objects establish emotional bonds with the subject, even to the point of causing emotional dependency. Thus the incorporation of the concepts from psychology, not mediated by Marketing, can afford us the possibility of a better approach to the user's necessities.

Some characteristics of this research have shown the phenomenological approach to be the best indicated, for it allows the understanding of the user's experience from his own point-of-view, utilizing at the same time inductive and deductive processes. Adequate to solve the problem of objectivity in cultural research (Vargas, 1985), Phenomenology is the most suitable method to be used where it is not possible to establish direct relations of cause and effect between the elements of study, as is the case of study in this paper. In the case of cultural research, the author indicates that the evidences take the place of verifications, therefore creating no need for an experimental conclusion, which is actually not possible due to the mutant character of the object of study. Assuming that the comprehension of the user's necessities is more important than its explanation, the truth criterion becomes the evidence of the conclusion, consisting of the understanding of the user and his relation with the world around him. Thus, there cannot be a conclusive answer, but only evident possibilities.

Some concepts and authors of the humanist psychology have also proven to be of special significance, which we shall describe below as a differentiated alternative to work with the user-cantered design methodology.

The user as a character

A designer's claim to know the user thoroughly is at best naïve and derives most of the time either from his arrogance or pure ignorance combined with a superficial approach based on common sense.

This present work is based on the concept of the user as a character in a play, a human being represented according to his multiple facets. We agree with the psychologist C. Bollas (1998) when he says it is not possible to fully comprehend the character in all his manifestations. The author asks: "*will I ever know the character which the other is? Who the other really is? Will I have the means to transcribe the other's subjectivity to a palpable place?*" (Bollas,1998, p.39). For Design, the subject is collective and will become individualized from the moment he identifies with the object, buys it and starts to use it, incorporating the object in his daily life and in his character.

Therefore we shall work with the concept of a "group of psychographic profiles" which can be described as a group of characteristics particular to an individual or to a group. Thus starting off from the personality, that is, from the Real Self, the objective is to find a group of characteristics to compose a profile.

If we understand the real problem present in the individual and in his environment, the object will be the only and obvious response to this well-defined problem. And thus the animated object becomes an extension of the subject himself, representing him. It is important, for that matter, which we work on data that have been obtained from the items presented in this paper. Hence the elaboration of what we call "character profile bank" is a vital step for the correct application of the instrument thus proposed.

Such profile bank aims at grouping the descriptions of individuals obtained from data collecting and transforming them into cards that can be referred to by designers at the start of a project to define a group of desirable characteristics for the user in question. The observation of everyday life in combination with interview techniques allow one to find the necessary elements to see beyond labels and stereotyped views on the user, a major problem for the development of good projects.

This idea is based on the Jungian concept of "persona" (as cited in Fadiman & Frager, 1986, p.53), defined as

> the form through which we present ourselves to the world. It is the character we assume; through it we relate with the others. The persona includes our social roles, the type of clothes we chose to wear and our style of personal expression.

We are also utilizing Adler's concept of the individual as a unified whole (as cited in Fadiman & Frager, 1986, p.76), the visible part of the individual Ego that can be seen partially by means of the analysis of his daily life. In combination with it we utilized the self-concept of Carl Rogers (2001) that represents the view the person has of him or herself.

Considering the concept of character, we can say: "the user are many", in reference to each of the characters the former represents in the scenario of everyday life. Thus, we have established as a basic principle that there is not one person, the user as an individual, a single entity, but a character that plays a role, a part of this individual's history in the contemporary scenario.

Therefore, if there is not an only individual, there cannot be an only description that represents him in his quotidian and neither there is a product that can satisfy all people. Thus, the technique presented below strives to reveal the character in his scenario by means of a phenomenological approach. In this "plot", the missing part is the object, which shall be designed so as to allow the maximum congruency between the three elements, namely the individual, the character and the user, constructing thus a possible history.

The character is, consequently, what he shows to others, and also a point we can start from to understand the user as a person. Originally devised by an author, the character must be capable of being played by many different actors, thus possessing well-defined personality traits that allow the comprehension of his self. The user will play the character, when identified with his profile, and the latter will represent the former as a possible facet.

Instrument Structure

An approach based on the phenomenological reduction and on participative experience

SCENARIO is a project instrument created with the objective to help the designer to comprehend both the profile and the user necessities, so that the former is capable of designing more adequate objects to the contemporary context. The objective is also to create conditions that allow the verification and validation of the designer's project proposal through the use of metaphors built on trend analysis.

The project is composed of three phases: Phase 1 – Identity; Phase 2 – Projections and simulations; Phase 3 – a possible history.

The following summary describes the structure and theoretical basis for the instrument proposed. Subsequently we shall discuss the methods for data collection and treatment.

Based on the premises described above, we have opted to work based on an only structure that can be repeated for all techniques, thus making it easier to organize, understand and utilize the presented concepts. For all instruments a synoptic table is presented displaying the references utilized in each of the techniques and proposed procedures. In this proposed structure, we indicate:

- the objectives and desired results,
- the procedures adopted,
- the techniques that should be used,
- the profile of the best suited professional for the stage (or procedure),
- a content model to be presented at the end of each of the stages.

Thus we understand that the application of the instrument is more easily effected during the project, once all procedures have been displayed in a comprehensible language for the designer and demonstrated through examples, boards and tables. The main point-of-view will be summarized in the item "commentaries". The works of Marconi and Lakatos (1999) and of Chizzotti (2001) have been used as reference for all the techniques and questionnaire structuring.

The four instruments of the Stage 1 – Identity are an attempt at collecting and treating the data that allow us to "go to the things themselves", to reflect the experience "[…] considering that human experience is always the source of all conceptual elaborations"(Forghieri, 1993, p.5-11). To minimize the effects of an analysis based on stereotypes and preconceptions the observer might have in relation to the subject, the "preconceptions" technique has the objective of preparing the observer for data collecting.

In an effort to know objectively the subject and the elements of his quotidian, the observer writes a descriptive text on his impressions about the subject (his quotidian, physical appearance etc). The result of such a qualifying analysis should make evident the observer's prejudice in relation to his subject. By contrasting this text with the subject's description of himself and with a third person's description of the same subject, we can establish the elements which grant us the identification of the self-concept, indicating the three dimensions of the self: who he is, how others see him and how he sees himself. In this stage we can also recognize some elements of the individual's unfoldment, very important for the design of objects.

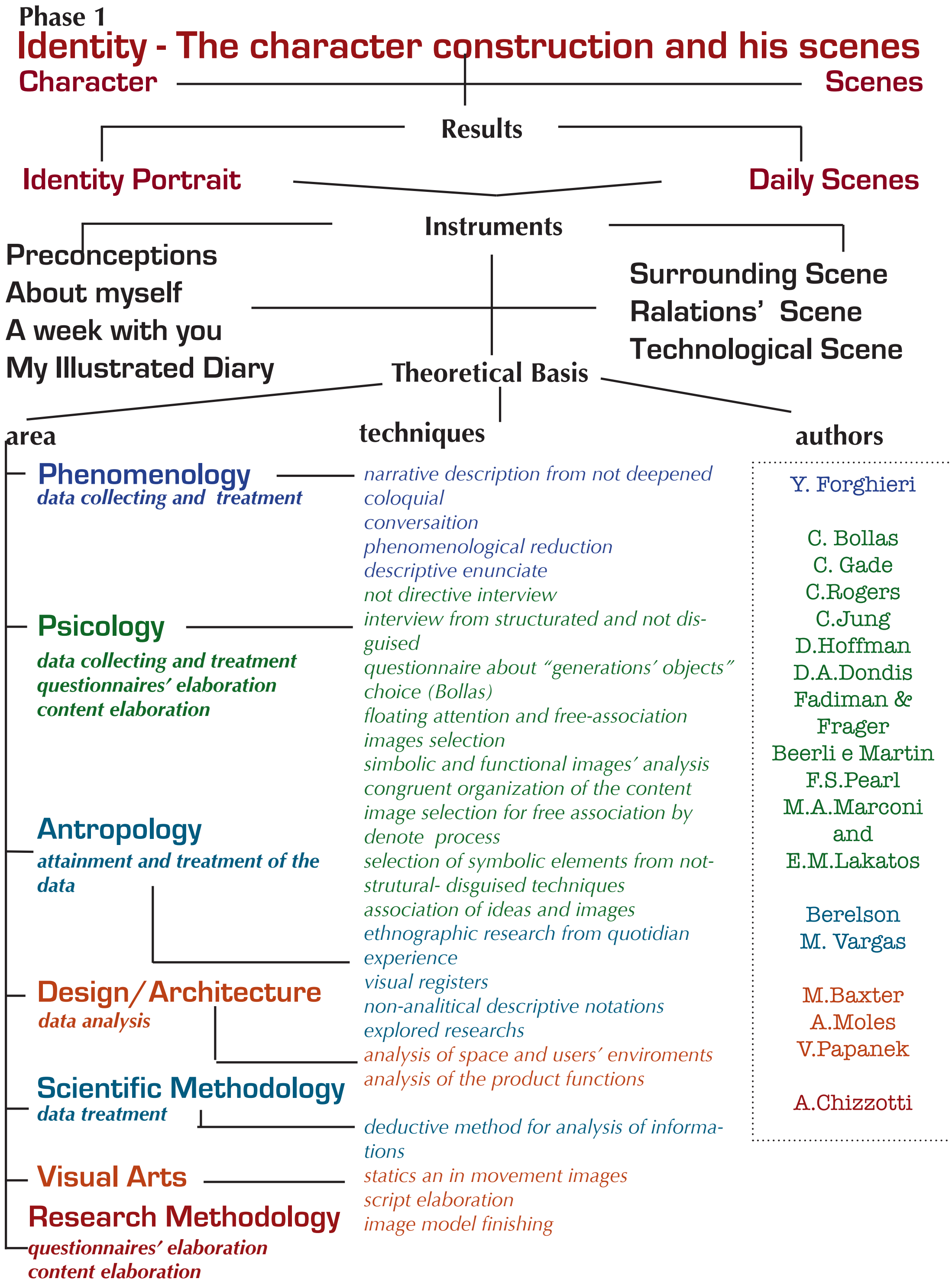

Figure 1: Synoptic diagram: theoretical structure of the 1st phase

About myself

The aim of this technique is to establish different profiles by means of interviewing different people. At this point it is important not to use any directive type of interview so that the interviewee can express himself more freely. A structured questionnaire can be used, mostly in what refers to the individual's cultural values and habits, but as long as the structure is evident. The interviewer should follow a pre-established itinerary. The desired result is a descriptive narrative about the individual and a definition of his socio-cultural profile using client-centred therapy techniques. It is important that the designer works together with psychologists for the objective is not a consumer profile but as said before, a socio-cultural one.

A week with you

This technique aims at building the character's profile from the experience of daily situations, where all aspects of the quotidian can be better observed. As a complementation of the previous technique (About myself), the same person should participate in this second part of data collecting. The underlying principle is that the main difference between the immediate quotidian existence and its theory is that the latter is always partial and limited, which cannot include the totality of the contrasting aspects experienced (Forghieri, 1993). Bollas (1998) says that "*the observation of the subject in his space allows the construction of a metaphor which enables me to come closer to what I want to say about the nature of the human character".* (Bollas, 1998, p.40). The combination of experience and participant observation associated with the fluctuating attention technique is a way not to emphasize any present element and to give the same attention to all presented data. Although it seems to be contrary to all the proposed principles of the participative experience technique with a phenomenological approach, we consider that the use of a directive itinerary will allow the researcher to focus on important aspects for the designer.

This experience shall be done with various different subjects, randomly chosen among common members of society without any privilege or demographic criterion. Following, there must be a detailed analysis of the quotidian habits, establishing a comparison between the information obtained in the "About myself" technique and the ones obtained in the participative experience so that the incongruent point can be found and thus it can be established the difference between the real self, the ideal self and the social self. The identification of the observer's personal characteristics allows the suspension of judgments of value about the user; therefore one should avoid any qualifications. The suspension of the observer's personality characteristics and personal tastes is capital to avoid a subjective reading of the elements present in the quotidian. This must be described following a personal itinerary, a card to be filled where the main points considered detrimental to the observation and the description of the quotidian can be identified.

My Illustrated Diary

The last technique in the construction of the character is called "**My illustrated diary**". Its main goal is to organize the data obtained from the experience "A week with you" and to formalize them to be further consulted and presented. The data obtained by the researcher in the previous technique are organized so as to allow simple reference to the information obtained. The facts and images obtained should be selected and analyzed bearing in mind two main criteria: the search for congruency between the elements present in the observation and their capacity to be representative on the construction of the quotidian (understood here in its two aspects, the connotative and the denotative). The image selection needs special

attention and should consider the semantic and symbolic criteria pointed out by Hoffman (2000), Persi (apud Fadiman & Frager, 1986) and Dondis (1991). The connotative aspects shall be utilized to find the structural patterns that may be visible in the images and which indicates us symbolic or subjective values depending on their repetition in different situations, what configures a pattern to be observed.
No list should be made before analyzing the images. On the contrary, reading the images should be the starting point on the discovery of the elements so as not to look for the confirmation of a previous theory about the individual, but to establish a profile based on a structured provided by the very individual. The data obtained in the experience “A week with you” should be described on paper in details and using colloquial language, with the intention of sharing that experience. After the written description one should try to establish the differences and similarities between what was described and what happened.

Three stages for the process

The first stage is the *Data analysis and interpretation: My Diary*, which is the material collected during that process. The second stage is called *Data verification with the subject: reading the diary*. Presenting the diary for the subject is his ascertainment of the meanings attributed to his objects (both internal and external). The individual should also make observations on the points which he does not agree with the facts occurred and which are consequently not representative of his reality. Thus the user is included in the process in a client-centred approach, from the three dimensions pointed out by Rogers (2001): listen, understand and accept. Firstly, listening to the client’s ideas about his own difficulties; then accepting the client as capable of understanding his own problems and, finally, understanding that the modifications can be directed by him, as well as the goal setting.

It is implicit in the third stage, *Content review and final redaction: My diary – definite version*, a critical point-of-view from the researcher. It is important that he compares his original notes, his first report and the subject’s observation to proceed to the elaboration of a possible description that characterizes what was presented. The material in *My illustrated diary* will work as the basis for the creation of an identity portrait.

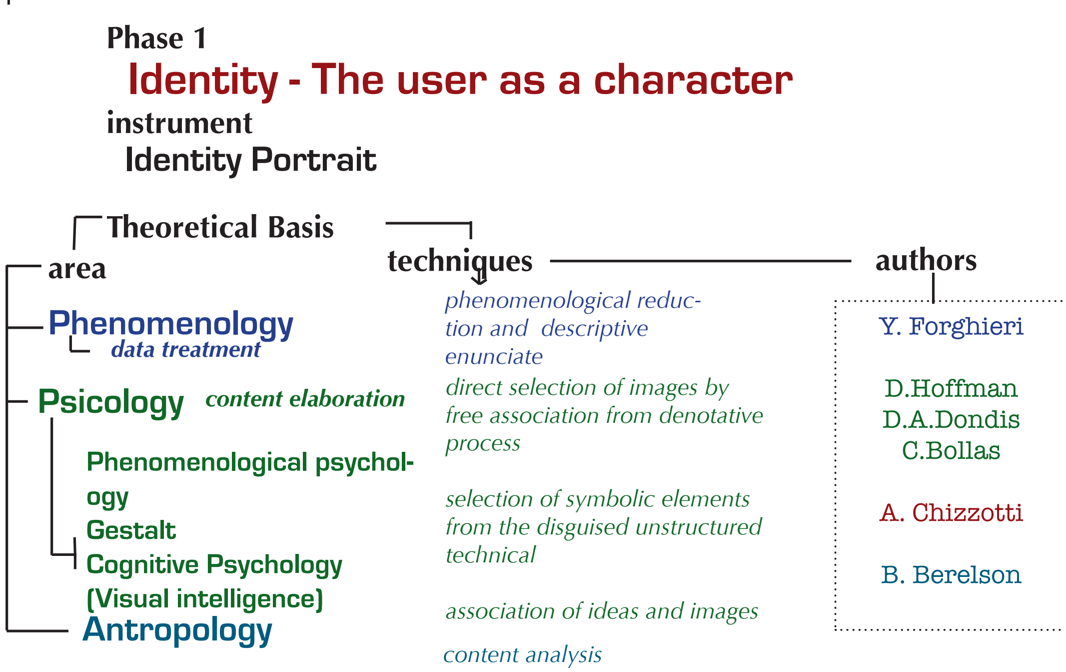

Figure 2 – Synoptic diagram: Identity portrait

Daily Scenes

The instrument **Daily Scenes** aims to put the character in context, from the insertion of images and objects taken of the **Identity Portrait** elements for building scenes and ambient. It is constructed by overlapping the 3 scenarios, the surrounding scenery, and the relational scenery and technological scenery. Work as a database, information that should be considered available and upgradeable to put the character in your environment in order to identify situations the closest to the real.

The overlap of the elements of the 3 previous scenarios, which should contain some descriptive text and visual elements, creating an imagistic model to facilitate understanding of current events and its aftermath

This model serves to mimic what happens in real life, validating the understanding of the theories presented (Vargas, 1985, p.172). The scenario as imagistic model should work also from the use of metaphor, trying to make sense of all the relations that can be established. The creation of a model imagistic daily scene allows us to “specialized” and understands the elements of this so that we can thus understand the future, the construction of the scenario projections.

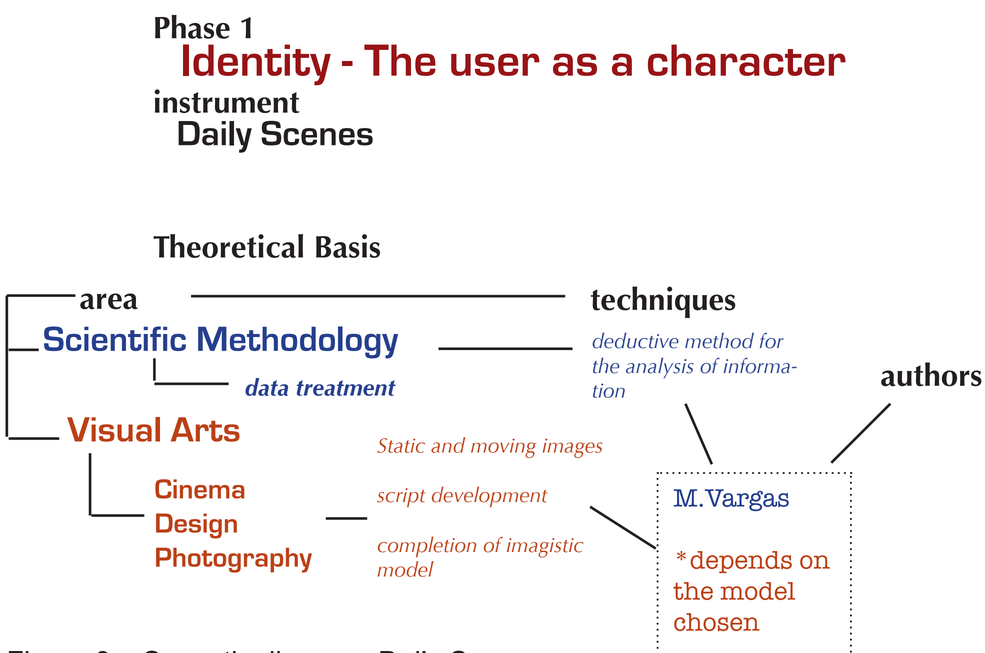

Figure 3 – Synoptic diagram: Daily Scenes

Projections and Simulations

This second stage, called **Projections and Simulations**, provides the application of data obtained in the previous step to create a model that can somehow simulate future scenarios for the implementation of the object. Thus, in one step is simpler because the data has been collected and are available for consultation. Therefore, it is one-step application.

Considering the claims of Bell (1976), Popcorn (1997) and Naisbitt (1998) that this shows us the way of the future, the main work in this step is the analysis of trends and opportunities from the creation of situations of simulation, order to test possible paths chosen by identifying the elements that characterize the changes found in the readings of the daily.

Thus, counter to reality and future prospects in the search, from a close eye on the trends of the components that characterize contemporary changes that may indicate the future directions. Taking advantage of the daily readings, the reconstruction of the repertoire indicates a scenario where simulations are possible and projections from the use of analogies and metaphors. Thus, the object is the result of needs identified in everyday life, and not born a priori.

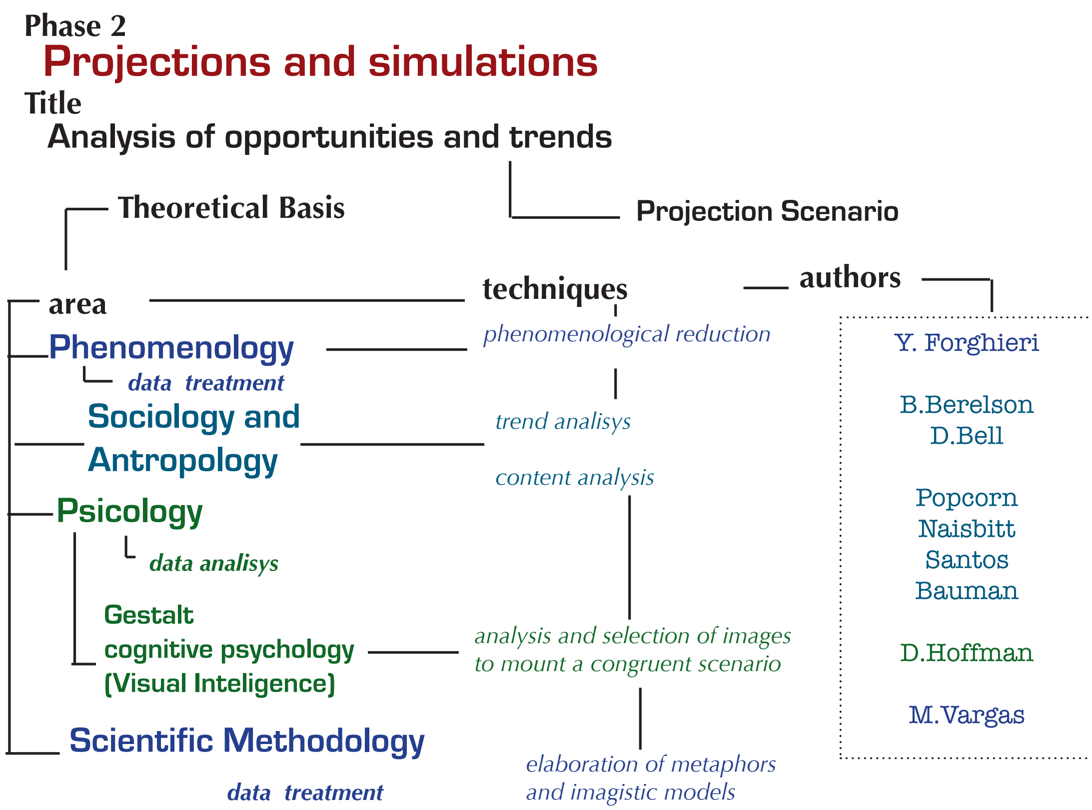

Figure 4 – Synoptic diagram: Projection and Simulation

A Possible History

This third and final stage, called **A Possible History,** is a description of the new daily. This is the synthesis of the whole process, where the application of data from all previous steps, formalized to create a model that can, somehow, describe the everyday future, with all the consequences this may entail.

The main objective of this 3rd. phase is to enable the development of user-friendly material that can describe a new daily life, from the junction of the 3 elements that build: character, settings and objects. We assume that the descriptive narrative format may be the best to assemble the story, which involves the juxtaposition of the various data obtained from previous techniques, so that one can construct a story as possible, and not an element of fiction, where the data presented leave only the imagination of author. Thus, for the avoidance attitudes romanticized in this last step, again to resort to the procedures and mitigation techniques, allowing for greater objectivity to the process to terminate.

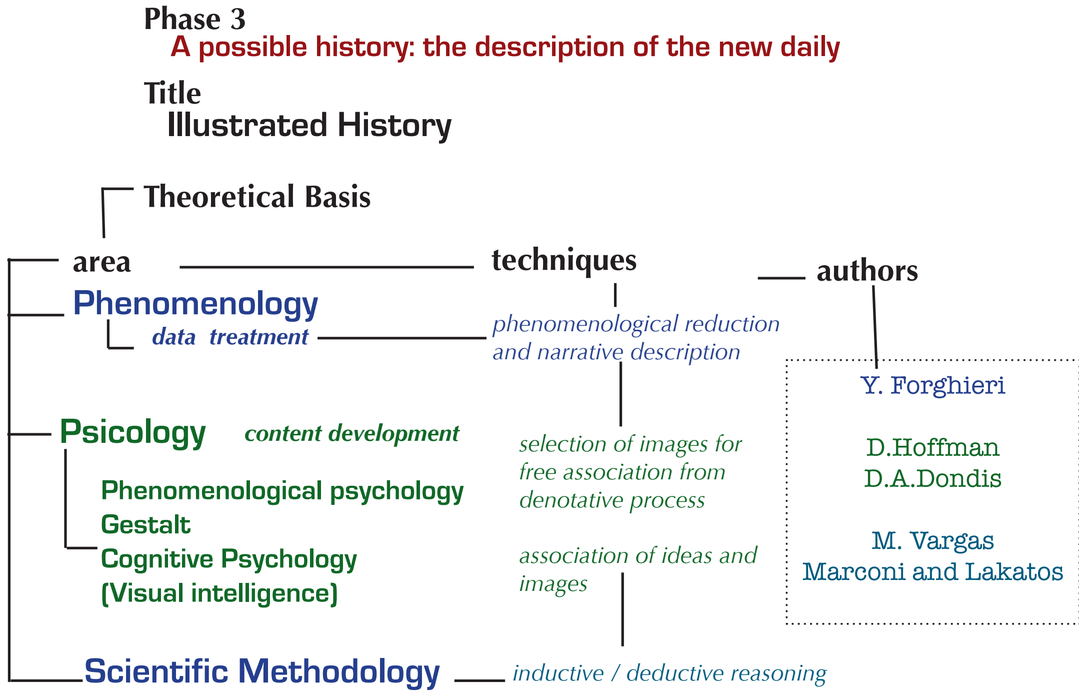

Figure 5 – Synoptic diagram: a possible history

Last considerations

Desirable characteristics for the proposed instrument

Just like a psychologist who adopts a given line of work to help his patient live better, trying to understand all the aspects of the patient's personality, the designer should, more than just understand the user, foresee his necessities, going from the collective subject identified as a consumer to the individual subject, the character that represents him, striving for an empathic relationship that allow the ideal distance to analyze the other, to "*feel what he would feel if he were in the situation and circumstance experienced by another person*" .

The proposed phenomenological approach allows a better understanding of the subject and of his quotidian. Being an inclusive theoretical structure, it also permits an easier updating just by substituting the key elements that are described in the tables used throughout the process.

The examination derived from the distancing using the phenomenological reduction technique allows the rationalizing of the data selection according to the criteria presented by Hoffman (2000), proving itself efficient in the creation of symbolic charts that help to build a history. The proposed structure for the analysis and the description of the elements to be observed favoured the facts of the quotidian, indicated as the most important for an analysis of society.

The organization of a non-linear structure allows you to work simultaneously with the 3 elements, allowing an organization that facilitates synchronous work in multidisciplinary teams.

Thus we believe to have proposed a methodological approach that has granted the final product a meaningful theoretical consistency to be presented, discussed and revised afterwards.

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Converting the participants' verbal expressions into design factors

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Abstract

Investigating and extracting users' desires and aspirations often conduct design researchers to a great deep challenge. Therefore, the designers usually examine several ways to get closer to these unrevealed feelings. These ways include applying various qualitative and quantitative techniques. Amalgamation of these techniques might be the most desired technique among designers in revealing deep inside feelings. But once a qualitative technique is applied, the design researchers deal with the difficulties of making the outcome data, including verbal and visual expressions, comprehensible enough in order to be used in the subsequent steps of design or to be conveyed to product developers. So, their usage of such qualitative techniques would be subject to misconception and misunderstanding, and here, the expertise of designer will have a crucial effect. Consequently, designers often find qualitative data formats as imperfect reports as they might not be applied convincingly throughout the design process.

This paper presents some encountered complexities of a pilot survey titled "Designing and Implementing an Artificial Design Tool Based on Improved Kansei Engineering" which, due to its concept, involves applying intermingled quantitative and qualitative methods. In addition, this paper is an effort to describe the borderline between quantitative and qualitative methods and their transformation point, and also to describe some practical solutions suggested by the authors.

Within any mixture of quantitative and qualitative techniques, there are two participants: human in one side (both as designer and also the focused and target group) and machine (computer) on the other side. In other words, within any combination of these two techniques, we encounter the qualitative data expressed by the target group and self perception of designers on one hand, and the quantitative data produced or required by the machine on the other hand. And then, the problem will be how to take advantage of these two sources for the analysis and concept generation phases. Surely the future methods of design together with the future design-assistant machines will raise this fundamental question: how can we overcome the rigid borderline between qualitative and quantitative methods and make a seamless concept of co-qual-quant model which will bolster the real human-machine connection. It is one of the design complexities of the time and one of the requisites of the future. We have come up with a solution through a conducted case study, in which we have made a bridge between the human and computer. So, we have used some qualitative methods on the human side (for example PPP and Mood Board) and some quantitative techniques (such as AHP) on the other side and we have tried to infer some co-qual-quant model-based parameters to inject to the design machine as a pure quantitative instrument.

Keywords

User-centric design, qualitative techniques in design, design problem solving, Kansei engineering, AHP in Kansei Engineering, co-qual-quant model in KE

Emotional bonds between users and products are an essential element that can determine the commercial success of a product. Eliciting user desires and emotions often presents a challenge to design researchers. Users can offer a valuable design resource to support the designing process. However, such involvement can be perceived as problematic. This is partly because users find it difficult to conceptualize and express their ideals and wishes, and therefore, they need to be supported. Product functionality as such is closely interwoven with social and cultural values. Users are not always conscious of their needs or may not regard particular pieces of information as useful. Likewise, users are not always able to verbalize their emotions and reflections. Coates distinguishes between the idea of the stereotype (what a typical product is currently like) and the ideal (the imagination of how an object should be like). New designs aim to come reasonably close to the ideal, whilst not leaving the perception of the stereotype (standard) too far behind. Coates criticizes the use of focus groups in market research based on its preoccupation with stereotypes instead of ideals, because the stereotype is what participants know best about and agree most upon. Ideals are “fuzzy” as they vary across people and are not necessarily conscious. *Blue-sky* and *what-if* possibilities are therefore more difficult to reflect upon and verbalize.

So, it is important to give users many different channels through which they can express their requirements and ideals. Several qualitative techniques like Mood Board and Product Personality Profiling have been proposed and employed recently to retrieve peoples' ideals rather than their stereotypes to overcome these shortcomings. A methodological “trick” to trigger novel ideas was employed by encouraging people to consider the “future”. By assisting users in *suspending reality*, new ideas and wishes may emerge. People begin to think more creatively and disclose their wishes and ideals more freely.

These techniques broadly use Images and enable communication of intangible emotions such as happiness, sadness and calm, beyond linguistic restrictions. Images are a powerful resource to convey meanings, particularly emotional values and experiences. Especially, abstract imagery which is applied in Mood Boards is often more successful in this than figurative images which can have strong literal interpretations. As they tend to be purely visual, they transcend linguistic restrictions. Their application can serve as an important tool to communicate values that cannot be expressed easily through words.

As the subject of design becomes more novel and complex, it would be more difficult for the users to think and imagine the hidden aspects of the subject, and also their unrevealed desires. Here, Qualitative techniques play an important role. They are more powerful tools in helping people visualize the current and future context of design and their imaginary and ideal products. Therefore, applying them seems crucial, but also interpreting their result might be a bit of minefield. So, in some occasions converting these qualitative data to quantitative data will bring about confusion and should be solved using combination of appropriate techniques. This is the main approach which will be discussed in this paper.

Framework of the paper:

As a descriptor for the applied technique, we propose a framework which governs all parts of the model. Here, the framework and its basis will be described.

The technique mainly combines AHP, Mood Board and PPP to provide the optimization algorithm with the necessary input parameters (attributes) and also importance weights (final weights resulted from AHP) of those parameters. The novelty of the design subject also made usage of Mood Board inevitable, because we had to reduce the representative objects in the questionnaires (sample products) into more sensible ones for the users. We used Mood Board for simplifying and reducing the representative objects from a complex, concrete and real world object (for example image of some green cars) to some simple and abstract images. Also it helps us to communicate with the unawareness of the users. In addition, we have further used our findings from both Mood Board and PPP in defining AHP criteria. Then, the final extracted weights of importance from AHP were inputted as the coefficients of the fitness function in Genetic Algorithm optimization, the project’s synthesis phase.

We will split the whole framework into some modules and will describe them separately. These segments include “attribute gathering”, “attribute reduction” (includes two sub-segments), “verification”, “importance weight extraction and final quantification”, and “result convergence”.

Case study:

This section is assigned to parts of a conducted project titled “Designing and Implementing an Artificial Design Tool Based on Improved Kansei Engineering” in which we examined application of Mood Boards and Product Personality Profiling as two qualitative techniques in some phases of Kansei engineering parallel to routine exploited quantitative tools. Further, we assessed the results by repeating the procedure with the conventional quantitative approach. The detailed procedure of case study in the first approach is illustrated in the following flowchart. Each block will be discussed separately in the following statements.

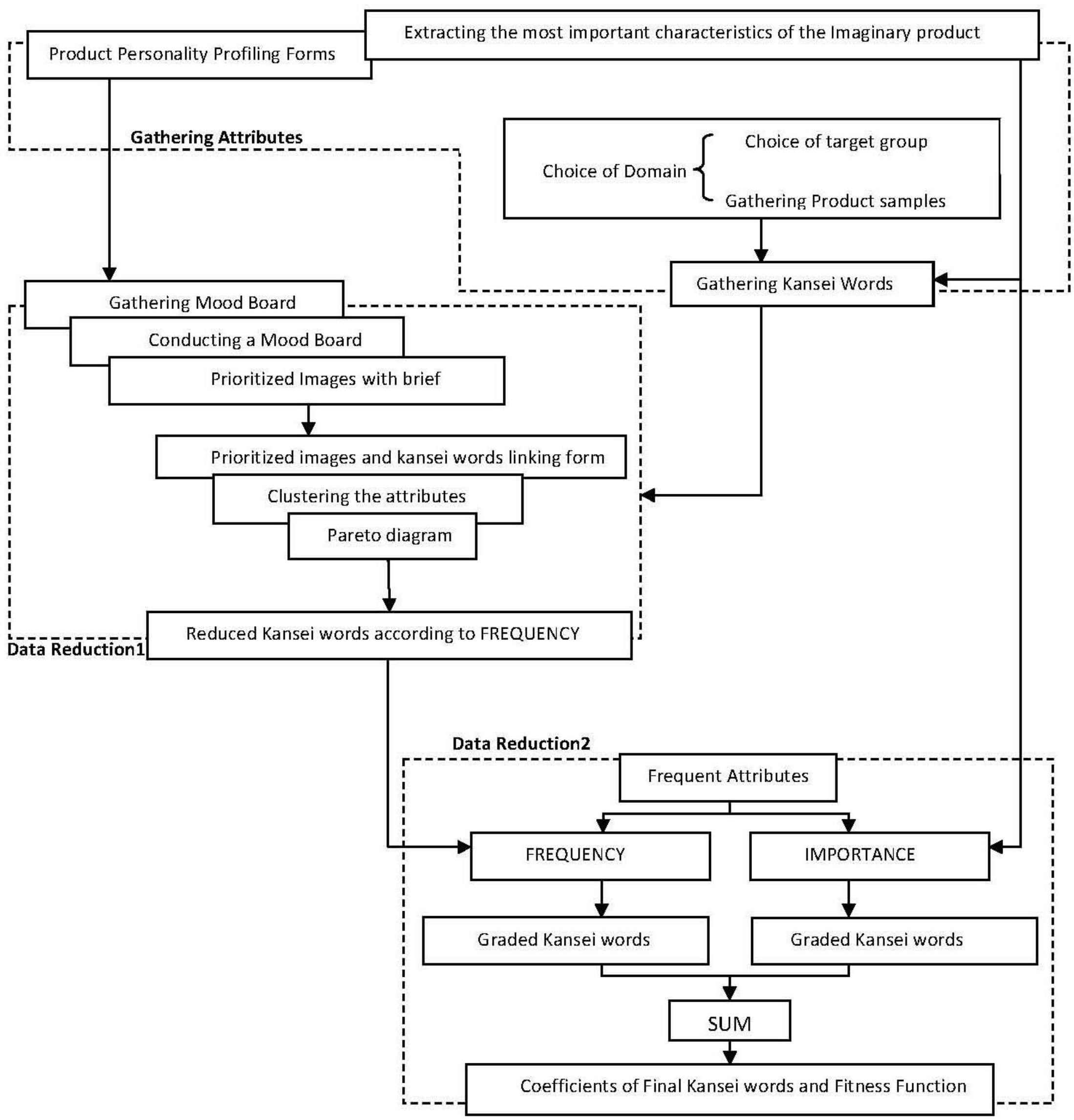

Figure 1. An overview of the whole process

Gathering attributes (Kansei words)

Commonly, the procedure of KE initiates with choice of domain in which the target group and sample products are chosen. The target group included 20-40 Iranian women and sample products ranged from electric and hybrid urban vehicles of renowned manufacturers to some new concepts. In the phase of gathering the Kansei words which is portrayed in the first dashed box in figure1, first all of the related sources such as internet, magazines, pertinent literature, experts, experienced users, relating Kansei studies, ideas, and visions were investigated, also a discussion group was held consist of 20 industrial design girl students in which they were asked to talk about the product samples and choose 3 most preferred ones in accordance with the project. All chosen samples were graded respecting their frequency and 3 of them were applied in the later PPP analysis. Then, we conducted a PPP session which included 20 participants who were shown PPP forms. This form included 3 columns for 3 selected products and also one more column for describing the imaginary product. One sample of this form is presented in figure 2.

Imaginary product	Product C	Product B	Product A	participant	
					sex
					age
					occupation
					lifestyle
					car
					personality
					Family environment
					clothes
					newspaper
					pet
					Favorite TV program
					Music
					Food
					Name
					Role in the family
					Favorite Cartoon Character
					Perfume
					Do you like to buy this product?
					Color

Figure 2. A sample of PPP form

Through PPP analysis we extracted a series of the most important attributes for imaginary products which were useful to be included with other gathered Kansei words. This analysis was also helpful for “data reduction phase”, the next step in KE.

Reduction of attributes, Phase 1:

The outline of this phase is shown in the second dashed box in figure1. Instead of regular application of marketing tools in this phase, Mood Boards was applied. At this point, previous PPP analysis was supportive in helping the design team to have much better visualization while gathering abstract images for Mood Boards. Afterward, one Mood board session consist of the same former 20 participants was held. A variety of images numbered as 778 from various categories were chosen. These images reduced to 271 images in the second classification. Then, all the participants were asked to set a layout of their 7 preferred images and also to prioritize them in accordance to their importance and relevancy to the Mood board question. They were also asked to express a short brief for each of their choices. Some of the advantages of using Mood Board were noticed as high enthusiasm among participants in fulfilling the task, and quicker understanding of the subject. One of these layouts is shown in figure 3.

Figure 3. A sample of a mood board layout used in the case study

The next task was to convert these qualitative responses to some fathomable values for the synthesis phase while reducing the number of Kansei words to the most important ones. Therefore, firstly all the gathered attributes were clustered and then linking forms were planned. This form included a list of all the new attributes and was presented to the participants to be marked for each of their 7 selected images. The list of attributes printed in the form is shown in the table 1.

Lightness	Particularity	Power	Slowness	Fun	Excitation	Complexity	Sensible
Heaviness	Ordinary	Softness	Rapidity	Seriousness	Calmness	Simplicity	Ornamental
Delicate	Sturdy	Sport	Spacious	Kind	Stylish	Compact	Happy
Sad	Mature	Childish	Feminine	Masculine	Smartness	Silliness	Unfriendly

Table 1. List of attributes

In the next step, these data were processed and the most frequent attributes were determined using Pareto diagram. The most frequent attributes in the first three priorities is illustrated in figure 4. These frequency values built the **Frequency** criterion for the second data reduction step.

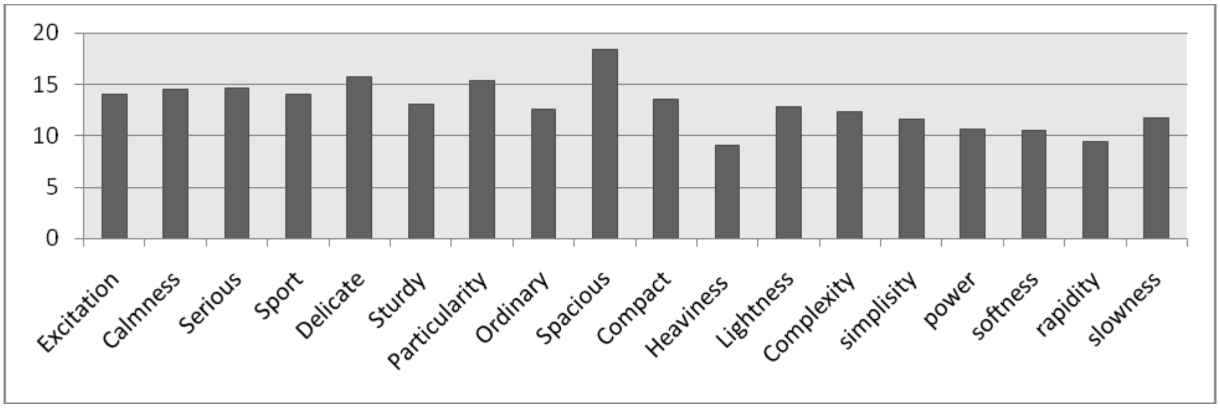

Figure 4. Comparative chart for frequency of attributes

Reduction of attribute, Phase 2:

In order to assign inclusive values to the attributes based on ideas of both participants and design team (the human side of design procedure), another reduction was conducted applying AHP. This phase is shown in the third dashed box of the figure1.As it was discussed in previous section, the output of the first reduction phase was used in defining the frequency criterion in the second step. Also, most of these attributes were in contrast with one another in the meaning; therefore, the attributes were rearranged to polar Kansei words like Spacious-Compact, Excitation-Calmness before being processed.

On the other hand, the **Importance** criterion was defined in accordance to the results gained from PPP analysis based on the designer's viewpoint and interpretation. Within this free point of manipulation, designers will be able to incline the results with respect to the main objectives of the project. For example if designers wish to orient towards a highly delicate final concept, they can assign a greater importance degree to the delicate attribute while processing it in AHP.

Furthermore, the partial scores for each attribute in both criteria were added together and the final scores were determined. Table 2 presents the first 5 attributes with higher final scores. These values were further used as coefficients of fitness function in the synthesis phase based on Genetic algorithm optimization.

FINAL SCORE	ATTRIBUTE
0.17	Spacious-Compact
0.114777	Sturdy-Delicate
0.088467	Particularity-Ordinary
0.083879	Serious-Sport
0.082718	Excitation-Calmness

Table 2. Final score of attributes based on co-qual-quant model

Verification:

In order to evaluate the quantification procedure of qualitative input data, a parallel process was conducted. Within this process all the attributes were graded using seven grade scales, and then the ten highest scored attributes were used in the first step of fuzzy survey. Figure5 shows a frame of the interface of this survey in which all the samples were scored with respect to attributes.

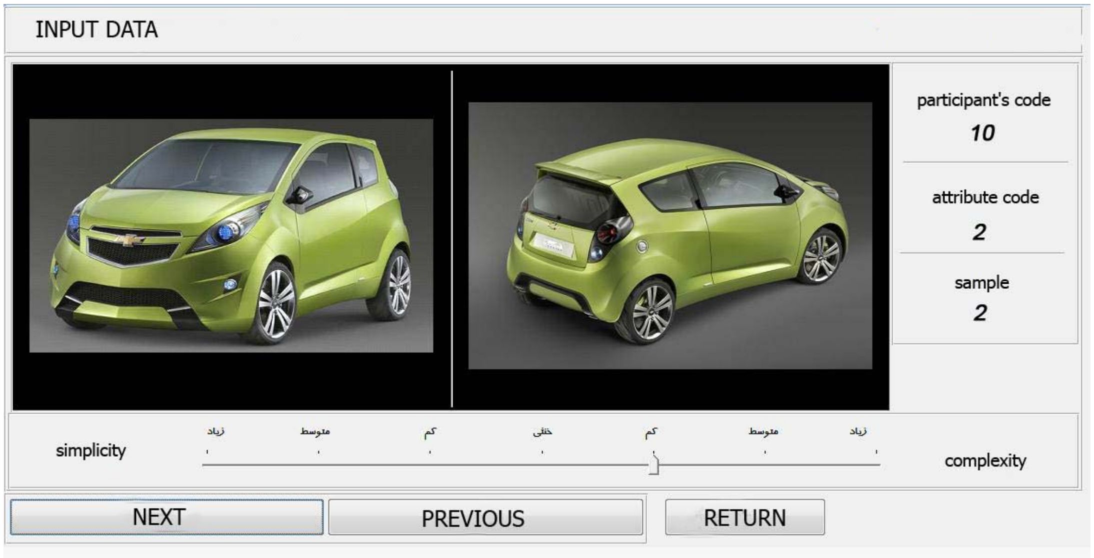

Figure 5. Fuzzy survey interface sample (Phase 1)

The output matrix of the first fuzzy step was categorized and reduced using Factor Analysis. By applying factor analysis the dependant variables or attributes were recognized and merged into one unique group, and then new name was given to this group of attributes. Interestingly, it was possible to categorize and name the main extracted attributes within similar five attributes obtained in the previous procedure like Spacious-Compact, Sturdy-Delicate, Particularity-Ordinary, Serious-Sport, and Excitation-Calmness.

In the second step of fuzzy survey, the data base obtained from the first step was used in order to give the participants a chance for comparing (and making a convergence between the mental concepts of Kansei terms), and also enhancing the accuracy of their choices. A frame of the survey interface is shown in figure 6. All participants were asked to firstly score the vehicle in the left side of the screen and then click the Enter button to see the car with the closer score to her choice. She was then free to change in her assigned scores according to her preference and was able to see the changes in data base accordingly. She was able to continue the procedure as long as she would feel pleased by her scores.

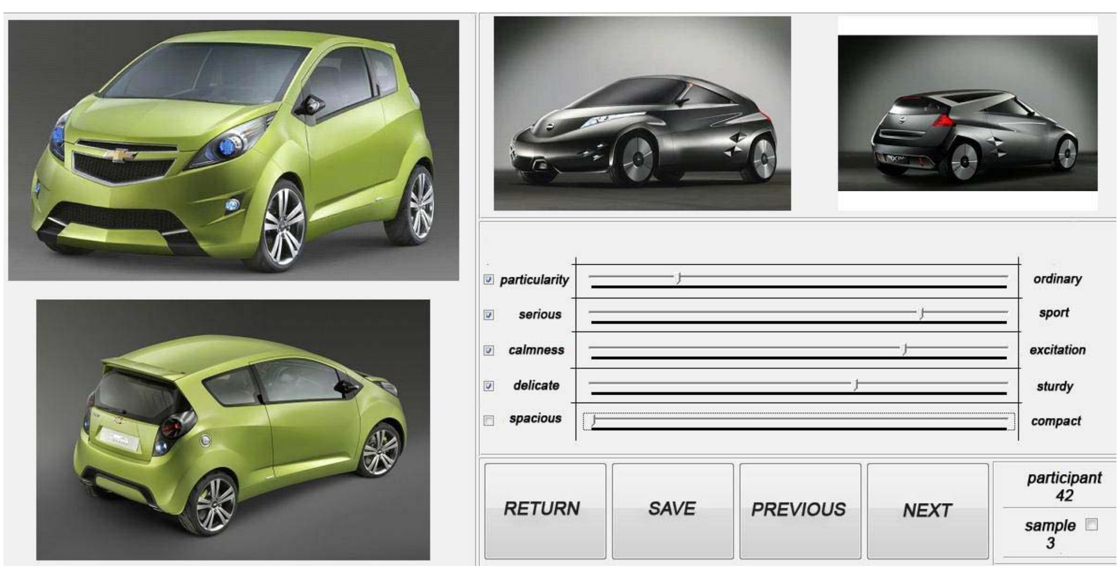

Figure 6. Fuzzy survey interface sample (Phase 2)

Importance weight extraction and final quantification

Due to the overall positive meaning of all of these attributes, in the next task they were all graded based on variance, which means that attributes with lower range of variance are of the most importance and have balanced mixture of both polar attributes, and vice versa. So, the attributes were again prioritized and scored applying AHP based on variance. Table 3 presents the new degrees of these attributes after AHP.

FINAL SCORE	ATTRIBUTE
0.177954	Spacious-Compact
0.088992	Sturdy-Delicate
0.077788	Particularity-Ordinary
0.09352	Serious-Sport
0.06641	Excitation-Calmness

Table 3. Final score of attributes based on pure quantitative procedure

Results Convergence:

After comparing the result of both methods (the pure quantitative method and the new co-qual-quan-titative method), it seemed that there was a meaningful correlation between the two sets of results. It was also expected that there would be such correlation and similarity between the results, because we have had selected a concrete and previously well defined object as the object of the design: a car. But it should be clearly mentioned that for different design objects or methods (for example for pure conceptual or state-of-the-art objects of design or for methodologies which use pure conceptual medium objects) there will be no guarantee for the convergence of the two results, indeed there will be a degree of divergence from a little difference between outputs of two methods up to total different sets of results.

Conclusion:

The new methods of design require the designer to use the numeric and quantitative tools. On one hand the daily developing use of CAD tools and computers and on other hand the need for satisfying the public interest, both force the designer to use computational and quantitative methods. This surely will save a lot of time and expenses in the manufacturing and designing industries, and accordingly will guarantee predicted success for the product.

But on the other hand, this may rise up some new problems in the design area: the designer role will be diminished and the users may show a faulty or unaware response to the quantitative design tool. This requires the methodology designers to revise the methods for overcoming this method.

On of the solutions is to inject some sort of “unconscious” awareness to the tool, and on the other hand there should be always enough role be left for the radical or intended presence of the designer.

As the result of such intention, we have re-designed some parts of a classic “Kansei Engineering” methodology to fulfill these needs. We have added some qualitative methods (as mentioned above, including PPP, MoodBoard and AHP) to the methodology and tried to expose the participants to some fully conceptual aspects and meanings of the object of design. Also we have tested the results in a real-world implementation, a project entitled “Designing and Implementing an Artificial Design Tool Based on Improved Kansei Engineering”.

As the final verification method, and as long as the subject of our project permitted us, we have rechecked the whole results with a pure quantitative and tested method and the result was to a compelling degree consistent. Despite what was mentioned above, in different design solutions or objects, the results might not be convergent like the mentioned project. However, as it seems that the philosophy of the modified methodology is enough reasonable and obvious, we suggest the usage of co-qual-quant techniques in such kind of complexities; for instance, a conceptual and ambiguous object or a culturally unfamiliar one. Not to mention the fact that surely there would be other combinations of such approaches, mixture of qualitative and quantitative approaches, which would yield the appropriate results.

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The Success of Designer-producers in Québec

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Abstract

The author identified more than 120 designer owned manufacturing companies in Québec. He interviewed 50 designers who owned such companies, and obtained detailed information on more than 75 companies. He examined these companies for: area of activity, size, longevity and economic impact. The companies are highly concentrated in the area of lifestyle products and are of comparable size to other manufacturing companies, show similar revenue per employee and have similar economic impact. They are also much more successful than other Québec manufacturers as far as longevity is concerned. These designer-owned companies create more direct employment than do industrial design consulting firms in Québec. The author proposes several hypotheses for the business success of designer-producers.

Keywords

Professional practice; Industrial design; Manufacturing; Business; Success; Québec

Since the 1960s, the practice of industrial design has been part of the industrial and cultural landscape of Québec. The demand for industrial designers was first felt among design consultancies, but the supply of design jobs within manufacturing companies soon greatly outnumbered that of consulting jobs (Emploi, 2009). This was followed by a new wave of employment in the virtual imaging field, representing a vocational route for a new generation of image-makers especially in the area of electronic gaming (Trépanier and Gosselin, 2007: 22). Other industrial designers began to work in public institutions, research organizations, in the promotion or management of design. A significant proportion of designers have also followed career paths that have led them to hold strategic or leadership functions in companies from a variety of sectors.

In addition, a good number of designers have edited, produced, or otherwise distributed their own creations at one time or another in their careers. Some of these designers have gone on to establish their own manufacturing companies. We call these entrepreneurs "designer-producers"—designers, because design is their field of training or what they claim to be, and producers, not only in the sense of manufacturers, but also in the sense of economic agents who participate in the risk and ensure the financing of their companies, much like film producers. These companies and their performance are the subject of this paper. It is based on a larger study, which was conducted in 2009, entitled "*Les designers-producteurs au Québec"* (Desrosiers, 2009).

The companies we have studied encompass the broad spectrum from craft production to mass production, from local manufacturing to offshore production, from regional distribution to global marketing. Though not common, the practice of designer-producer has nevertheless existed since the birth of industrial design (Choko et al., 2003). Are designers successful in business? Why do they succeed or fail? Are the economic repercussions of designer-producer companies significant? These are some of the questions this paper will address.

Methods used

From January to July 2009, around 50 interviews were conducted with designer-producers, usually at their companies or workshops, occasionally at a café or in their homes. During these meetings, the designer-producers often recommended other designers or identified other designer-producer companies. In this and other ways, our list grew and now includes over 120 companies. If one considers that no more than 3000 individuals practice industrial design in Québec (Emploi, 2009), but more realistically 1500, this list is actually quite extensive.[1] Without claiming that we have identified all companies, we are confident about the representativeness of our study. Since few studies had addressed this issue, we chose to chronicle not only current companies, but also those that were founded over thirty years ago and that are still active, have been sold or merged, or have simply closed.

The interviews were recorded and took place in two phases. A first questionnaire was used to identify the characteristics, motivations, and socio-economic profile of designer-producers, while a second questionnaire produced a description of each company. By combining a number of quantitative and qualitative questions in the interviews, we were able to use both types of information and establish correlations between the two where appropriate. The collected information was then revised, supplemented, and verified by consulting the *Registre des enterprises du Québec*, the database of the *Centre de recherche industrielle du Québec* (CRIQ, 2009) and the biographical notes of designers on their websites or in press kits (Choko, 2004). Several shorter phone interviews were also conducted.

Interviewees were not selected randomly. We attempted to reflect the geographical, historical, and economic diversity of the field. We interviewed in Québec City, Laval, Boucherville, Rigaud, Verchères, and of course, Montréal. We met men and women between 28 and 76 years of age, some whom have been designer-producers for most of their professional lives, and others who have only produced occasionally.

Where possible, and where our sampling permitted, we compared the data with those of similar studies focusing on entrepreneurship (Aramis, 2006) or the manufacturing sector in Québec (Statistiques, 2007).

Definition of designer-producer

In 2007, Michel Trépanier and Pierre-Marc Gosselin (2007:13-15) identified three types of industrial design practice: in-house industrial designers, industrial design consultants, and independent industrial designers or manufacturers. Our study addresses, in part, this latter category. It is our understanding that this last category is quite inappropriate and somehow assimilates practices that are often opposite in the spectrum of practices of industrial

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1 Data from Service Canada shows 2,950 industrial designers in Québec. A review of this data and their definition suggests that Service Canada uses a broader definition of industrial designer than we do and includes many categories of draftsmen. Their definition is as follows: "Industrial designers conceptualize and produce drawings for manufactured products." A trade definition such as this is at odds with the professional vision that characterizes the industrial design milieu.

design. Leaving the discussion of this typology aside, and to further orient our study, we first define what we mean by “designer-producer.”

The definition of design provided by the International Council of Societies of Industrial Design can be read as follows:

"Design is a creative activity whose aim is to establish the multi-faceted qualities of objects, processes, services and their systems in whole life cycles. Therefore, design is the central factor of innovative humanization of technologies and the crucial factor of cultural and economic exchange." (ICSID, 2003).

This broad definition includes several activities not traditionally associated with industrial design. The design of a chirurgical procedure could certainly fit this bill, yet few would call this industrial design. It also encompasses both goods and services, and considers the aesthetic attributes of objects as part of their "multifaceted qualities.”

In this context, what is the meaning of "industrial"? Does it refer to mechanized or mass production, or simply to the processing of raw materials? How central are materials to this definition when all around us, objects are being defined less and less by their materiality, and more and more by the meanings and values we attribute to them? Furthermore, the definition of “industry” is associated with the production of goods as opposed to the provision of services. This separation between goods and services, already outmoded (Findeli, 2001: 15), is increasingly difficult to maintain. In our modern economies, goods can practically no longer be dissociated from services, and vice versa. Whether we are talking about a bank account booklet, a simple light fixture sold with a guarantee, or software for a video game console, all these products reflect this duality.

We have opted for the broadest and most inclusive notion of industry. We visited designer-producers whose workshops occupy a few square meters, and we visited major industrial facilities. We also looked at companies whose entire production is outsourced, and other companies where every stage of production is conducted in-house, including the manufacturing of their moulds and production tools. In the lighting industry alone, we met artists, craftspeople, technicians, architects, graphic designers, environmental designers, and industrial designers who have started and operated manufacturing companies. In our opinion they are all designers. They define themselves as designers as does the general public. As such, we met designers from a variety of training backgrounds, with different experiences and with various business skills. In this study we did not consider diplomas as the sole criteria for defining professional identity. Rather, we placed an emphasis on the accounts of the participants themselves.

Insofar as we were interested in the practice of designers who have started production companies, our primary concern in this study was the examination of manufacturing companies. Thus, although consulting firms are obviously companies, and their owners and founders entrepreneurs, they were excluded from our area of research unless they comprised a division or branch whose mission was to produce, manufacture, or distribute goods. We also excluded from our interviews those companies whose main activity is trade.

We thus define designer-producers as “designers who have undertaken to produce goods and services (or have them produced) and to market them." This definition encompasses both artisans and more traditional manufacturers, and is one that the people whom we interviewed could easily identify with.

Measure of Success

Early in our study, we wanted to identify factors and markers of success. It quickly became apparent that the concept of success is relative (Chandler et Hanks, 1993). First, success is relative to each entrepreneur and to each entrepreneur’s motivation for transforming his or her project into a company. While money was a primary motivation and a measure of business success for some, it was not the case generally. For many designers, distribution, reputation, the satisfaction of seeing their products sold and therefore purchased, lifestyle, as well as independence were the main motivations. Secondly, success is relative to that of others.

To a large extent, it is the motivation of the entrepreneur that defines his success. Satisfaction changes over time as the motivations of entrepreneurs change. Achieving a goal can sometimes bring about a new one, while for other entrepreneurs, attaining the goal or the original vision is an end in itself.

While all businesses must end, the great majority of entrepreneurs invest time, effort, and money so that their ventures will last. It is interesting to note, however, how the expiration date of a company is a concept that, at least initially, is foreign to entrepreneurs. A few did foresee the end of their ventures, but for the most part, these projects were of indeterminate length (Desrosiers, 2009:21).

In industrial design, longevity is rarely a measure of success. Most design awards, for example, do not recognize the durability or longevity of goods. Instead the organizers request that these products be recent, usually less than two years on the market. There are even awards for products that do not or will not exist. Design tends to celebrate innovation and novelty, not longevity and durability. For the few designers that enjoy license revenues, however, longevity does have its rewards. It is ironic that in industrial design it is easier to obtain an award for a product that does not exist than to get one for a product that has sold for a decade.

In business, it is generally accepted that profits, size and longevity (Dafna, 2008: 305-306) are the ultimate measures of success. Since unprofitable businesses do not endure, we considered profit a *sine qua non* condition for a company’s survival, i.e. it is a means more than an end. In terms of economic impact, job creation, and social utility, a company's longevity is certainly an indicator of its success, and it is the indicator we retained.

Findings

Areas of company activities

The fields of application of industrial design are many and varied. Each year, in Québec universities, a large number of undergraduate projects in industrial and environmental design are related to the fields of transportation, health, sports and recreation, and electronics. Furniture and household consumer goods are also presented, but they clearly do not represent the bulk of the projects of these future designers.

Through their creative input and diverse technical expertise, designers are able to contribute to a wide variety of industries. It must be said, however, that the more a product undergoes transformation and processing, the more designers are involved in its production. Designers are mostly absent from the primary and food sectors. Although it is difficult to classify companies according to the level of contribution of designers, based on the NAICS,[2] we separated industries into two groups: those that are "accessible" to designer-producers and those that are not. In Table 1, industry groups that we considered "accessible" appear in bold. Columns indicate the percentage of manufacturing shipments by year for each industry group.

	1992	1997	1998	2001	2002	2004	2006	2008
Food Manufacturing	14,0	11,7	11,2	10,8	11,1	11,2	10,9	11,8
Beverage and Tobacco Product Manufacturing	3,9	3,1	3,1	2,8	3,0	2,6	2,1	2,3
Primary Metal Manufacturing	8,8	10,0	10,2	10,4	10,3	11,2	14,8	15,2
Paper Manufacturing	9,6	10,0	9,9	9,1	8,6	7,9	7,4	6,7
Printing and Related Support Activities	3,0	2,4	2,6	2,4	2,4	2,4	1,9	1,8
Petroleum and Coal Products Manufacturing	4,9	4,1	3,3	5,1	5,4	7,4	9,7	11,7
Textile Mills	2,6	2,4	2,5	2,0	2,0	1,6	1,0	0,7
Textile Product Mills	1,2	0,9	0,9	0,8	0,8	0,6	0,5	0,4
Chemical Manufacturing	7,6	7,0	6,2	6,2	6,3	6,8	7,6	6,5
Machinery Manufacturing	3,7	3,9	4,2	3,9	3,9	3,8	3,7	4,1
Apparel Manufacturing	**5,5**	**4,3**	**4,1**	**3,6**	**3,5**	**2,8**	**1,9**	**1,3**
Leather and Allied Product Manufacturing	**0,6**	**0,5**	**0,4**	**0,4**	**0,3**	**0,3**	**0,1**	**0,1**
Wood Product Manufacturing	**4,7**	**6,2**	**6,4**	**6,1**	**6,7**	**7,1**	**5,4**	**4,3**
Plastics and Rubber Products Manufacturing	**3,3**	**3,8**	**3,9**	**4**	**4,4**	**4,6**	**4,6**	**4,1**
Nonmetallic Mineral Product Manufacturing	**2,0**	**1,8**	**1,7**	**1,8**	**2,0**	**2,2**	**2,1**	**2,1**
Fabricated Metal Product Manufacturing	**4,5**	**4,3**	**4,4**	**4,9**	**5,0**	**5,2**	**5,0**	**5,6**
Computer and Electronic Product Manufacturing	**6,7**	**7,0**	**8,1**	**6,5**	**5,1**	**4,8**	**3,4**	**2,8**
Electrical Equipment, Appliance, and Component Manufacturing	**2,6**	**2,1**	**2,1**	**2,4**	**2,4**	**2,4**	**2,6**	**2,5**
Transportation Equipment Manufacturing	**6,9**	**10,7**	**10,7**	**12,3**	**11,9**	**10,5**	**11,1**	**11,8**
Furniture and Related Product Manufacturing	**2,2**	**2,1**	**2,2**	**2,9**	**3,0**	**3,0**	**2,5**	**2,6**
Miscellaneous Manufacturing	**1,6**	**1,9**	**1,8**	**1,6**	**1,8**	**1,7**	**1,7**	**1,7**
Industries accessible to designers	**40,6**	**44,7**	**45,8**	**46,5**	**46,1**	**44,6**	**40,4**	**38,9**
Industries not accessible to designers	59,4	55,3	54,2	53,5	53,9	55,4	59,6	61,1

Table 1. Québec manufacturing shipments, by industry group, 1992-2008, in % (Enquête, 2009)

Many in-house designers work in the transportation or rubber and plastic industries, which alone account for 16% of the manufacturing activity in Québec, and about 40% of accessible manufacturing. In contrast, about two-thirds of designer-producers form companies related to household objects (furniture, decorative accessories, lighting, tableware). Out of some 100 companies established by designers, 30 were from the furniture sector, 13 from the lighting sector, and 18 from the decorative accessories or

2 North American Industry Classification System.

tableware sector (figure 1). Therefore, designer-producers tend to operate in areas that represent only about 5% of manufactured goods in Québec. We were thus able to identify the sector of choice for designer-producers (table 2).

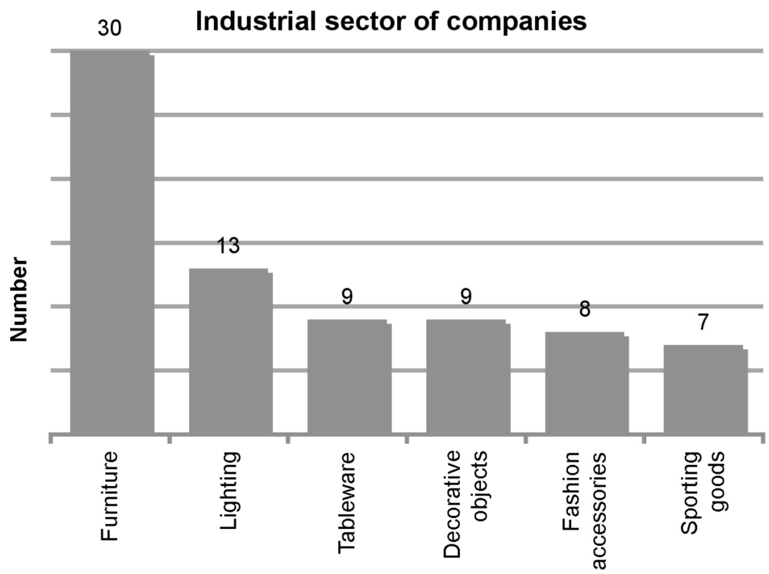

Fig 1. Industrial sector of companies founded by designer-producers

We must be cautious in interpreting these figures, since there is no indication that business opportunities are distributed proportionally to manufacturing shipments. The fact remains that the chosen area of activity of designer-producers is not driven as much by market opportunities as by their love of the activity and the prospects it offers for self-expression (Desrosiers, 2009:19). One could argue that this area requires less investment, or that there are fewer technical and commercial challenges; this is not the case, however. Recent years have been extremely demanding for the furniture sector, with fierce international competition and a particularly difficult economic climate.

	1992	1997	1998	2001	2002	2004	2006	2008
Electrical Equipment, Appliance, and Component Manufacturing	2,6	2,1	2,1	2,4	2,4	2,4	2,6	2,5
Furniture and Related Product Manufacturing	2,2	2,1	2,2	2,9	3,0	3,0	2,5	2,6
Sectors of choice of designer-producers	**4,8**	**4,2**	**4,3**	**5,3**	**5,1**	**5,4**	**5,4**	**5,1**

Table 2. Manufacturing shipments in sectors of choice for designer-producers by industry group, Québec, 1992-2008, in % (Enquête, 2009)

Designers create companies in areas they are passionate about (Desrosiers, 2009:18). For a few designers, this means sports or recreation, but the vast majority opts for the more expressive areas of decorative and household objects. This passion for beauty, for personal expression and aesthetics, is the same motivation that led them to design. This feature of designer-producer companies is important and reveals the underlying motivations of this group of entrepreneurs. It also underlines the historical link between the design profession and decorative arts, here as elsewhere. But does this passion, infused with emotion, prevent entrepreneurs from cogently building their companies, or on the contrary, does it provide the necessary fuel for driving them?

Company size

Some measurements are used to assess a company's size, the most common being the number of employees and sales. These two factors vary considerably during a company's life cycle. From the entrepreneurs we interviewed, we obtained the highest sales and employee numbers on record for each company. We must therefore be cautious about the resulting portrait because it is the most favorable possible. For example, our top company in terms of job creation employed 300 people. However, these jobs were not all in Québec, and the company shut down abruptly in 1982 because of soaring interest rates.

The number of direct jobs is an important economic and social indicator (figure 2). We obtained employment data for 75 companies. About half of these companies had two employees or less. The average number of jobs created, at peak employment, was nineteen.[3 4] About one third of the companies had created no jobs, while nine companies had created more than fifty. The latter are all well-established, commercially successful companies.

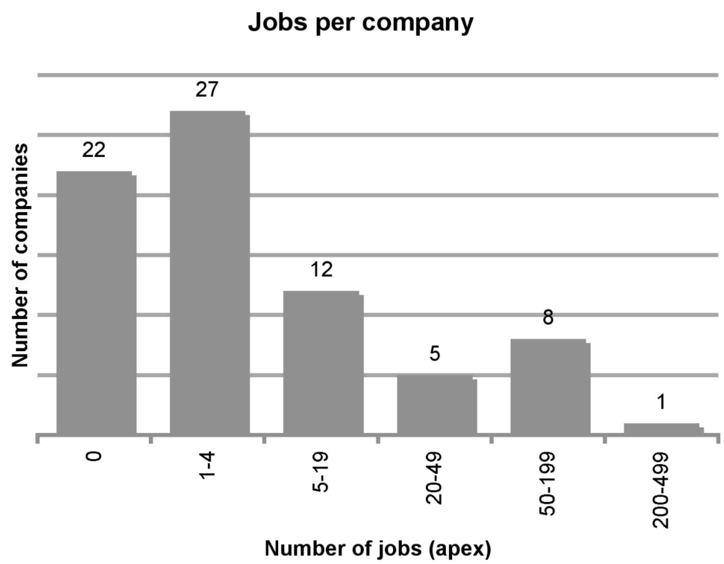

Fig 2. Number of jobs created per company

3 Mean = 18.79; standard deviation = 46

4 If we survey only job-creating firms, the average increases to 27 jobs.

Questions can certainly be raised about companies that create no jobs or whether they can be legitimately considered businesses. A large proportion of these companies were created for specific projects, but were dissolved for lack of income; a few remained active because there was no reason to close them, and some remain at the start-up stage. Nevertheless we chose to consider all of the above as businesses.

Another measurement of a company's size is its revenues. Total median revenues were $100,000 per year. This represents total median revenue of about $50,000 per job. This low revenue per job indicates that these are generally small and not particularly productive companies. It also indicates that a significant portion of these companies are not creating jobs. The chart (figure 3) shows the distribution of companies by revenue. The average maximum annual sales per company were around $2,000,000, with revenues around $100,000 per job. As in most industrialized societies, a high proportion of these companies are micro-enterprises, but a third of designer-producer companies showed sales in excess of $500,000.

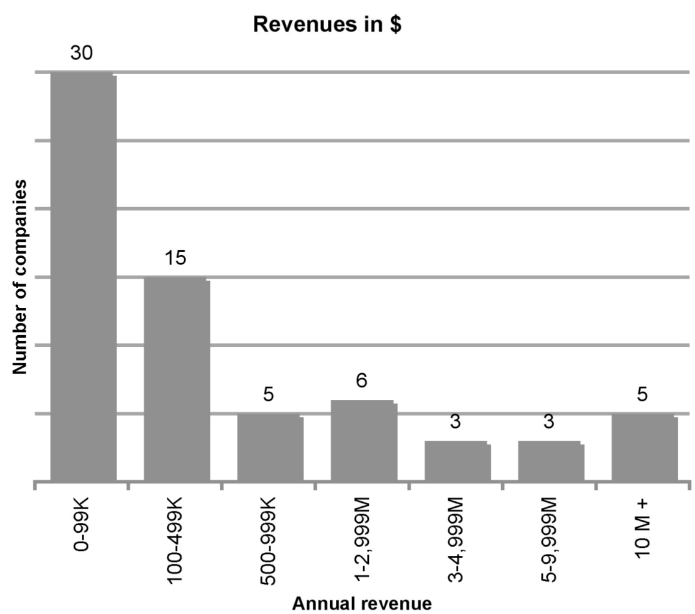

Fig 3. Annual revenue per company

When compared to the manufacturing sector in Québec (Statistiques, 2007), designer-producers companies fared well, creating slightly more jobs per establishment and with slightly higher revenues per employee. When compared to other companies in the sector of choice of designer-producers, their results were somewhat similar to their peers.

Company longevity

One of the main questions this study seeks to answer is whether designer-producer companies are successful. We wish to know how they compare to other companies in Québec. At the beginning of this section, we examined and then defined the notion of success in terms of a company's longevity. In 2008, the MDEIE[5] published a study entitled "*Taux de survie des nouvelles entreprises au Québec*"[6] (Desbiens et al., 2008). Unfortunately, we were unable to compare our results directly with results from the MDEIE study. We did not have access to the data it used, and it was difficult to ask owners about data from their companies' T4 slips (fiscal employment slips) for past years. In addition, we would have had to compare data from the same cohorts and ensure that we had identified all companies of a single and same cohort.

Whereas the authors of the survival rate study define a company as "an economic and social structure having at least one employee working in an organized manner to produce goods or services for its customers" (Desbiens et al., 2008: 88), we did not consider employment as a necessary criterion for inclusion in our sampling. However, we did use this definition in determining the survival and continuity rates of designer-producer companies, so we could better compare them. We have vested significant efforts in identifying the largest possible number of designer-producer companies. It seems likely, however, that companies that shut down abruptly for lack of funding, markets, or perseverance may be underrepresented in our sample. Since these false start-ups rarely generate jobs, we estimate that this has had little impact on the survival rates we have calculated.

In examining the survival rates of all manufacturing firms in Québec, we found that half of them ceased their activities after three years (Desbiens et al., 2008: 43). If we examine the same rates for designer-producer firms, we note that these companies survive, or endure, for a long time. Three quarters of the companies are still operating after nine years (figure 4).

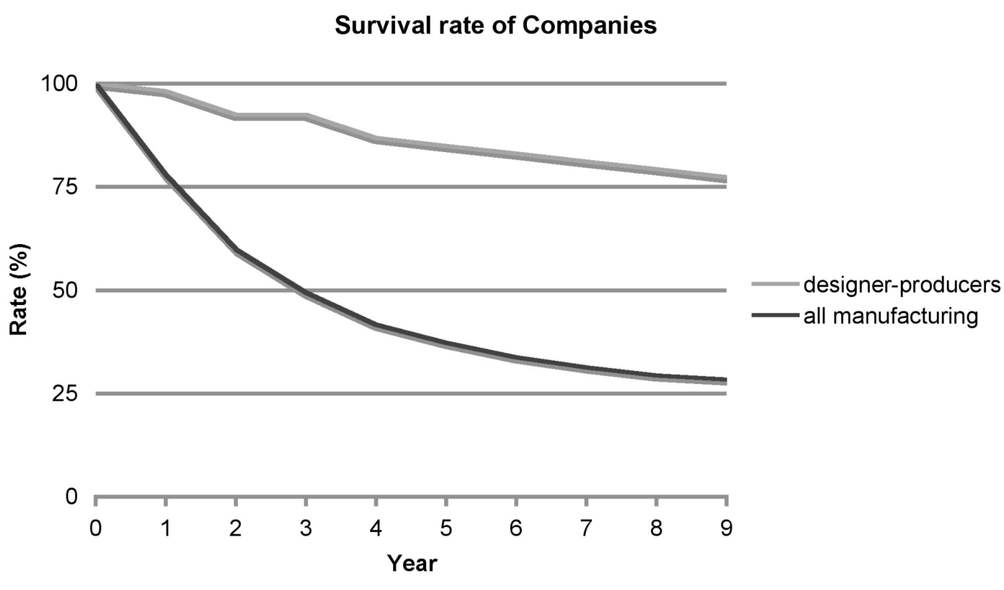

Fig 4. Comparative survival rate of companies in Québec

5 Ministère du Développement Économique, Innovation et Exportation

6 Survival rates of new businesses in Québec

Economic impact

Do the companies we studied have a significant economic impact? Obviously they do for the thousands of people who depend on them for their bread and butter. We estimate at aproximately 13,000[7] the number of job-years created by the 74 firms we surveyed, and nearly 19,000 if we extend our results proportionally to our entire population of companies. It is both a little and a lot. A little, given the millions of job-years represented by the Québec job market, and a lot when one considers the small number of designers trained here and the 125 companies identified in our study.

These jobs are, for the most, productive, wealth creating, unsubsidized jobs, and they have a multiplier effect within the economy.

We compared the number of direct jobs created by designer-producers with those created by designer-consultants. Using the MDEIE directory of industrial design consulting firms (Répertoire, 2009), we were able to total the number of employees represented by this sector. All told, there were 370 jobs for 140 consulting firms or self-employed consultants.[8] Even if we extrapolate these jobs over thirty years,[9] it is clear that designer-producers create at least as many jobs in Québec as do designer-consultants. This is not the only measurement that quantifies the economic activity and impact of designers, but it affirms that the practice of designer-producer is as important as that of designer-consultant in terms of job creation. Both practices, therefore, deserve the attention and support of educational institutions and governments.

There are other impacts of designer-producer companies. Inasmuch as they produce innovative and original products, these companies contribute to the cultural identity of Québec and Canada. The economic value of innovation and its relevance as a business strategy has often been debated, especially in societies in which money and the price of objects are first-order criteria. Despite our passion for design, the answer is not always obvious or rational. What is indisputable, however, is that all societies, to varying degrees, express and identify themselves through the objects they produce. It is a source of pleasure and pride for them. This, then, is an undeniable contribution of the companies we have described.

Discussion

Despite the small size of our sample and the difficulty of comparing the data we collected, nothing leads us to believe that companies formed by designers are less successful or less performing than others. We even dare assert that, in the manufacturing game, designer-producers fare particularly well and have greater staying power than other companies. We offer a few explanations for this.

- Design has been established as a factor of success for public companies by previous studies (Design Council, 2004) and books (Martin, 2009). Whereas several studies have shown that design benefits differentially the companies that use it (Abdel-Malak et al., 2008), our sample used design to the greatest extent of all.

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7 Job-years = Σ (jobs apex x company duration / 2)

8 We excluded one company that was clearly not an industrial design consulting firm, and two professors of design.

9 340 jobs x 30 years = 11,100 job-years

- For many companies, developing a new product is a costly, risky, and lengthy process involving no revenue and many expenses. For designer-producer companies, such expenses are minimal and are usually associated with the cost of making prototypes. The ability of these companies to last, if only for the time it takes to develop their first products, is greater than that of comparable manufacturers. Designer-producer companies nearly always survive the product development phase. Designers are particularly well suited to making prototypes, building trademarks, and producing their company's image.
- Their founders may unduly keep some companies alive. In many instances, these companies act as avatars for their creators, fulfilling an emotional need to exist as a designer. Whether they generate revenue or not seems secondary to their owners.
- A large proportion of our subjects had university training in design (82%) and the occurrence of entrepreneurs in their families (80%) was very high (Desrosiers, 2009: 15-16).
- It may also be that the project-based training of designers, and thus “the abilities to reconfigure a firm’s resources and routines in the manner envisioned and deemed appropriate by its principal decision-maker(s)” (Zahra et al., 2006: 918), are particularly conductive to starting and maintaining a successful manufacturing business.

We propose that the answer to the manufacturing success of designer-producers lies somewhere within these explanations.

Conclusion

Designers create successful and relatively durable companies that generate economic and cultural wealth. Such companies are heavily concentrated in the areas of decorative objects and furniture, and make original products that stand up well against international competition and contribute in concrete ways to collective wealth. Designer-owned companies vary in size and represent different levels of risk. They constitute attainable and achievable projects. These companies generate more direct jobs than all design consulting firms in Québec put together. Despite this remarkable track record, the practice of designer-producer has been overlooked by design history and education in Quebec.

Whether as in-house designers, as consultants, or as designer-producers, designers could benefit from a more refined and developed ability to recognize business opportunities and the societal changes that underlie them. The university training that designers receive greatly shapes their professional identity. If this training supports and promotes an antiquated, incomplete, and borrowed image of a profession that itself is in constant evolution, this will only lessen the opportunities available to graduates. In Quebec, today’s designers are not only apt at creating new products for business ventures; they are also very capable of creating the ventures themselves.

It is important for the training of designers to be relevant and to better prepare them for the contemporary challenges of economic competition. Insofar as we have shown that designer-producers are an economically viable creative force and that they are numerous, there is ample reason for including notions of entrepreneurship and business in the training of young designers. This single action will, in turn, affect the perception that this profession has of itself.

It would be desirable to compare our observations with those made elsewhere, especially in economies that are the most dynamic and creative in terms of design. Such further research could help to determine the necessary knowledge to better equip future cohorts of industrial designers.

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Design, Democracy and Agonistic Pluralism

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Abstract

In this paper, the author presents an alternative approach to 'design for democracy,' drawing on the notion of agonistic pluralism. Specifically, the author highlights the differences between politics and the political within agonistic pluralism, and employing examples of contemporary design projects, discusses how these differences can been seen in the objects and practices of design. Through this critical examination, the author contributes a new perspective to the discourses of 'design for democracy' and expands the possibilities for democratic action and critique available to both practicing designers and design scholars.

Keywords

Design, Politics, Political Design, Agonism, Democracy

Over the past decade there has been an increased interest in 'design for democracy.' Not only are these efforts significant for design practice, they also suggest new topics and trajectories for design scholarship. However, within the mainstream practices and discourses of 'design for democracy,' the notion of what constitutes democracy is relatively unexamined. If we study the projects and papers that populate this arena, it seems our familiar notions of democracy are taken as a given good: it is implicitly accepted that democracy is a matter of pursuing consensus through activities of structured deliberation and 'design for democracy' primarily involves improving the mechanisms of participation in politics. Although such endeavours are crucial, they do not express the range of democratic action and critique available to practicing designers or design scholars.

In fact, the concept of democracy is neither given nor fixed. What democracy was to the Greeks is not usually what we consider as democracy today, and democracy in the United States is different is different from democracy in Sierra Leone, which is different from democracy in France. Even within a single nation-state system, the ideals and practices of democracy vary widely. As a thought experiment, we can consider democracy along a spectrum. At either end of the spectrum are governing principles and associated concerns, which serve to characterize democracy and suggest possible courses of action and critique. At one end of the spectrum, the governing principle is consensus and the associated concerns are those of access to information and procedures. At the other end, the governing principle is contestation and the associated concerns are those of revealing and challenging hegemony. Although such a diagrammatic model of democracy is simplistic and exaggerated, it is useful for considering the range of differences within the concept we call democracy.

The diversity of ideas about what constitutes democracy *should* have impact on design and design studies because they suggest different, at times fundamentally different, courses of action, themes for inquiry, and bases for judgment and critique. The trouble is that the exemplars of design practice and scholarship that fall within the context of 'design for democracy' overwhelmingly gather at that end of the spectrum governed by the principle of consensus and the associated concerns of access to information and procedures. Thus, we have a limited notion of what counts as 'design for democracy.' This is a problem because if design is to truly serve democratic ends, and if design scholars are to study the relations between design and democracy, then an understanding of the range of democratic thought and action is necessary in order to better design artefacts and systems that enable or enact democratic conditions, and more rigorously study those products and their contexts of use.

In this paper I will present an alternative approach to 'design for democracy,' drawing on the notion of agonistic pluralism. Specifically, I will highlight the differences between politics and the political within agonistic pluralism, and employing examples of contemporary design projects, discuss how these differences can been seen in the objects and practices of design. In doing so, it is not my intention to dismiss or diminish existing important efforts in mainstream 'design for democracy' projects, but rather, to outline a wider range of possibilities for democratic action and critique available to designers and design scholars.

Agonistic Pluralism: A Model for Rethinking Democratic Action and Critique

Agonistic pluralism is a model of democracy grounded in productive conflict or contest. In theories of agonistic pluralism, democracy is cast as an endeavour of fervent competition and struggle among competing ideals, values and beliefs. This competition and struggle takes place through all forms of social practice and material assemblages, including customs, laws, institutions, the built environment and designed products. In contrast to more familiar notions of democracy epitomized by scholars such as Habermas and Rawls (Habermas 1989; Habermas 1996; Rawls 1971; Rawls 1993), which prize rational deliberation and consensus, theories of agonistic pluralism acknowledge the presence and necessity of radical difference and contentious expression in the practice of democracy. This is not to say that rational deliberation and consensus are impossible from the perspective of agonistic pluralism, but they are not the default or required conditions and qualities of democracy (Connolly 1991; Connolly 1995; Honig 1993; Lalcau and Mouffe 1995; Mouffe 2000, Mouffe 2000b).

For political theorist Chantal Mouffe, the beginnings of an agonistic pluralism reside in recognizing the paradox of democracy: that a pluralistic society is a goal that must be pursued, but can never be fully achieved (Mouffe 2000b). The pursuit of a pluralistic democratic society is characterized by conflict because it is conflict, expressed as tension, friction and dissension, that defends against the erasure of difference. As Mouffe states:

> What is specific and valuable about modern liberal democracy is that, when properly understood, it creates a space in which this confrontation is kept open, power relations are always being put into question and no victory can be final. However, such an 'agonistic' democracy requires accepting that conflict and division are inherent to politics and that there is no place where reconciliation could be definitively achieved as the full actualization of the unity of 'the people'. (Mouffe 2000b, p. 15)

Drawing from Mouffe, one of the tasks of those wishing to support and further democracy is, then, creating and enabling these spaces of contest. In such spaces, difference and dissensus are brought forward and the assumptions and actions that shape power relations and influence are revealed and challenged.

There are a multiplicity of these spaces of contest and a multiplicity of forms and modes of agonism. In fact, one of the characteristics of agonism pluralism that sets it apart from more familiar models of democracy is that it does not require, or even desire, a unified public sphere or uniform set of procedures to enact democratic ideals. Often, and particularly within the academy, the spaces of contest are discursive: lectures, journals and books. Beyond the academy they include the organizing and lobbying activities of social movements, such as those concerned with labour, human rights or the environment. The legislative and judicial systems are also active spaces of contest, as conflicting and competing ideals, values and beliefs are played out through laws and regulations: the contests concerning abortion in the United States being a prime example (see Honig 1993). The questions from the perspective of design then are: *How can we distinguish design in the context of agonistic pluralism from more mainstream objects and practice of 'design for democracy?'* and *How can design objects and practices work in support of an agonistic pluralism?*

Politics and the Political in Agonistic Pluralism

In discourses of agonistic pluralism, politics and the political have distinct meanings. These distinct meaning are useful for distinguishing among designed objects and practices and beginning to describe alternate — agonistic — 'design for democracy' endeavours. In the discourses of agonistic pluralism, politics are *the means* by which a state, organization or other social order is held together: politics are the structures and mechanisms that enable governing. These range from codified laws and procedures to unspoken but observed habits of interpersonal interaction and performances of beliefs and values. Different from these means, the political is *a condition* of society. It is a condition of ongoing opposition and contest. This condition is experienced and expressed in a multiplicity of ways, from debate to acts of provocation, protest and resistance.

Within discourses of agonistic pluralism, the problem with politics is that the structures and mechanisms of governance often hide or mitigate the essential contests of life. In benign forms, this occurs in an effort to lessen public strife and smooth the processes of governance. In less benign situations, politics become the very methods of extending hegemony by feigning to provide opportunities for expression and action, thereby re-directing or sublimating contestation and reinforcing the status quo (Honig 1993; Mouffe 2000). Put another way, politics often functions to *counter* the political. This is a problem because following from the frame of agonistic pluralism, engaging the essential contests of society is an inherent and necessary characteristic of the democratic endeavour. Whether benign or not, diverting attention away from the political by a focus on politics, i.e., a focus on the improving the mechanisms of governance, can endanger the practice of democracy because it draws us away from engaging in the contestation necessary for democracy.

The difference between politics and the political has significance to the practice and study of 'design for democracy' because it allows us to make meaningful distinctions between projects based upon how they engage with the democratic endeavour. Most 'design for democracy' projects fall within the realm of politics, with a focus on improving structures and mechanisms that enable governing. They are 'design *applied to* politics', or 'design *for* politics.' While such projects are important, they are not political in an agonistic sense and they do not represent the range of possible thought and action available to design within the democratic endeavour. If we accept the notion of agonistic pluralism as at least one possible approach to democracy, then we should ask, *What are examples of 'political design' rather than 'design for politics?*' and *How, as design studies scholars, would we describe, analyze and judge such practices and objects?*

Exploring The Differences Between Design for Politics and Political Design

The most direct way to explore the differences between design for politics and political design is by comparison of projects that fall within these rubrics. The Design for Democracy (DfD)[1] initiative within the American Institute of Graphic Arts (AIGA) is emblematic of design for politics. Although it does not encapsulate all of the activities that fall under the general rubric of 'design for democracy,' it is a concerted effort to provide a professional organizational structure to such efforts within the United States, and as such provides a salient example. According their self-description, DfD "applies design tools and thinking to increase civic participation by making interactions between the U.S. government and its citizens more understandable, efficient and trustworthy." (AIGA 2008) The programs within the DfD initiative are indeed broad reaching. They include the *Get Out The Vote* program which solicits non-partisan graphic design to promote voter registration and participation; the *Government Officials: Get Help* program which provides design services to "make government more accessible, transparent, and efficient" (ibid); the *Polling Place Photo Project* which solicits and presents citizen journalism documenting the voting experience in the United States; a design advocacy program to promote the importance of design in government; and the *Ballot and Election Design* program which strives to improve the experience and increase the efficacy of voting through the redesign of ballots, polling place signage, instructional materials and poll-worker training materials.

As a counterpoint, the *Million Dollar Blocks*[2] project provides an example of political design: it is a project that is implicitly contestational and demonstrates one notion of what 'design for democracy' might be like from the perspective of agonistic pluralism. Developed by Laura Kurgan at the Spatial Information Design Lab at Columbia University, *Million Dollar Blocks* uses geographic information systems (GIS) to map crime-related data. Rather than asking, *Where does crime occur?* or *Who are the victims of crime?*, as is the common approach to crime-mapping projects, Kurgan begins the project with the question, *Where does the prison population come from?* The primary product of the project is a series of maps of fours cities (Phoenix, Wichita, New Orleans, and New York),

[1] See http://www.aiga.org/content.cfm/design-for-democracy, access January 24, 2010.

[2] See http://www.spatialinformationdesignlab.org/projects.php?id=16, accessed January 24, 2010.

which graphically depict the distribution of the residences of prison inmates throughout the respective cities. In addition to the maps and related information graphics, Kurgan and her colleagues have produced two self-published books documenting the process and issues, *The Pattern* and *Architecture and Justice* and a scenario-planning workshop (and accompanying documentation) with design professionals and community, civic, and social justice organizations and individuals.

The efforts of DfD in election design have had direct and measurable effect: in 2007 the U.S. Election Assistance Commission accepted the AIGA guidelines for ballot and polling place information design; the *Polling Place Project* has garnered significant participation with thousands of photos submitted and presented; and the *Get Out The Vote* program has produced dozens of compelling posters, replicated in the thousands. This work is exemplary of design for politics: the purpose of the work is to support and improve the mechanisms and procedures of governance. This purpose is clear in the positioning of the work and the stated motivations, e.g., increasing voter participation, making government more transparent and efficient, increasing the efficacy of voting through design.

In contrast, *Million Dollar Blocks* does not work to support and improve existing means of governance. Rather, it strives to critically investigate an issue and raise questions concerning the conditions of that issue. By asking *Where does the prison population come from?,* Kurgan reframes the discussion of crime and the built environment. As she states:

> By focusing solely on [crime] events, the human underpinnings of crime were left largely unaffected. When we shift the maps' focus from crime events to incarceration events, strikingly different patterns become visible. The geography of prison differs in important ways from the geography of crime. (Kurgan 2008)

From this question more questions follow. A key question for Kurgan is, *Is their pattern in this data that reflects a pattern in an underling condition?* and if so, *How might the recognition and interrogation of that pattern bring to light inequalities as they are manifested in the urban environment?* The title of the project — *Million Dollar Blocks* — comes from the recognition that there is indeed a pattern: within any given city, there are sets of city street blocks in which the government is spending more than $1,000,000 annually to incarcerate residents of those blocks. Discovery and articulation of this pattern then raises further questions such as *Who lives on those blocks?*, *What are those blocks like?,* and *How might that money be otherwise spent and perhaps to better effect?* The *Million Dollar Blocks* project can thus be considered as exemplary of political design because it functions to reveal, question and even challenge conditions and structures in the urban environment, that is, it opens a space for contest, and too, it suggests new practices of design in mapping and urban planning.

Agonistic Pluralism and the Work of Political Design

One way to approach the description, analysis and critique of political design in design studies is by examining its purpose, or the work it is supposed to do. Simply stated, the purpose of political design is to do the work of agonism. This means first and foremost it does the work of creating spaces for revealing and confronting power relations, i.e., it creates spaces of contest. This occurs both in and through the objects and processes of design: the objects and processes of design are both the site and means of agonistic pluralism. For example, in the case of *Million Dollar Blocks*, the maps document the existing configurations and conditions of power, and serve as objects through which contestational claims can be made and arguments advanced. It is important to note that the processes of design can be agonistic and political as well. For example, the act of problem definition can be a contestational effort, as when Kurgan inverts the standard modes and directives of crime mapping, by shifting the question from *Where does crime occur?* to *Where does the prison population live?*

We can, however, be even more exacting in describing the work of political design. Through the process of creating spaces for revealing and confronting power relations and influence, political design identifies new terms and themes for contestation and new trajectories for action. Most often, and almost by definition, these terms, themes and trajectories are contra to those of common practices and discourses, and contra to design for politics.

The *Million Dollar Blocks* project engages in precisely this endeavour of identifying terms, themes and trajectories and runs counter to the utilitarian framing of design for politics. Beyond the literal naming of a condition (as 'Million Dollar Blocks'), the project reveals previously obscured configurations in the cycle of crime and incarceration. Through this revealing, these conditions and structures become available for debate and further investigation. In subtle but profound ways, the design artefacts and activities of the project question and challenge how we understand and use crime statistics and practices of mapping, and reveal what understandings, uses and implications we leave out of our analyses and representations. This is exemplified in a quote by Kurgan, describing the maps of the *Million Dollar Blocks* project,

> With this map, we stop talking about where to deploy police resources or how to track individual prisoners for institutional purposes; instead we begin to assess the impact of justice on a city, even a city block, and start to evaluate some of the implicit decisions and choices we have been making about our civic institutions. (Kurgan 2008)

These maps, then, provide the opportunity for an ongoing series of contests and dissensus concerning the relationship between crime, the built environment and policy; the political affects of maps as artefacts; mapping as a practice; and the city as a series of relationships between people and space. With this notion of revealing and contest, we can begin to consider political design as a kind of inquiry into the political condition. That is, whereas design for politics strives to provide solutions to given problems within given contexts, political design strives to articulate the elements that are constitutive of social conditions. Such a notion of political design as inquiry is hinted at when, in being asked about the purpose of the *Million Dollar Blocks* project, Kurgan replied, "I am not trying to find the solution, I am trying to find the right questions." (Kurgan 2008) The purpose of political design generally, and the efficacy of the *Million Dollar Blocks* project specifically, is not to be found in improving usability, extending functionality or achieving a readily identifiable form of change. Rather, the purpose is to prompt and act as evidence in new discourses and practices and as the foundation of new questions.

Conclusion

While projects such as increasing the legibility and use of voting ballots or providing access to the facts of issues ranging from climate change to healthcare are important, they are not political in an agonistic sense. Rather, they serve to support the generally accepted means of politics, and in the process, they may mitigate some of the productive tension, friction and dissension within society. The *Million Dollar Blocks* project provides a particularly useful example of an alternative — agonistic — approach to design. One value of it as an example is its familiarity in form and medium and its relative gentleness in contestation. This is of value because it serves to illustrate that political design that does the work of agonism need not fall prey to common misconceptions about conflict and contestation. Terms such as contestation often garner images of radicals clinging to extreme positions and beliefs, which they communicate in an aggressive and rough fashion, through outsider means. Such stereotypes inhibit taking political design seriously. *Million Dollar Blocks* is thus also a useful example because it demonstrates that political design can, and often does, consist of actions and processes from within, using familiar mediums and forms, to subtly, but powerfully, reveal and question the conditions and issues of democracy.

Although by no means complete, this essay makes a claim for the inclusion of agonistic pluralism in the practices and discourses of 'design for democracy.' Furthermore, it suggests how we might describe design that supports or fosters agonism by way of the distinction between politics and the political, and offers a distinction between design for politics and political design. In contemporary design, projects such as *Million Dollar Blocks* are the anomaly rather than the norm: there is much more work in the realm of design for politics than the political design. However, if we accept a broader notion of democracy, which includes agonistic pluralism as one among many possible conceptualizations of democracy, then we should accept that political design, such as *Million Dollar Blocks*, has a role to play in the democratic endeavour, and is one option of action and critique for practicing designers and design scholars.

The challenge for design scholars is to further consider how we might describe, analyze and judge these works. One possible framing device for design scholars is to consider how political design works to create spaces for the confrontation of power relations and influence by the identification of new terms and themes for contestation and new trajectories for action. We could ask of these works: *What new terms and themes were identified?*, *How do they reveal and challenge hegemony?,* and *What new trajectories for action are set?* The next step for design scholars is to build a discourse around political design, and to explore other alternative conceptualizations of democracy and their implications for practicing designers and design studies. This endeavour will not unfold overnight, but it offers unique topics and courses of action for designers and design scholars interested in the broad context of 'design for democracy.'

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An Exploratory Study of Scientists' Perceptions of Design and Designers

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Abstract

As part of a wider empirical study in to the potential role of industrial design in scientific research, a series of semi-structured interviews were conducted with scientists to understand how their perceptions of design and designers might influence collaboration.

This paper reports that scientists without prior experience of working with designers may be unclear as to their skills and areas of expertise, and may subsequently be missing out on collaborative opportunities.

Scientists perceive a greater possible impact on applied research through engagement of professional design skills. It was revealed that design interventions could be suitable for many scientists as their range of research activities is likely to include both basic and applied research. Opportunities were identified for designers to play a role in scientific research, especially with issues relating to communication.

Keywords

collaboration; multidisciplinary; industrial design; perception.

There is potential for industrial design to play an important role in the advancement of science and technology as highlighted by Lord Sainsbury in his 2007 Review of Science and Innovation. "Evidence suggests that the use of design helps scientists to develop commercial applications for their work while it is still at a research stage or at the outset of technology" (Sainsbury 2007, p151). Indeed there is substantial evidence of the value of industrial design in the development of new technology in industry (e.g. Kotler & Rath 1984, Lorenz 1994, Black & Baker 1987, Roy 1999, Gemser 2001, Hertenstein et al 2001). This work concludes that industrial designers can help to commercialise technology by becoming involved earlier in the development process. Despite this, surprisingly little academic work has been carried out looking at the role that industrial design might play in scientific research, from which much technology originates. Existing studies in this area are anecdotal and lack first hand evidence of the factors influencing collaboration:

- Chris Rust identified opportunities and barriers for collaborative work between designers and scientists, and outlined 'tentative principles' for designers in collaborative research (Chris Rust 2004 and 2007).
- The MIT media lab provides an environment for 'exploring basic research and applications at the intersection of computing and the arts' (http://www.media.mit.edu/research/ accessed Sep 2007). Similarly, there are a number of multinational firms who have experience of operating these 'sand-pit' environments; e.g. Microsoft, Bell Labs and Google.
- A pilot scheme was supported by the UK Design Council in partnership with the EPSRC and UCL Ventures, to bring design consultancies into scientific research (Design Council 2006).
- A UK Design Council scheme in partnership with Maddison Design and Oxford University brought design consultancies into university technology transfer offices (Design Council 2009).

To address the current gap in empirical research in this area, a study was set up at Cambridge University in which designers worked collaboratively with scientists in supporting their research activities. In addition to exploring the potential role of industrial design in scientific research, this study set out to understand how contingent factors such as the scientific discipline, the status of the research and the type of design intervention would influence collaboration. This paper presents the findings of a series of preliminary interviews conducted with scientists as part of this study, to gain insight into these issues.

The objectives of the interviews were:

1. To explore the scientists' perceptions of the status of their research in terms of how applied it is and at what stage of development it is.
2. To explore scientists' perceptions of design and designers and to understand how these perceptions may influence collaborative work between designers and scientists.
3. To gain scientists' views on the possible roles designers might play in supporting their research activities.

Although the focus of the study was on industrial design, the scientists were asked their views about design in the broader sense so as to capture their views on a wider range of issues.

The paper begins with a description of how a literature review influenced the design of an interview to achieve the above objectives. It then outlines the interview procedure before presenting and discussing the results. The paper concludes with implications for future study.

Literature Review

Classification of Scientific Research

Recognising that 'science' covers a wide range of disciplines and research activities, and that the role of design will likely depend on the context of the research, a method of classification of scientific research is required.

Pierce's outline classification of science illustrates the wide range of activities that employ a scientific method (Vehkavaara 2001). It was decided that participants from this study would be selected from a wide range of scientific disciplines including the physical (e.g. physics, chemistry, and biology), applied (e.g. engineering and medicine), formal (e.g. mathematics) and social (e.g. psychology) sciences.

Linear models have been applied to scientific and technological development in the form of Applied Science Readiness Levels (ASRLs) and Technology Readiness Levels (TRLs), which were developed by NASA to manage their R&D programmes (Millis 2005 p13, DoD 2002 pp204-205,). These models suggest that scientific research can be classified by developmental stages.

It is also important to consider the motivation for scientific research. Traditionally, research has been categorised as either "basic" or "applied", the former being focused on improving understanding of fundamental principles, and the latter focused on considerations of use. Stokes suggests that there is a third category of research motivated by both the pursuit of understanding principles and their application, which he called "use-inspired basic research" (Stokes 1997, p73).

Based upon these views, a model of scientific research was developed to position scientists' work both in terms of the stage of development and the degree to which it is applied. The model shown in figure 1 shares Stokes's motivations for scientific research, and anticipates definable stages of development similar to TRLs.

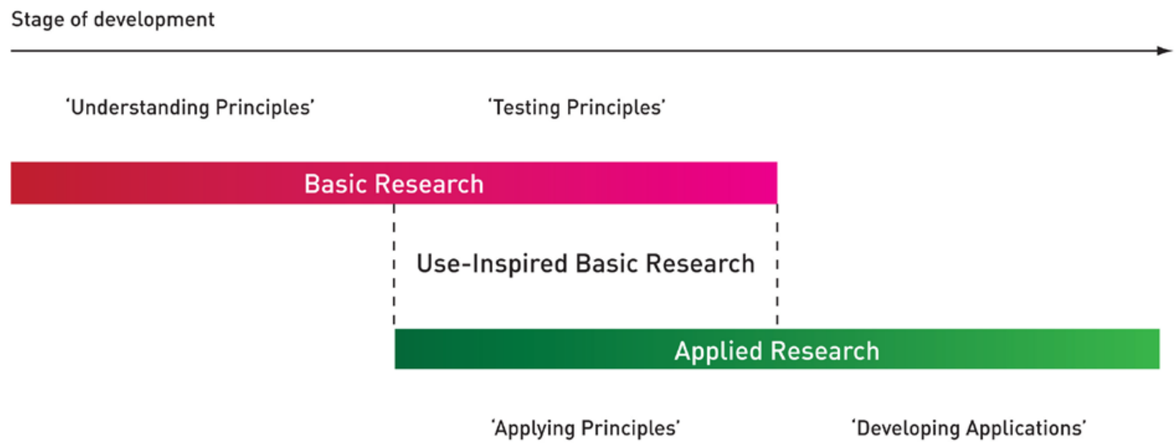

Figure 1 Model of Scientific Research

Designer Characteristics

In order to meet the second objective of the interviews, a list of characteristics was developed which could be used to describe a designer. It was decided that these would be adapted from the Scottish Credit and Qualifications Framework's list of the main areas of learning for students enrolled in higher education (SCQF 2007). This was because these learning areas were developed to reflect what is expected of a professional designer by industry. These characteristics were "Skills", "Knowledge", "Ways of Thinking" and "Role in a Multidisciplinary Team".

Methodology

Potential interviewees were selected following meetings with the head of research at the university's engineering department and representatives from the Research Services Division. Of the 28 scientists contacted, 12 were interviewed, 4 declined, 6 did not respond and 6 sent delayed positive responses. Of those who declined, 2 cited time restrictions and 2 felt that design played a very limited role in their research. Table 1 gives a short description of each of the interviewees.

Scientist	Background
Engineer 1 [E1]	• Manages a research group with a portfolio of projects • Direct experience of collaborating with industrial designers on a research project
Engineer 2 [E2]	• Previously sat on the committee of research councils with an interest in funding design • Previously worked for a group of trusts, one of which funded a collaborative student project with designers and engineers
Physicist 1 [P1]	• Manages a research group • External designers had developed a Graphic User Interface for software his research team had created • Advocate of open innovation in software development and computational science
Physicist 2 [P2]	• No experience of working with designers • Married to a graphic designer
Engineer 3 [E3]	• Experience of working with companies that employ designers
Biochemist 1 [B1]	• Manages a research group • Multiple university spin-out companies • Experience of employing designers in later stages of product development
Clinical Scientists [C1, C2]	• Work in the clinical engineering department of a hospital • Bridge the gap between clinical departments and engineering designers • Experience of working with companies who employ designers • Mostly single patient or single institution use – little commercial activity
Engineer 4 [E4]	• Manages a research group • Previously managed a team including scientists, engineers and designers in industry • Experience in the commercialisation of products
Biochemist 2 [B2]	• Working on a collaborative project between biologists and chemical engineers • No experience of working with designers

Psychologist 1 [PSY1]	• Established a research group into multidisciplinary design • A member of the governing body of a leading art and design university
Material Scientist 1 [M1]	• Manages a research group • A member of a commission that funds student designers
Chemist [C1]	• Working on a collaborative project with an engineer and an architect • Married to an architect

Table 1 Interviewees

Interview Procedure

A semi structured interview was created which was split into three sections to meet the objectives stated in the introduction. The interviews lasted approximately an hour and were recorded for later transcription. The interviewees were informed that they would remain anonymous.

1. The scientists were first asked to describe their field of research, a current research project and their day-to-day research activities. They were asked to try and identify stages of development of their research and to comment on how applied they considered it to be. They were then presented with the model of scientific research developed in the literature review and asked to use it to try and position their work.
2. The scientists were then asked to describe what they understood by the word 'design'. If they had experience of working with designers they were asked how successful the collaboration had been and how they overcame any difficulties that may have been encountered. They were encouraged to list the characteristics of a designer under the headings "Skills", "Knowledge", "Ways of Thinking" and "Role in a Multidisciplinary Team".
3. Finally, the scientists were asked to identify any potential opportunities for the designer they had just described to support them in the research activities they had mentioned in the first part of the interview.

Interview Analysis

Soon after each interview, a summary document was written and emailed to each of the participants for comment. Two of the scientists requested that minor amendments be made to the interpretations. A synopsis of the interview summaries was written including partial transcription. The scientists' answers to each of the questions were gathered and key themes were extracted for discussion.

Results

1. Scientists' Perception of Their Research

All of the 8 scientists who attempted to position their work on the model of scientific research described it as including both basic and applied elements. This was because the scientists were often working on multiple projects at different stages of development with research teams from other universities. Thus, the map was less helpful in positioning the work of senior academics, who managed a complex portfolio of research. The map was more successful however in positioning individual research projects.

One scientist raised the point that what he considered applied research would be considered basic by others:

> *"In order to incorporate my work into the same map with other people's you need to make it hierarchical...if you talk to a person who actually deals with the real world rather than the software, they would say that all of what I do is here [understanding]"* [P2].

Although some scientists made attempts at defining stages of development, no common threads emerged and some commented that the linear process suggested by the diagram was not representative of research practise:

> *"You can go in any direction... I mean a lot of pure scientists say to me 'well, you know what you're doing is you're taking our knowledge we've gained alright?, and all you're doing is applying it', this is a common view and it's total tosh I can tell you...We have one at the moment, a very specific application I'm interested in...we're going to have to generate some new fundamental knowledge...we've got about 5 or 6 approaches we're looking at, I don't know off hand which one is going to come up trumps"* [B1].

Conclusions

- It is difficult to position the work of a particular scientist in terms of how applied it is, particularly when the scientist is engaged on multiple projects. However, it is possible to position individual projects, at a specific point in time
- It is difficult to define common stages of the scientific process, as much science is inherently iterative, with both application and the search for underlying principles occurring concurrently. This suggests that linear development models such as TRLs do not easily apply.
- Following the interviews, a new model of scientific research was constructed which more accurately reflected research being conducted at the university. The model shown in figure 2 illustrates how research, basic or applied, can give rise to applications, and how the development of applications can generate new scientific and technological research.

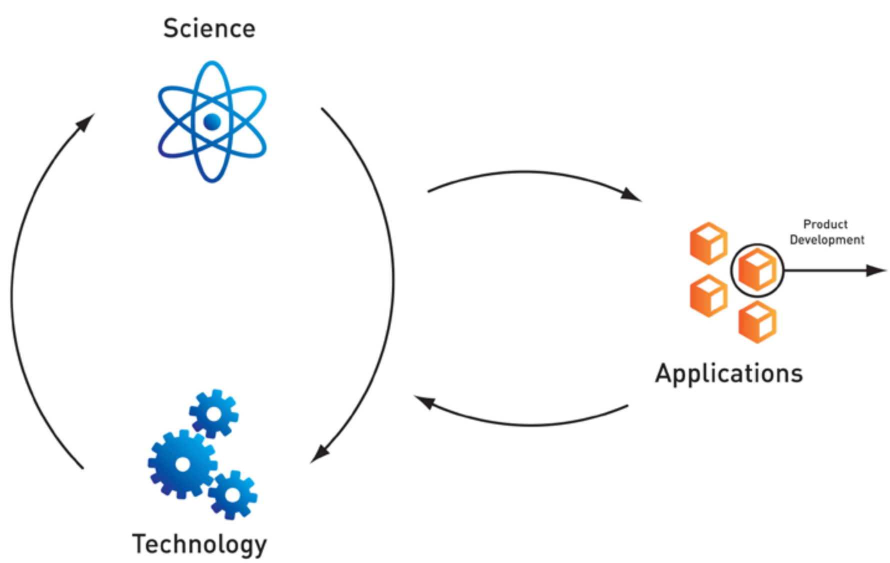

Figure 2 Model of scientific research post interviews

2a. Scientists' Perception of Design

The scientists said 'design' was something they did as part of their everyday work, for example engineering design, circuit design, experimental design, clinical design, survey design, alloy design or composite design.

Three quarters of the scientists interviewed mentioned at least one type of design profession in their answer. These were industrial, product, graphic, architecture and fashion. Those who did not mention specific disciplines said the following about design:

> *"You're talking about a different sort of design [to engineering design], the sort of design in which you bring somebody else along who thinks in terms of the shape and the looks and whether the general public like that colour or not"* [E2].
>
> *"I suppose I would associate it [design] more with the arts and fashion"* [P2].

"It [design] is a creative process... [A designer] is somebody who has a very visual way of looking at the world and who would work with materials and with people to...translate a vision into reality" [B2].

Some of the scientists commented on negative aspects of design:

"What I feel is a dangerous aspect...of design is the sort of making it look glitzy and pretty and calling that design, because I think it distorts what design is about..."The designer comes along with ideas that have no basis in the technology and maybe superimposes them on the design in a way that doesn't...benefit it and may actually detract from it...for me the idea of design is starting from the technical...and the sort of adding on has to be done very carefully" [E2].

"Product design is a bit more airy fairy really isn't it – it tends to be the fashion stylistic sort of approach...an industrial designer is just an engineer in my view" [E1].

"We rough out the ideas and it goes to a professional [designer] who tarts it up" [B1].

"Whether there is an aspect of design which maybe fulfilling the objective of art and beauty which degrades the fitness for purpose is actually very interesting, for example a very clever looking chair that's so uncomfortable you can hardly sit on it" [M1].

Some scientists had a more rounded view of design. More than half of the scientists described functionality, aesthetics and usability as being key aspects of design, with some also mentioning planning. Only one scientist used the word creativity in their description of design.

Conclusions

- The scientists interviewed recognise that design is an important everyday aspect of their work.
- There are fields of design closely linked with science e.g. experimental design, survey design. The scientists did not necessarily make clear distinctions between these and creative professions such as product, industrial, graphic and fashion design.
- Some of the scientist's initial perceptions of designers were as superficial stylists.
- These different perceptions are indicative of the difficulties in establishing consistent definitions of design.

2b. Experience of Working with Designers

5 of the 12 scientists had direct experience of collaborating with designers. A further 2 had indirect experience i.e. they may have worked with companies that employed designers. When asked what issues were encountered during this collaboration, communication was cited as the most common obstacle:

"Conveying the ideas and making sure we all understood what we wanted in terms of the design and the designer understood what was important to us. And that they had to convey to us what they thought was important...in terms of a getting the product in a package that could be used easily" [E1].

"Maybe visualisation is a tough one right? Or the language where I need a little bit of fill-in on some technical terms that might be utilised by him and in my case he would definitely need fill-in on the technical terms because he's not a chemist right?" [C1].

In both cases, these communication issues were overcome by maintaining frequent contact between the participants in the form of brainstorming sessions, meetings and workshops. Chemist 1 explained how problems encountered in interpreting 3D information were overcome by moving to 3D printing. He said "That helps put a lot of things into something I can physically touch and see and get an appreciation for".

Engineer 4 had experience managing a team including scientists and a designer. He said of the designer "He was very dogmatic, so he had very strong views about the importance of design and he would get very upset if people didn't get it or didn't think it was important". This became a problem with one of the designer's engineering colleagues.

Biochemist 1 saw his team as consisting of 'creative scientists'. He said "Creative scientists are few and far between, believe me...where they can see laterally as well as vertically...Most scientists think vertically...a lot of designers probably do think more laterally. If I look in this place in my experience over 30 years I'd probably put about 3 in that category [creative scientists]".

2c. Characteristics of a Designer

The scientists gave a very broad range of answers to this question. For example there were 30 different skills listed by the scientists.

Their answers showed large variation and depended very much on whether the scientist was describing the skills of a designer, themselves (in their capacity as a designer), both or neither. Of the 12 scientists interviewed, 6 described a 'designer', 2 described themselves, 2 described both and 2 did not annotate the graphic. Their answers also depended on the type of designer they had experience of, for example 3 scientists described industrial or product designers, 2 described graphic designers and 3 were not specific about the type of designer they were describing.

A selection of the most common and interesting answers is given in table 2. The numbers in brackets represent the number of scientists who mentioned each point:

Skills	Knowledge	Thinking	Role
Technical: Sketching (1) Model Making (1) CAD (2) Research (1) Engineering (2) Holding Focus Groups (1) Simulation (1) Technical Drawing (1) Project Management (1) Personal: Creativity (3) Communication (3) Observation (1) Patience (1) Listening (1) Restating (1)	Materials (5) Manufacturing Processes (4) Fashion/Styling (2) Graphics (1) Market (1) Technical (1) Regulations (1) Safety (1) Ethics (1) History of Design (1)	Lateral (3) Imaginative/ Artistic (2) Creative(1) Novel (1) Out of the box (1) Innovative (1) User Perspective (3) Curious (1) Holistic (1) Practical (1) Critical (1) Logical (1) Analytical (1) Unrealistic (1)	Integrator (3) Facilitator (1) Project Manager (1) End User Focus(1) Holistic (1) Commercial Focus(1) Inspire (1)

Table 2 Characteristics of designers according to scientists

Conclusions

- The scientists without experience of working with designers did not have a clear understanding of their characteristics.
- Those with experience had a more well-rounded view of designers, recognising their skills are wider than specific technical or materials knowledge.
- Materials and manufacturing processes knowledge were the most commonly recognised traits of designers

3. Scientists' Views on Potential Role of Design in Scientific Research

The scientists were generally sceptical about the role a designer could play during the early stages of scientific research. Biochemist 1 smirked at the question and said "I find it difficult to believe that they [designers] could contribute much round here [understanding] because you'd have to have a really detailed knowledge of the detailed science...You're better coming in somewhere around here [application].

> *"If you want design engagement in the scientific process, I don't see how the designer would have enough scientific knowledge to contribute to the discussion, so they may have divergent thinking, but only in terms of how to put bits and pieces of existing technology together. I don't see how they would be able to help in the brainstorming process of 'what are the scientific reasons why it's not working...I can see all these really strongly in the product development end"* [E4].

However some scientists didn't rule out the possible contribution of a designer in basic scientific research.

> *"How do you access the unknown unknowns, yes? The scientist isn't going to do it because it's unknown by definition yes? Anyone with different viewpoint...different ways of thinking about things, approaching problems can perhaps provide a route into those unknown unknowns. Every bit of science is suffering from this because every real issue in science at the moment is complex"* [P1].

> *"We have learnt so much, by working together between biology and engineering because you need to learn a different language...it's really opened up our horizons. That's why we are keen to work with other disciplines still because it just enriches your way of thinking so very much"* [B2]. When asked if she could see any potential benefits of working with designers, she replied, *"I don't know, it never does any harm to talk and you never know what comes out of it"*.

> *"Perhaps there is a design contribution in that area [scientific principles or understanding], I certainly haven't thought of it"* [E1].

Communication was identified as an important area in which designers could make a contribution.

> *"If someone can help me to see from the outside what the research looks like...that will help me putting my work across"* [P2].

> *"Most scientists have no understanding of what the general public out there actually understand, it's very important to relate it to them...a designer there would come in very well, say a poster for example"* [B1].

> *"I would put that [designers assisting with funding applications] down as marketing again, you're trying to get support from somebody for academic funding...I'm not used to getting money out of the EPSRC or the science funding bodies but they seem to like words...Using words alone is much less effective than words plus images, so I'd add pictures, images and video to the text"* [E4].

> *"Anything to do with public understanding and outreach, I fully agree [design input would be useful]...because that's not to do with functionality of a device it's t do with communication and visual appeal"* [B2].

Some other interesting areas of potential collaboration were identified

> *"Have we left ourselves with less of a development opportunity because we don't engage designers at a scientific level? I think that might be interesting if designers could spot ways of improving that process. And it's largely by not using Heath Robinson toolsets...by perhaps looking at the laboratory equipment, the methods of handling or moving or managing or conveying substances, the methods of testing...it could be design of the space, design of laboratory, design of the bench...that's where I would say the contribution could come in"* [E1].

> *"Lab space design, ha. That is true...thinking about how to lay things out – boy, that just never happens at the moment. It's a good point though"* [E4].

During the first 6 interviews, some of the scientists found it difficult to suggest ways in which a designer might be able to contribute to their research, so it was decided that a list of possible design engagements would be created to stimulate ideas:

- Application Exploration
- User/Market Research
- Concept Design
- Materials/Manufacturing Processes
- Engineering Design
- Prototyping
- 3D Visualisation
- 2D Communications
- User Interface Design
- Lab Space/Equipment Design
- Stimulate Interest/Excite
- Challenge Established Views

This list drew from the recommendations of the Design Council's pilot scheme in which design consultancies worked with scientific researchers (Design Council 2006). It also contains suggestions made by the first 6 interviewees, such as the design spaces and equipment.

Figure 3 Scaled design engagements

Figure 3 illustrates the effect of scaling the list of design engagements according to how many times they were selected by the scientists as playing a potential role in their research activities.

Assistance with communication was picked out by half of the scientists, closely followed by visualisation of products or concepts. Despite some of the scientists recognising that designers know about materials and manufacturing processes, only one of them said their research would benefit from support in this area. Engineer 4 suggested that designers would be of use in assisting with the production of technology 'demonstrators' to pitch an idea to investors or funding bodies. Two of the scientists' work was sufficiently close to market that the assistance they required was more akin to product development than scientific research.

> *"You get an awful lot of people...not far from where I'm sitting now, that actually come up with things...that you'd ever even conceive are going to be useful. And yet they'll spend ages and get research council money for it...They've got their pet project and they're looking for an application for it...There's a lot of pressure on people at the moment to get some sort of application...its government pressure, it's funding, pier group pressure"* [B1].

Talking about open innovation in computational science, physicist 1 commented "I see it [design] no longer divorced from the mainstream development, but sitting at all of the interfaces to make the fundamental science interact with the other bits of development.

Conclusions

- Some scientists perceived that there is scope for design engagement in their research activities, especially with issues relating to communication.
- However, the general consensus was that there isn't an immediately obvious contribution that design can make to basic research but some scientists would be open to exploring this further.

Implications

This research starts with the hypothesis that industrial designers might be able to make a contribution to the early stages of scientific research. Findings from this initial series of semi structured interviews provide some interesting insights into the factors which may affect collaboration between designers and scientists:

- Scientists' current knowledge of and perceptions of designers is limited, and where they have little prior experience, they are often sceptical about the potential for designers to make a positive impact on their research.
- Unless they have previous experience of working with designers, scientists are unlikely to be clear about designers' skills and areas of expertise, and some may perceive them as superficial stylists. Sharing knowledge about the characteristics of the two disciplines should open up more opportunities for collaboration.
- Design interventions could be suitable for many scientists as their range of research activities is likely to include basic and applied research
- Scientists perceive a greater possible impact on applied research through engagement of professional design skills.

Recognising these challenges, in order for design engagement to be successful, the following issues require consideration:

- It may be difficult for designers to persuade a scientific team or individual working on basic science to participate in a collaborative project, as the potential benefits are not immediately obvious. Offering to provide communication support could provide a possible avenue for entry into such a project.
- Designers should be sensitive to the fact that scientists participate in certain design activities as part of their everyday work e.g. experimental design, engineering design, and survey design.
- To overcome the cultural, conceptual and linguistic differences between the different disciplines, collaborative work between designers and scientists should be underpinned by effective communication. This involves frequent contact with the team members to gain a mutual understanding of key issues and to appreciate what each group considers important.

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Developing a Framework for Mapping Sustainable Design Activities

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Abstract

The notion of sustainable design has become increasingly prominent within the design community. As a result, numerous design theories, strategies and tools are available to designers. Yet, limited attempts in the field evaluate these activities by placing them in relation to each other or within the broader context of sustainable development. Based on a literature review this study develops an integrated framework which connects the areas of sustainable development and sustainable design. This framework may be utilised in two ways: firstly, to visualise the interdependencies of sustainable design and sustainable development; secondly, as an assessment tool to measure and compare the potential of sustainable design activities.

Keywords

Sustainable Design; Sustainable Development; Design Strategy; Framework.

Sustainable design is a widely used phrase amongst a number of synonyms which all reflect a contemporary trend in the design community to respond to environmental and socio-economic concerns. The focus of attention is thereby the concept of sustainable development which became increasingly popular over the last few decades. As the idea of sustainable development itself is open to various interpretations it may not be surprising to find a large number of theories, strategies and tools when it is married with design, a discipline similarly regarded as being broad-ranging and hard to define.

So far, sustainable design is rarely conceptualised in direct relation to the bigger picture of sustainable development. Moreover, literature is lacking in appropriate evaluation methods which are capable of classifying sustainable design activities in this multi-dimensional context. In this regard Baumann *et al.* (2000) state that “there are too many tools around, but we should try to use the already existing ones, instead of introducing now ones”. Then they conclude by saying that there is “too little linkage between strategic intent and content [and] too little about the larger context of product development”.

This study aims to develop a criteria-based compound framework which allows both the visualisation of the relationship between sustainable design and sustainable development as well as the classification of sustainable design theories, strategies and tools according to this context. Thereby the study merges appropriate models from both disciplines to generate an integrated framework with aims to be able to:

i) provide understanding of how sustainable design may be seen in the context of sustainable development
ii) allocate a given design activity in terms of its position within this context
iii) classify a given design activity in terms of other design activities
iv) specify the individual ‘sustainability potential’ of a given design activity

In order to create a framework featuring those characteristics the following questions form the focus:

a) How are the areas of sustainable development and sustainable design conceptualised so far?
b) Which visual representations of these concepts may be useful in terms of this study?
c) How can we generate a compound framework based on the existing models?

The study is based on a literature review which is presented in the first half of the paper. The review covers the areas of sustainable development and sustainable design and focuses on the first two questions stated above. The compound framework itself is introduced in the second part of this paper, where we deal with the third question. The paper concludes with a discussion of the framework, which includes the introduction of possible implications of both a theoretical and practical nature.

1. Reviewing the scene

The following review is divided into two parts. The first part discusses the nature and relationship of the concepts of sustainable design and sustainable development, in order to establish clarity in terms of basic definitions. In the second part the emphasise is on visual models of sustainable design and sustainable development. Here innovation models are also discussed as sustainable design strategy is increasingly described with the aid of innovation theory.

1.1 Sustainable design in the context of sustainable development

By nature, sustainable design corresponds with the concept of sustainable development. Yet, as sustainable development is to be seen as a concept emerging from the environmental discourse it is imperative to shed light on the evolution of environmentalism to fully understand the complex and partly conflicting nature of sustainable development. In this sense, the evolution of sustainable development may be traced back to the most fundamental concepts of value which are reflected in the basic world views. The following paragraphs briefly introduce each 'mile stone' of this journey.

1.1.1 The two major world views

According to many scholars (Glacken, 1967; Passmore, 1974; O'Riordan, 1981; Capra, 1982; and Milbrath, 1984) two major world views have been developed in the history of humankind which define the relationship of humans to their environment. Commonly a distinction is made between the '*conservative-nurturing'* and the '*radical-manipulative'* world views. The underlying mind sets of these views are almost contradictory: Favouring the conservative-nurturing world view humans regard themselves as part of nature, considering the environment to be the focus of attention. It follows that "the task of human beings [is] to tend the Earth" (O'Riordan, 1989). The radical-manipulative world view, in contrast, shapes a moral pattern of action which is based on the belief that humankind not only has the right, but also the obligation to shape the world in order to create a better place. In the light of the success-oriented western culture Merchant (1992) suggests a further differentiation of the radical-manipulative world view which finally leads to the following classification:

i) 'Ego-centric' – describing a moral mind set based on ones 'self';
ii) 'Homo-centric' – specifying a moral principle resting upon 'society'; and
iii) 'Eco-centric' – characterising the conservative-nurturing world view.

In literature the categories *(i)* and *(ii)* are often summarised under the umbrella term '*anthopo-centric*', or '*techno-centric*' when the industrial nature of the western culture is emphasised.

1.1.2 The emergence of ecology

As occidental history is closely related to the Christian tradition proclaiming the manipulative world view, the environment has historically been seen as external to humanity (Hopwood *et al.*, 2005). A first step towards environmental awareness was the emergence of the academic discipline of *'ecology'* (Von Haeckel, 1866). This resulted in the discovery of interdependencies of the non-human world and the human world. Finally, ecological matters were seen as an integrated system on a local, regional and global level. As a consequence, environmental awareness began to affect action in many parts of western society. However, 'ecology' is not only a domain of knowledge but also a terminology for movements which aim to change things for the sake of a better (more 'eco-centred') future. Terms such as *'Radical ecology'* (Merchant, 1992) or *'deep ecology'* (Pearce, 1993) may be mentioned in this context and be seen as part of a spectrum of environmental considerations.

1.1.3 About environmentalism

Whereas the early environmentalism in the late 19th century was predominantly concerned with landscape conservation (Kuester, 2009), modern environmentalism since the 1950's promotes a departure from the status quo in industrialism (Dryzek 1997) and takes an all-embracing view of environmental issues. Ultimately, environmentalism developed a broad ranging spectrum of values which all have their origin in one of the basic world views introduced earlier. Therefore, it is evident that different viewpoints may have considerably contrasting beliefs in what environmentalism can be. In his largely used categorisation O'Riordan (1989) tackles this issue and introduces a classification of four different *'trends in environmentalism'*, ranging from the extreme eco-centric to the extreme techno-centric side. Pearce (1993) presents a very similar categorisation but also refers to the discussion of *'sustainability'* by adding *'sustainability labels'* to each of the four categories *(fig. 1)*.

	Ecocentrism		**Technocentrism**	
	Deep ecolpgy	Communalism	Accomodation	Cornucopian
Green Labels	Extreme **preservationist** position	Resource **preservationist** position	Resource **conservationist** and managerial position	Resource **exploitative** and growth orientated position
Type of economy	» **Very deep green** economy, » heavily regulated to minimise 'resource-take'	» **Deep green economy**, steady-state economy » regulated by macro-environmental standards and supplemented by Els.	» **Green economy**, green markets » guided by economic encentive instruments [Els] (e.g. pollution charges etc)	» **Anti-green** economy » Unfettered free markets
Management statistics	» **Reduced** scale of economy and population » Scale reduction imperative » at the extreme for some there is a literal interpretation of Gaia as a personalised agent to which moral obligations are owed	» **Zero** economic growth, zero population growth » Decoupling plus no increase in scale. » Systems perspective – health of whole ecosystems is very important Gaia hypothesis and implications	» **Modified** economic growth (adjusted green accounting to measure GNP) » Decoupling important but infinite substitution rejected. » Sustainability rules: constant capital rule	» **Primary** economic policy objective, maximise economic growth (Gross National Product [GNP]) » Taken as axiomatic that unfettered free markets in conjunction with technical progress will ensure infinite substitute possibilities capable of mitigating all "scarcity/limits" constraints (environmental sources and sinks)
Ethics	**Acceptance of bioethics** » moral rights and interests conferred on all non-human species and even the abiotic parts of the environment » intrinsic value in nature (ie. valuable in its own right regardless of human experience)	**Further extension of ethical reasoning** » interests of the collective take precedence over those of the individual » primary value of ecosystems and secondary value of component funcions and services.	**Extension of ethical reasoning** » 'caring for others' motive – intragene rational and intergenerational equity (i.e. contemporary poor and future people) » instrumental value in nature	**Support for traditional ethical reasoning** » rights and interests of contemporary individual humans » instrumental value (ie. of recognised value to humans) in nature
Sustainability Labels	**Very strong sustainability**	**Strong sustainability**	**Weak sustainability**	**Very weak sustainability**

Figure 1: The sustainable spectrum (Pearce, 1993) [redrafted]

1.1.4 The concept of sustainability

The principle of sustainability was first mentioned by Von Carlowitz (1713), at a time, when the term 'ecology' had not even been coined. In these early days, sustainability was clearly linked to resource management in the forest industry. Current conceptions of sustainability which are conceived of in this way carry the term *'sustainable utilisation'* (IUCN, 1980) and can be viewed as rather anthropo-centric as their aim is to maintain a certain status quo in nature in order to sustain resources. Subsequently, an eco-centric perspective on sustainability has been introduced in literature as well which is normally used in ecology to refer to an ecosystem's potential to subsist over time (Jabareen, 2006). Tonkinwise (in Gregory *at al.* 2008) states: "Sustainability is the measure of the capacity of a system [...] to reproduce itself in the changing circumstances upon which it depends [...] which might involve changing [...] or evolving in form and function." The different arguments stated above clearly show the contradictions in the conception of sustainability and here again, the two basic world views define the positions. However, despite its inherent polarity, the concept of sustainability is to be seen as a key aspect in the environmental discourse (Hopwood *et al.*, 2005). In this context the previously mentioned sustainability labels should be considered which correspond with the environmental spectrum as described before (Pearce, 1993; Haughton and Hunter, 1994).

1.1.5 Towards sustainable development: the evolution of a paradox

Whereas the notion of sustainability can be viewed under the umbrella of environmentalism, the concept of ‘sustainable development’ (Brown, 1982) reaches beyond purely environmental considerations. The so called *‘Brundtland report’* (WCED, 1987) observes: “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” Here it is evident that this concept also embraces social and economic issues. What seems to be a modest statement is ultimately quite remarkable: O’Riordan (1989) points out that sustainable development is “bridging the gap between developers and environmentalists”. A consequence of this is the unification of the techno-centric and the eco-centric world view, which were previously considered incompatible. However, this achievement produces an “ethical paradox” based on the “dialectical relations between sustainability and development” (Sachs, 1993) which is highly problematic as it causes constant contention (Hopwood *et al.*, 2005). Furthermore, many scholars lament the ambiguity of sustainable development (Middleton *et al.,* 1993; Wackernagel and Rees, 1996; Holden, 2007) as it “is open to interpretation of being anything from almost meaningless to of extreme importance to humanity” (Hopwood *et al.*, 2005). However, despite all criticism, to date sustainable development is considered to be the most promising concept to tackle contemporary problems.

1.1.6 About sustainable design

In order to understand the nature of sustainable design it may be helpful to consider a fundamental mode of design. According to McLennan (2004) the action of design is always informed by the mind-set of the person conducting a particular design activity. Furthermore, the activity of design, rather than being an isolated end in itself, is an applied activity which always answers a purpose (Dorschel, 2003). In this light, the following paragraphs may be seen:

The origin of sustainable design is not entirely new. In fact, sustainable action in design has been conducted in many cultures within living memory, as those cultures never abandoned their sustainable life style. McLennan (2004) goes even beyond the human sphere when introducing his four ‘evolutionary stages’ of sustainable design. However, this study concentrates on the modern conception of sustainable design in the industrialised world which might be almost understood as a re-invention of this concept after a time of highly unsustainable development. The renewed interest in this concept had been encouraged by design theorists such as Buckminster Fuller (1963) and Papanek (1971).

Yet, sustainable design should not be understood as a design discipline such as graphic or industrial design. According to McLennan (2004), it is rather to be seen as an underlying notion which has the potential to inform all design activities. On this philosophic level sustainable design responds to the concept of sustainable development by raising questions about the optimal transition scenario for a more sustainable future, the idea of well-being, or the optimal status of goods (Vezzoli and Manzini, 2008). However, it might not be surprising that answers to these questions can diverge considerably, again, according to the basic world view. By trying to overcome these differences, system design approaches become increasingly important (Vezzoli and Manzini, 2008).

Theoretical considerations as discussed above naturally inform decisions on more applied levels such as design strategy and finally the actual design activity. At this point the direct correlation between the fundamental world views and the modern design process becomes evident.

1.2 Models capturing the scene

Considering the ambiguity of sustainable development as well as the diversity of sustainable design, it might not be surprising that literature provides a multitude of models which each aim to visualise either one, or both, concepts. To provide structure, the present study works with a classification of two main categories. Thereby the first category deals with nominative visual explanations which aim to comprehensively display a concept from an overall point of view, whereas the second category is reserved for evaluative frameworks which apply defined criteria to discuss a concept under certain conditions. Furthermore, visual models of both categories may be utilised in two different ways. Firstly, as cognitive maps which visually represent theoretical constructs, and, secondly, as assessment tools which promote the categorisation of further knowledge material (Choucri, 2007).

1.2.1 Models for sustainable development

Although the purpose of nominative models for sustainable development is clearly defined, the variety of attempts is extensive. A further distinction may be made between '*domain-based models'* (which concentrate on the different areas sustainable development is referring to), and '*principle-based models'* (which try to capture the concept by identifying its underlying principles). Generally principle-based models may also be seen 'just as sets of criteria' as their graphical sophistication tends to be limited. However, a classic example for a domain-based nominative model is the well known 'Venn diagram' which introduces the "three pillars" (Sutcliffe, 2009) of sustainable development (environment, economy, and society). Further basic examples are introduced by Giddens *et al.* (2002). In contrast, Choucri (2007) presents a comprehensive nominative framework. Typical principle-based models, on the other hand, are introduced by Jabareen (2006) and Haugton (1999). Finally, Pawflowsky (2008) and Spangenberg (1997) present nominative models which are based on a combined approach, featuring domain-based and principle-based elements.

By looking into the area of evaluative models one is confronted with considerable diversity. This is due to the very nature of this category, as each model features certain aspects of sustainable development according to the criteria applied (*cf.* Holden, 2007). Of particular interest for this study, however, is a model developed by Hopwood *et al.* (2005) *(fig. 2)*. Based on the environmental spectra of O'Riordan (1989) and Pearce (1993) *(fig. 1)* the framework maps different approaches in the field of sustainable development according to their "attitude towards change" (Hopwood *et al*., 2005). Thereby the whole spectrum from eco-centrism to techno-centrism is applied to both the *x*- and the *y*-axis, each respectively describing environmental and socio-economic concerns. The resulting space between the axes enables allocation of any sustainable development principle in relation to its position concerning both directions: the range from eco-centric to techno-centric in addition to the spectrum from environmental preferences to socio-economic concerns. Finally, the space is divided into three zones ranging from 'Status quo' through 'Reform' to 'Transformation'.

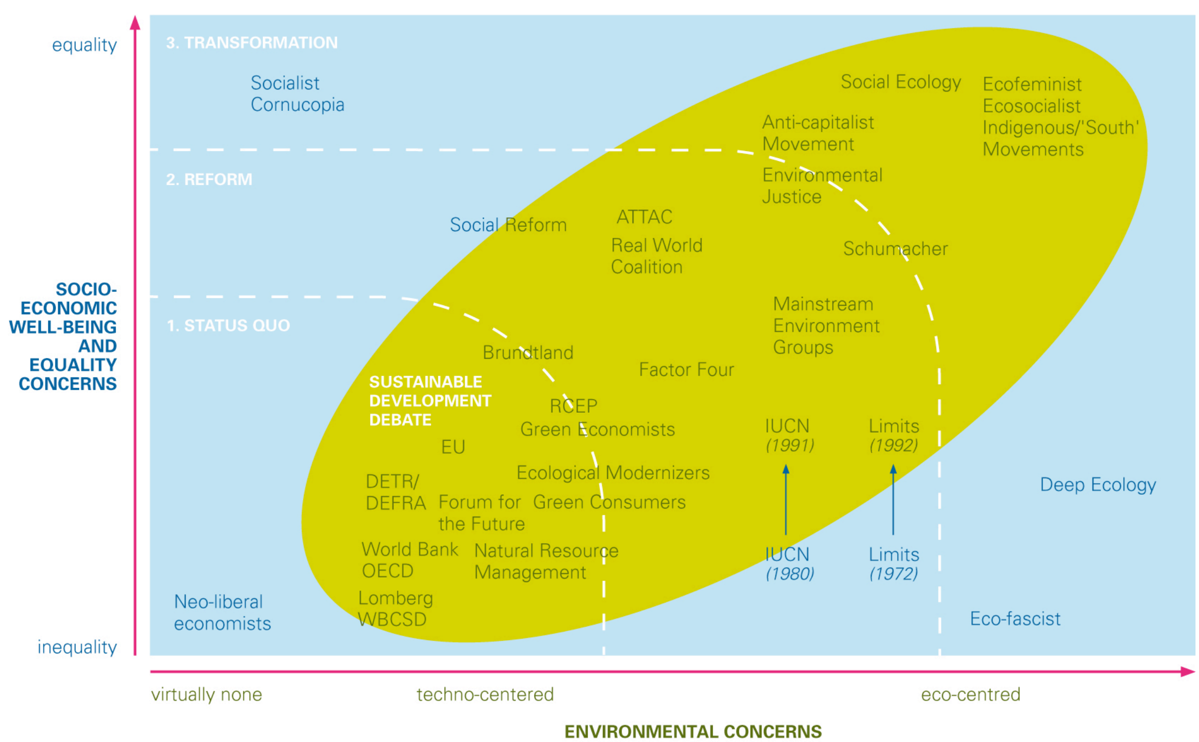


Figure 2: Mapping the views on sustainable development (Hopwood *et al.,* 2005) [redrafted]

1.2.2 Models for sustainable design

Nominative models for sustainable design may be also divided into domain-based and principle-based models. Examples of domain-based models are introduced by McDonough and Braungart (1998) and Fuad-Luke (2009). Here, all authors aim to present a complete picture of what sustainable design might be according to their conception. Principle-based models of different complexity are introduced by Van der Ryn and Cohen (1996), McDonough (1992) and McLennan (2004).

Regarding evaluative models for sustainable design, naturally the situation is comparable with the circumstances already described for evaluative models for sustainable development: Innumerable visualisations are provided in literature which are all concerned with a specific problem (e.g. Porter, 1985; James, 2001). Yet, Vezzoli and Manzini (2008) provide a model which is of relevance to this study. Here, the field of sustainable design is described by four different *'levels of intervention'* with increasing potential to depart from the status quo in the industrialised world. Thus, each of the four levels is connected with a certain stage of transformation in technology and society in order to achieve a more sustainable livestyle:

Level 1: Environmental redesign of existing products
Level 2: Designing new products and services
Level 3: Designing new production-consumption systems
Level 4: Creating new scenarios for sustainable life styles

In essence, the model described by Vezzoli and Manzini is strongly informed by innovation theory, an area which is discussed in the next section.

1.2.3 Innovation Models

Innovation models are increasingly used by scholars to address aspects of sustainable design (Tischner, 2008). Whereas basic models distinguish between incremental and radical innovation, many scholars have introduced more advanced models to be able to better understand the nature of radical innovations (Abanathy and Clark, 1985; Freeman and Perez, 1988; Clark and Staunton 1989). In this context the term 'system innovation' was coined which refers to "far-reaching changes in technology [which may influence] several branches of the economy [or even] give rise to entire new sectors" (Freeman and Perez, 1988). In a conventional context these innovation models are clearly linked to an economic environment. The finite goal of innovation in this sense is therefore economic success (Arrow, 1961). However, when it comes to the issue of sustainable development, additional success criteria of a social or environmental nature play a decisive role.

In order to visualise the sustainability potential of different innovation types Foster's (1986) classic 'S-curve model' is used as a basis by many scholars (Brezet, 1997; Weterings et al., 1997; Halila and Hoerte, 2006). The 'levels of intervention' introduced by Vezzoli and Manzini (2008) may also be seen in this respect. Yet, Magnussen (2001) presents a framework which draws on a different approach. By building on Abanathy and Clark (1985) he introduces a two-by-two matrix which not only allows the visualisation of different types of innovation, but also sets them in context with each other by applying specific criteria on the x- and y-axis of the matrix. Konrad *et al.* (2003), finally, follow this tradition and introduce a framework which aims to highlight the sustainability potential of certain innovation types in the context of product development at a company or industrial level. Thereby "changes in market-actor relations" and "changes in knowledge, technology and organisation" are defined as the criteria which establish the coordinates for the framework *(fig. 3).* As a result, the following innovation types are defined: *'incremental innovations'* (minor changes in both market-actor relations and technology), *'radical innovations'* (minor changes in market-actor relations paired with major changes in technology), *'behavioural innovation'* (major changes in market-actor relations but minor changes in technology) and *'system innovation'* (major changes in both, market-actor relations and well as technology). Regarding this model, system innovation has the highest sustainability potential as it sits on the radical end of both axes.

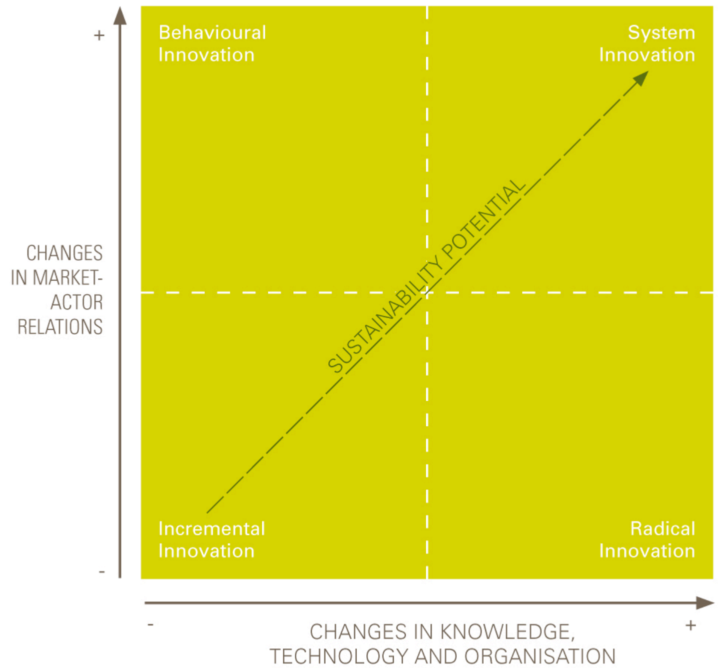


Figure 3: Differentiation of innovation types and their sustainability potential (Konrad *et al.,* 2003) [redrafted]

2. Building the compound framework

After reflecting on the scene, now the compound framework is introduced. The section is divided in two parts. The first part presents basic specifications, whereas the second one finally introduces and discusses the compound framework itself.

2.1 The basic approach

To generate the compound framework this study builds on visual explanations already introduced in chapter one. The following issues are therefore considered:

2.1.1 The nature of the compound framework

Owed to the objectives stated in the introduction of this paper, evaluative models of sustainable development and sustainable design are the core of interest. Moreover the study's focus is on those models which have the potential to accommodate further knowledge material and work as assessment tools (see section 1.2). To integrate models of both spheres a 'frame and picture' analogy is chosen which captures the subject of sustainable design within the wider context of sustainable development.

2.1.2 Specifications of the compound framework

Generally the framework aims to capture the issue of sustainable design in the context of sustainable development on an overall level. As a consequence, different aspects can be covered, ranging from the product development level to matters embracing society as a whole. Naturally the position of the frame, capturing the area of sustainable development may be seen as slightly tuned towards the issues of sustainable design, owing to the very nature of the study. Technically both parts of the compound framework are intended to have the same perspective in order to be compatible. That is achieved by applying equitable criteria.

2.1.3 Criteria applied to the compound framework

The fundamental idea of sustainable development is the departure from status quo towards more sustainable scenarios, although there are different beliefs in how this could be done most successfully. Sustainable design is corresponding to this issue which is particularly expressed in the models of innovation theory. Therefore the criteria applied to the compound framework are designed to measure the potential of any mapped design activity to depart from the status quo in society.

2.2 The compound framework

To build the compound framework different models are introduced and adapted in order to meet the specifications as discussed above.

2.2.1 Building the frame – capturing sustainable development

To establish the frame, the study follows Hopwood *et al.* (2005) *(fig. 2)* and builds on the classifications of O'Riordan (1989) and Pearce (1993) *(fig. 1).* However, in contrast to Hopwood *et al*.'s model, the environmental spectrum established by O'Riordan (1989) and Pearce (1993) is not applied to the full length of the x- and the y-axis. To emphasise the fundamental discrepancies between the eco-centric and the techno-centric world view, the spectrum is divided into two halves which are depicted by one of each axis. The resulting L-section constitutes the frame of the compound framework, representing the two basic attitudes in the environmental debate in terms of how to migrate from the status quo in the industrialised world towards more sustainable scenarios *(fig 4).*

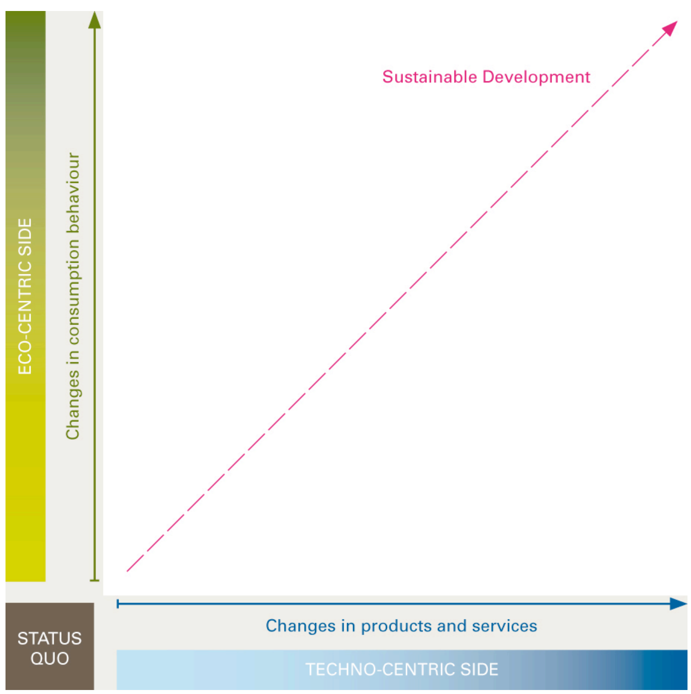


Figure 4: The 'frame' of the compound framework capturing sustainable development

In essence the eco-centric side stands for the conservative-nurturing world view and may be seen as the 'sustainability-side' of sustainable development (Sachs, 1993). Supporters of this perspective believe in the idea that humankind needs to change its behaviour in favour of a more sustainable life style (O'Riordan, 1989 and Pearce, 1993). In the light of consumerism in western society the proposed changes target mainly consumption behaviours, provoking the demand for lower consumption (Vezzoli and Manzini, 2008).

The techno-centric side represents the radical manipulative world view and could be interpreted as the ‘development-side’ of sustainable development (Sachs, 1993). Here, supporters strongly believe in technical sophistication and development to overcome social and environmental problems (O’Riordan, 1989 and Pearce, 1993). So, moderation in consumption may be viewed as a lower priority. However, with ‘doing things better, rather then less’ the basic attitude seems to be appropriately described, resulting in the need to constantly refine production techniques, products and services. (Vezzoli and Manzini, 2008).

According to (O’Riordan, 1989) the notion of sustainable development may be located in between the eco-centric and the techno-centric side trying to marry both spheres. This position is indicated by the pink arrow in figure 4.

2.2.2 Building the picture – capturing sustainable design

The core part of the compound framework mainly builds on the system innovation model introduced by Konrad *et al.* (2003) *(fig. 3)* but is also informed by Vezzoli and Manzini (2008). The choice of this particular innovation model is based on reasoning that it works according to the same criteria as the frame of the compound framework introduced above: It evaluates the potential for certain innovation types to depart from the status quo towards more sustainable scenarios. Yet, Konrad *et al.* (2003) explicitly focus on a company or industry level. As this study is aimed at an overall level the following implications are to be taken into account.

Firstly, the notion of ‘systems’ change as they may not be seen as purely economic structures in future. In the new context systems should be understood as “existing arrangement[s] of technologies and supporting organisational, economic, regulatory, knowledge, and cultural structures” (Vergargt, 1999).

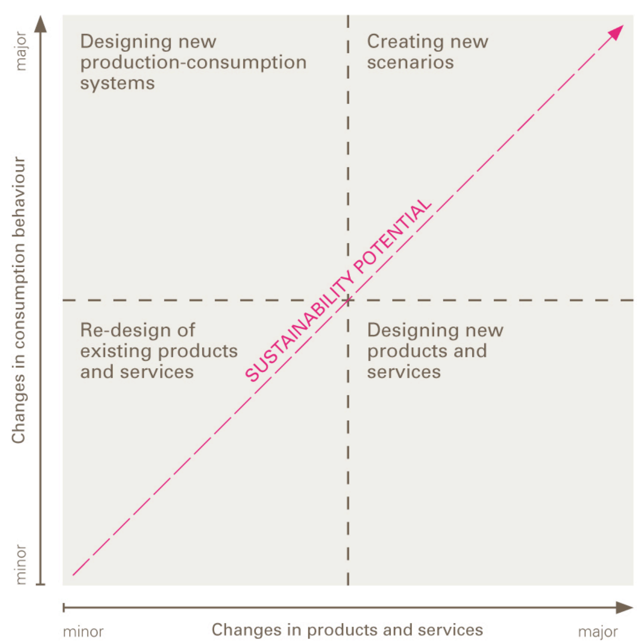


Figure 5: The ‘picture’ of the compound framework capturing sustainable design

Secondly, the criteria of the original framework are modified from ‘changes in market-actor relations’ and ‘changes in knowledge, technology and organisation’ to ‘changes in consumption behaviour’ and ‘changes in products and services’. This step supports both the alignment of the criteria to the more general orientation of the final framework, and a consistent compatibility between the final framework’s ‘frame’ and ‘picture’.

Finally, the four different innovation types introduced by Konrad et al. (2003) are replaced by a set of four 'modes of designing' which are closely informed by the "four levels of intervention" (Vezzoli and Manzini, 2008) discussed in section 1.2.2. These design modes conform with the meaning of the innovation types they replace but have greater potential to represent the issue of sustainable design (rather than that of innovation theory).

The resulting framework *(fig. 5)* ultimately shows a coherent conception of sustainable design: Two fundamental constants of design – the user (or consumer) and the designed product or service itself – determine a set of transition scenarios towards a more sustainable lifestyle. Additionally, the sustainable potential is maximised when both sides are brought together.

2.2.3 Frame and picture – the compound framework

By finally integrating 'frame' and 'picture' the compound framework is built as displayed in figure 6. The following paragraphs discuss the function of the framework as well as its utilisation as an assessment tool.

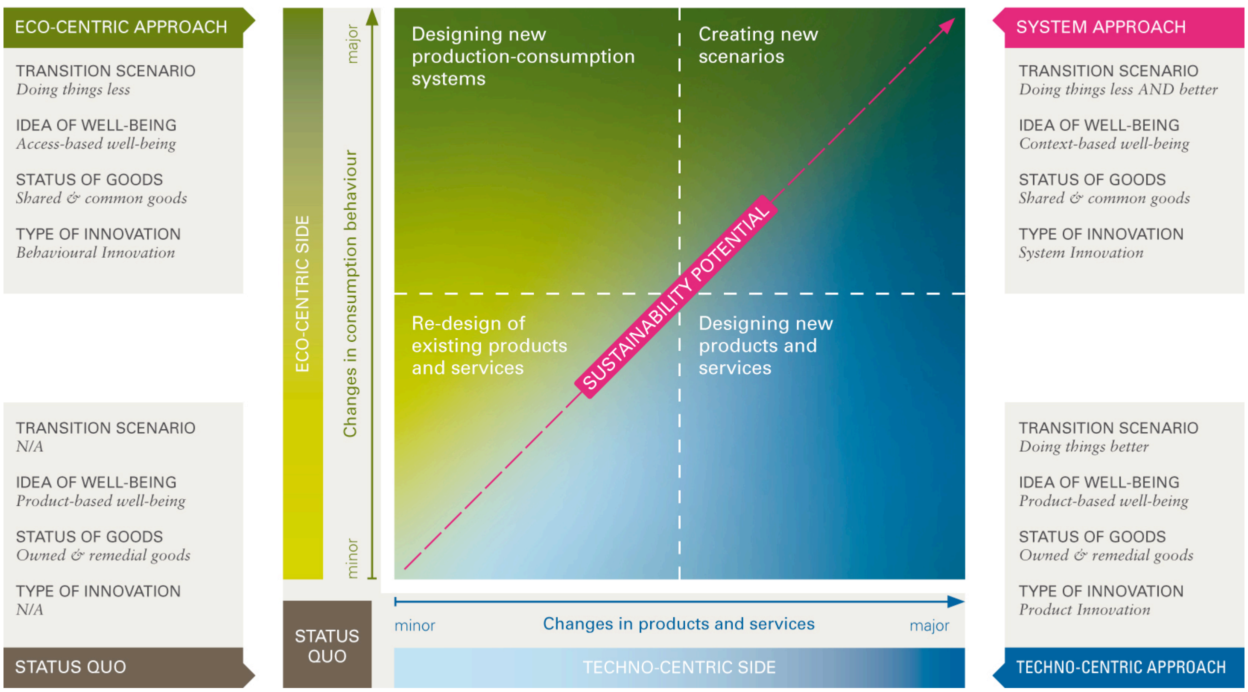
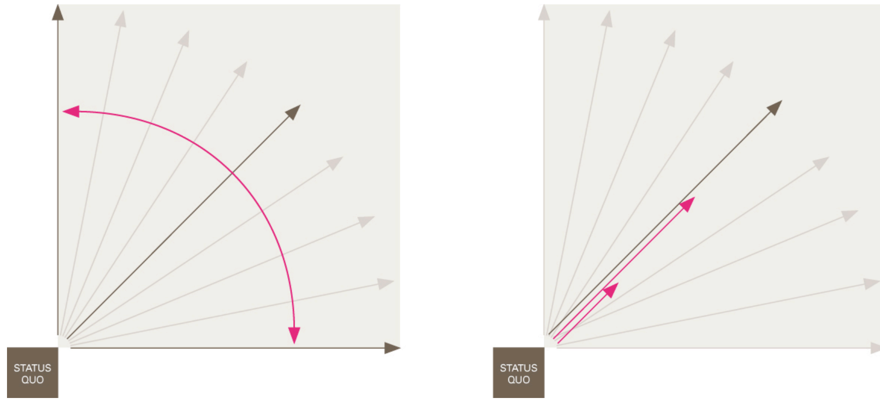


Figure 6: The compound framework – Sustainable design approaches in the context of sustainable development

In essence, the L-section of the framework (the 'frame') opens up a space within which the matter of sustainable design is located. Thereby this space covers two different aspects. The first aspect is concerned with the departure from status quo in the industrialised world. As already discussed, this is possible by following different directions. Yet, as illustrated in figure 7 the direction of departure does not necessarily need to follow either the eco-centric or the techno-centric approach, but may take any angle in between both extremes. Thereby the sustainability potential increases as the closer the departure's direction gets into the centre of the spectrum (cf. 2.2.1). The second aspect describes the intensity of the departure from status quo, which would be the equivalent of an innovation's scope in innovation theory moving from incremental to radical (cf. 1.2.3). As the framework does not work with the terms of innovation theory the departure's scope is consequently specified with neutral terms describing a range from minor to major changes *(fig. 8).*



Figures 7 and 8: The departure's direction and intensity

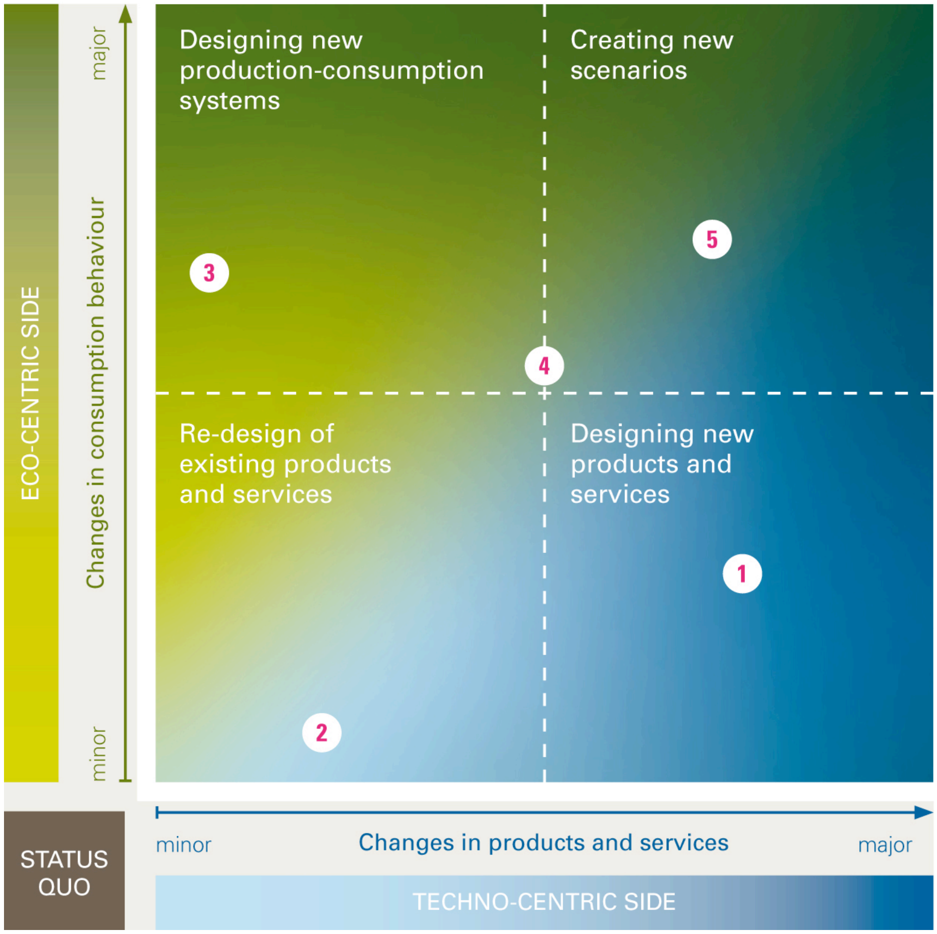
Additionally, the sustainability potential increases as a more determined departure from the status quo is performed. As a result, the framework defines the upper right corner as the area with the highest sustainability potential.

The space described above is populated and further defined by the 'picture' of the framework dealing with sustainable design. The coloured background of the matrix thereby illustrates the relationship of the eco- and the techno-centric approach. In this context the 'four modes of designing' (cf. 1.2.2) appear in a more informed way, as their relationship to the bigger picture of sustainable development becomes obvious: The bottom left corner of the matrix is closest to the status quo. Here it becomes evident that a 're-design of existing products and services' has the lowest potential to depart from the status quo towards more sustainable scenarios. However, the top left and bottom right corners illustrate that even major changes in consumption behaviour or products and services cannot achieve top levels in sustainability performance as long as they are conducted independently. Ultimately, only if both the eco-centric and the techno-centric side are united in order to perform major changes, truly sustainable development can take place. This is reflected by the top right corner and might result in the creation of new scenarios for a more sustainable life style.

As an extension to the framework four text boxes are provided which specify the corner stones of the framework with additional demarcation criteria based on Vezzoli and Manzini (2008). As already discussed in 1.1.6., when it comes to issues such as transition scenarios, ideas of well-being, or the status of goods, the boundaries between sustainable design strategy and the notion of sustainable development become blurred. As a result the text boxes are able to inform the 'frame' and 'picture' providing comparable information for both, the status quo, as well as the three main directions of departure form status quo: the 'eco-centric approach', the 'techno-centric approach', and the 'system approach'.

2.2.4 Mapping sustainable design activities

Beside its function as a visual map which describes the relationship between sustainable design and sustainable development, the framework may be also utilised as an assessment tool promoting the categorisation of further knowledge material (Choucri, 2007). In the latter case the model should be seen as "a sort of skeleton, something like an application form with many blanks or slots to be filled" (Minsky, 1986). In this case the supporting information such as the text boxes or the like is not essential anymore. In figure 9 the framework's mode of operation is illustrated by mapping the following basic strategies based on Fuad-Luke (2009). Thereby the design strategies get evaluated according to their potential to depart from the status quo as well as to their location on the eco-centric/techno-centric spectrum:



Figures 9 The compound framework utilised as an assessment tool

1. Bio-Manufacturing	–	*nature directly supports the fabrication of products (e.g. fruits become packaging)*
2. Clean Production	–	*production's impact on nature is reduced by putting appropriate systems in place*
3. Community Ownership	–	*maximises the product's efficiency through shared usage (e.g. car sharing systems)*
4. Dematerialisation	–	*products are replaced by services*
5. Downloadable Designs	–	*reduces the impact on nature and opens up entirely new scenarios*

Conclusion

Confronted with a considerable variety of different sustainable design activities such as theories, strategies or the development of tools, this study ultimately aims to establish conceptual clarity within the area of sustainable design. In order to provide a solid foundation for the area of sustainable design, it is important to define the context within the notion of sustainable development. However, due to the fundamental nature of sustainable design, it may not be entirely possible to define the field completely.

This study focuses on the relationship between sustainable design and sustainable development. The approach is based on the assumption that sustainable design may not be seen as a normal design discipline, but as an underlying notion, a philosophical approach to almost any design activity (McLennan, 2004). This notion finally responds to the same issue as the concept of sustainable development: At the centre of attention, is the departure from the status quo towards more sustainable scenarios.

To capture the fields and their relationship as described above, a visual approach is chosen. A literature review provided the basis for the conception of sustainable design in the context of sustainable development. Building on this, visual models of both spheres are introduced, classified and discussed to build a data base for the framework to be created.

As a result, a compound framework has been developed which is able to visualise the field of sustainable design in the context of sustainable development recognizing the potential to depart from the status quo as described above.

Depending on how it is used, the framework has the following implications: On a theoretical basis, the framework works as a visual map which describes the relationship of sustainable design and sustainable development. On a practical level the framework may be utilised as a visual assessment tool which promotes a better understanding and evaluation of the growing number of sustainable design activities. However, the mapping process may be debatable as many factors are not finally defined yet. This might be the starting point for future research.

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Understanding the practical challenges of moving from closed to open source collaborative design

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Abstract

This inquiry examines how effective collaborative user experiences can be shaped in open source communities. It focuses on the changing design and development conditions of the prototype computer software application *LabanAssist* (Ebenreuter, 2008). These changes stem from, the project's prior development as a prototype application in a relatively closed collaborative environment. This environment had developed through a human-centred participatory design approach and changed into one that was dynamic and embraced open source collaborative design.

By changing the project's environment and activity of development, it is envisaged that a range of experts will have the potential to participate in the ongoing advancement of *LabanAssist*. The challenge, here, rests in designing a way in which an integrated view of the design situation and the associated activities required to continue the open development of the *LabanAssist* project, can be shared and communicated effectively across different design domains.

In this paper, literature concerning the nature of collaborative activities in open online communities is examined. This is done to better understand the challenges of communicating interdisciplinary ways of working and thinking that contribute to the holistic development of open design projects. To address these challenges, a number of interaction design guidelines for facilitating collaborative action are offered as a means to maintain the purpose and activity of open design projects.

The proposed guidelines offer a way of thinking about the manner in which interactive tools can be designed to assist with the identification of design elements in open design projects and to be able to visualise the relationships between various collaborators from different areas of expertise. An open design environment that has the potential to support collaborative action is shown through various interface designs of a conceptual tool that illustrates how a shared view of the form and significance of evolving ideas may be communicated over time.

Keywords

Open design; collaborative action; participation; guidelines; workflows; open source.

The environment and activity of design

Changing business models, methods of innovation and interaction fuelled by the capacity of the Internet to facilitate communication through emerging uses of technology have introduced alternative avenues in which design products and services can be developed. An example of this can be seen in the increasing number of open source development projects, which potentially involve any number of global participants who contribute to the collaborative development of a product's advancement online. In this way, products are designed to adapt, not to a fixed need, but provide a place for action that expedites the needs and intentions of diverse users, in dynamic situations.

This research is built upon on the understanding that open collaborative design practices have the potential to enhance the exploration of unknown design potentialities and the creation of innovative outcomes (Harhoff et al., 2003). In this (Harhoff et al., 2003) view open design can be understood as a dynamic and complex process made up of diverse people, methods, perspectives, and values. This process is fundamentally different from the design of a product that offers a determinate solution to a particular need or desire. Instead, the unfixed or open nature of design potentialities that can take shape is therefore unknown. The notion of unfixed design potentialities is further enhanced by the dynamic direction of open design projects. These projects are essentially driven by end-user needs and intentions and provide the potential for innovative ideas and solutions to develop (Harhoff et al., 2003).

To support the development of innovative design outcomes, useful and informative resources that inform the practice of designing are needed to communicate the idea, purpose and function of open design projects. Communication of this information should be done in a way that bridges the gaps of understanding between individuals from different knowledge groups and varying levels of expertise. In open source software communities it is customary to offer up existing software systems for iterative development in terms of ‘change requests’ and desired ‘product features’. This is done across a variety of online forums and discussion groups, in the form of ‘to do lists’ and ’bug reports’ which do not offer potential collaborators of the project a global view of the design situation. Ubuntu Brainstorm (n.d.) provides an online forum to support the collaborative development of ideas to enhance its software platform. The environment in which the communication of shared ideas is made possible is problematic. The environment typically does not offer end-users the tools or the useful presentation of ideas in a manner that is either useable or helpful (Ashton, 2009).

The focus of this research concerns the changing design and development conditions of a prototype computer software application called *LabanAssist* (Ebenreuter, 2009). The *LabanAssist* project is a continuing work in progress that is seeking to make the knowledge garnered from its prior development, as a prototype application, into useful and informative resources. These resources can potentially be shared, understood and continued to be developed in an open design environment by a range of experts. It involves the clarification of countless interrelated dimensions of a project together with the variety of information, objects, events and practices relevant to the fields of user interface, interaction and software design. Since many issues can arise when conversations within their respective fields are discussed in terms that are seemingly diametrically opposed to one another, the challenge lies in designing a way in which a shared view of the *LabanAssist* project can be communicated effectively.

In the following sections I give context to this research. I discuss the challenges involved in building the necessary relations between different fields of knowing, doing and making with respect to the active involvement of potential participants of open design projects. I propose a number of interaction design guidelines for facilitating collaborative action in open design projects. Through a series of interface design concepts I illustrate the significance of these guidelines on the design of an interactive tool that seeks to support the dynamic structure and activities of collaborators from three different design domains.

I conclude the paper with further remarks concerning the future potential of this research.

Changing design and development conditions

In light of the changing environment and activity of design Keinonen (2009, p. 64) proposes two emerging fields of design practice: (1) ‘immediate design’ which focuses on various practices of use from a user-centred approach; and, (2) ‘remote design’ which is concerned with facilitating practices that lead to structural change. While the idea of distance is used to differentiate the two types of design practice, the development of objects and events that constitute the elements of the design situation, should be understood as part of an organized integrated system. Dewey (1938, p.72) expands upon this idea when he tells us that “we never experience nor form judgments about objects and events in isolation, but only in connection with a contextual whole”. This is an important distinction because without the capacity to build the necessary relations between diverse fields of knowledge, the elements of the design situation and potential participants of a design project there is no significant foundation for the creation of form as a unified whole.

In terms of the initial development of the *LabanAssist* project, carefully developed task analysis schematics and design rationale (Ebenreuter, 2007), worked to assist the early conceptual development of a prototype tool that enables members of the dance community to document movement as Labanotation scores. In the same way that musicians can document scores of music as musical notes on a staff, dancers can document scores of movement using the vast symbolic vocabulary of Labanotation. Taking a fundamentally ‘immediate design’ approach to the creation of *LabanAssist,* the prototype application was co-created with and for students, and educators of the movement notation system called Labanotation. This work was undertaken, on location, at The Ohio State University’s Dance department. As a result, the interaction design of the application’s functionality is firmly grounded in the practical problems and user experience of documenting movement in a symbolic form.

The ability to build the necessary relationships between different fields of knowing, doing and working with potential participants of a project is critical to an open design project. Building these relationships are central to providing a variety of collaborators with the necessary tools and power to contribute constructively to a project throughout its iterative development. This idea is in keeping with Keinonen’s notion of ‘remote design’. Design that facilitates structural change, however, providing a common ground in which participants can identify opportunities for collaboration is essential to their active involvement in open design projects (Barcellini et al., 2008; Détienne, 2006; Ye & Fischer, 2007). I argue that the project for the ongoing development of *LabanAssist* requires a common ground or basis for understanding where, and how one can take action. This stems from the underlying rationale for design in which the project was initially developed. In support of this Ye and Fischer (2007) tell us that careful consideration should be given to specific design decisions in a way that encourages the potential for participation and collaboration.

Making the rationale for designing explicit is significant as it has the potential to provide an opportunity in which a strategy for assisting others to take collaborative action can be developed. One in which prior knowledge of the design situation can orient a participant's understanding of a particular aspect of a project, in relation to the whole and better equip collaborative negotiations to develop concerning what is useful, usable and desirable to the design situation. This is a strategy for action that revolves around the development of ideas in relation to what could be done, as opposed to what must be done to carry the development of a project further. In this way a participant's perspective, experience, and judgment made during the process of designing is vital to the arguments and subsequent actions taken to shape the direction of a project. As a result, this way of thinking and working becomes central to the formation of the design process in open design projects.

The practical challenges for facilitating a variety of open design processes becomes apparent when the elements made available to participants for iterative development are not necessarily developed in complete isolation from one another. This is because various design elements, which require collaborative development, carry with them interdependencies that span across different fields of knowing and doing. These interdependencies and the complexity in which design problems can occur during the conceptual development of newly formed products or services, gives us insight. We begin to understand the benefit of social creativity practices that leverage the perspectives, expertise and fields of knowledge of a number of different individuals (Fischer, Giaccardi, Ye, Sutcliffe & Mehandjiev, 2004). In doing so, a shared understanding of a design situation and it's potential resolution can be shaped collaboratively by participants involved in the process of designing (Fischer et al., 2004). However, there remains a necessity for open design projects to establish a concrete connection between the elements and activity of design. This must be achieved across a number of domains, to provide a flexible structure in which open design projects can be successfully developed.

Navigating open and collaborative design environments

In order to effectively coordinate and navigate the potential contributions of participants in open design environments, an integrated understanding of the design situation is required. Literature that gives focus to the requirements for participation (Barcellini et al., 2008; Ye and Fischer, 2007) and a variety of issues concerning the collaborative development of tasks and activities in online communities (Détienne, 2006; Carroll, Neale, Isenhour, Rosson & McCrickard, 2003), offer a starting point in which a strategy for collaborative action can be developed. While Ye and Fischer (2007) seek to address end-user motivations in combination with effective tools and management support, the focus of this research is to enhance the design of interactive tools that facilitate collaborative action in open design projects. The ability to do so is based on the creation of an integrated understanding of the design situation, its elements and actions, across different design domains, rather than creating meaningful experiences that seek to encourage existing participants to further extend their collaborative commitment.

Drawing on the literature available (Antikainen et al., 2008; Fischer et al., 2004; Kensing & Blomberg, 1998; Divitini & Farshchian, 1999; Détienne, 2006; Carroll, et al., 2003; Ye and Fischer, 2007; Barcellini et al., 2008), I identify critical aspects concerning the participants of the design situation, the representation of design elements and their associated activities across different design domains as a way to enable the potential for collaborative action to take shape. In doing so, participants of open design projects may better understand: (1) Who their fellow collaborators are and what they know; (2) What design elements are being developed and by whom; (3) Where they can make a contribution to the project's evolutionary development; (4) How the project's design activities are advancing the overall design situation; and, (5) Why particular courses of action have been taken and what future actions will be taken to support the project's development.

I propose a number of interaction design guidelines for facilitating collaborative action in open design projects:

1. *Provide cohesive structures of communication*
   The fundamental structure and operation of open design environments should provide participants with a cohesive system of communication in which they can contribute.

   - Visualise the progressive development of ideas and design decisions.
   - Order and arrange the priority of elements.
   - Give hierarchical form to collaborative discourse.
   - Highlight the steps and stages of interactive processes.

2. *Establish an environment of activity*
   A system of use should derive from a common understanding of the elements and activities of a design situation, across a variety of knowledge areas.

   - Establish a collective tool set of design practices.
   - Illustrate how participants' activities give shape to the design situation.
   - Create independent structures of activity that progressively require collaborative development.
   - Visualise individual and integrated workflows.

3. *Create situational relevancy*
   The ongoing development and relevancy of elements that constitute the design situation should be understood as part of an organized integrated system.

   - Give context to interconnected elements of the design situation.
   - Connect collaborative conversations to design artefacts and the underlying rationale for their development.
   - Build relationships between participants' expertise and activities.
   - Assign interactive characteristics to the changing and unchanging elements of the design situation.

4. *Allow for potentiality*
   The boundaries of a system should work to orient different ways of knowing, thinking and doing in a way that opens up the potential for a variety of concrete possibilities to develop.

   - Enable the possibility for variety.
   - Allow for the alternative arrangement and organization of design processes.
   - Create an environment in which understanding and learning is possible.
   - Provide the potential in which the mutual exchange of diverse perspectives can enhance and cultivate creativity.

Fundamental to forming a foundation for collaborative action is the interaction and interface design of a tool that supports specific user tasks in a way that successfully illustrates its utility. This is because the underlying methods of interaction, designed to facilitate various end-user tasks, directly informs the visual interface design and key elements of support tools (Armitage, 2003). The interaction design guidelines, listed above, provide a basis in which to consider the challenges of enabling collaborative action to take shape in open design environments. They offer a way of thinking about the manner in which these concerns are addressed through the design of an interactive tool.

Essential to the specific purpose of this research is the consideration, of the practical challenges of facilitating open design projects, and the design activities or tasks relevant to the processes and practices of three different design domains.

In this research the design domains and activities include:

- Interaction design
    1. Information architecture
    2. Wireframes
- User Interface design
    1. User interface design concepts
    2. User interface style guide
- Software design
    1. System architecture
    2. Application programming interface

The above design activities work to complement the existing knowledge collected through the human-centred participatory design approach taken to facilitate the early development of the *LabanAssist* project. These activities encompass diverse methods and techniques of design thinking and working that provide a starting point for the collaborative development of *LabanAssist* as a fully functioning software application in an open design environment. While these design areas are represented as distinct from one another, knowledge used to support the wide variety of design practices that exist today, are not mutually exclusive to any single domain of design. Instead, each domain draws on a variety of different disciplinary practices to assist in the collaborative development of new products or services and reflects the transdisciplinary nature of design (Margolin, 1996).

An approach towards facilitating collaborative action in open design projects

A holistic view of the design situation should communicate the evolving product idea, its overall purpose and function to assist the progressive development of open design projects. It is envisaged that by visually illustrating interactive processes and workflows, that constitute the activity of the design project, the user experience of participating in open design communities will be enhanced. The ability for potential participants to gain an understanding of the basic structure and operation of open design projects should assist in establishing an integrated system of use in which they can contribute. This system of use, or way of working, should derive from a general and familiar understanding of the activities relevant to the design situation and the domains of design involved in a project's development. In this research, consistent workflows of connected activities form the basis of open design processes. These processes give shape to the design of a proposed interactive tool that seeks to facilitate collaborative action in open design projects.

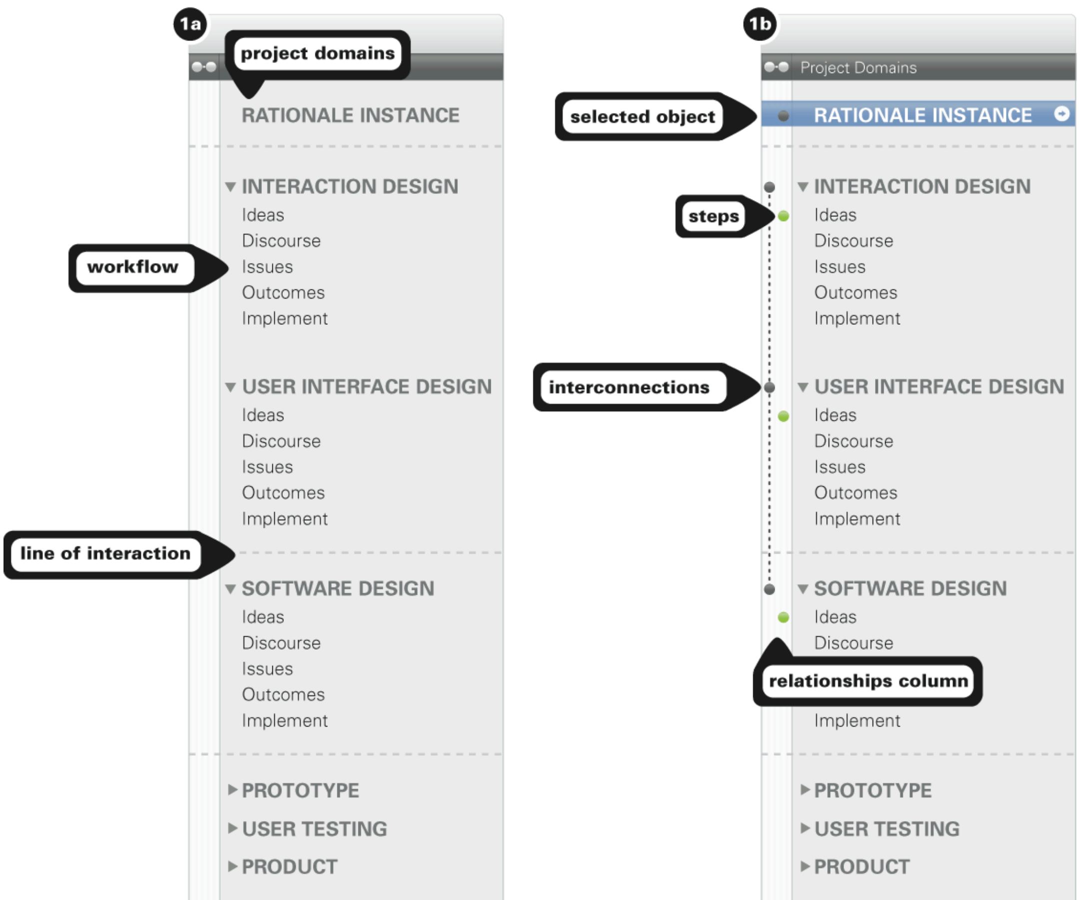

Fig 1. *Workflow structure and relationships across different design domains*

In Figure 1a the interface design of an interactive tool seeks to support the dynamic structure and activities of three different design domains. It illustrates a consistent workflow of connected activities that provide a foundation for the development of ideas as design outcomes and their subsequent implementation as fully functioning products or services. The basic workflow structure displayed in Figure 1a encompasses the ideas, discourse, issues, outcomes and implementation aspects of the design situation, specific to each project domain. Different project domains are made visually distinct in the design of the interface by various horizontal lines of interaction that are placed at the intersection of two closely related domains. In this way, the working relationships between project domains that focus directly on the user interface and interaction design of a software application are highlighted for the work they do in close collaboration. This is because of the immediate impact each human-centred area of design has on one another. Software design, however, is treated differently in the design of the interface because of the technical and supportive role it offers the design of interaction, user interface design and prototype development of software applications. Distinct again from these project domains are the areas of prototype development, user testing and the final product, which hold direct implications for one another during their iterative development. It is envisaged that these areas will also involve end-user participation in both the evaluative stages of a product's early prototype development and the final product release.

The proposed visual distinctions made in the design of the interface are not made to imply that a clear-cut top down approach to designing should be followed. On the contrary, Figure 1b illustrates the interconnections between design elements and various project domains that can potentially exist. In this example (see Figure 1b) the selected object, which is a rationale instance, holds relevancy across three project domains. This is visually represented in the far left of the relationships column, by the positioning of a grey circular marker alongside each relevant domain of the design situation. The relationships are then visually established via a grey dashed line that identifies and unites them. In addition to this, the progressive steps in the design process that connect one activity to another, are represented in the far the right of the relationships column. The following steps of a project are suggested by a coloured circular marker, which is positioned at a lower level in the interface to that of the currently selected object. In Figure 1b the rationale instance is highlighted in blue to indicate that it is the currently selected object. The selected state of the rationale instance is also represented by a circular marker alongside it to suggest that a progressive relationship exists between the rationale instance and the development of ideas across different project domains. In doing so, the structure and stages of interactive processes are highlighted to provide a coherent structure to the communication of developing ideas.

Discovery and Recognition

As an approach to facilitating the inquiry into an open design project, rationale instances in Figure 2 offer potential collaborators of open design projects a way to learn about a particular aspect or object of the design situation, in relation to the whole (Ebenreuter, 2009). They work to provide situational relevancy in open design environments by giving context to the interconnected elements of the design situation. Rational instances achieve this by presenting interdisciplinary design knowledge concerning the development of components, relevant to the design situation, which can be integrated into a larger complex system over an extended period of time. Each rationale instance provides a descriptive account of a component for further ideation and development. They give focus to the relationship between: (1) the specific problems found in the practical user experience that the software application seeks to address; and, (2) the design artefacts created to overcome these issues. The first two points are then further supported with: (3) an explanation of how the function of the design outcome operates; and corresponds to both; (4) the visual attributes found in the interface design of the proposed artefact; and, (5) the interactive elements that the proposed artefact will communicate with, in relation to the system's overall software design.

The design rationale captured within each instance provides a frame of reference in which a variety of designers concerned with the interface, interactive and software elements of a project can continue to shape the development of new products or services. By providing participants with additional knowledge and documentation surrounding each component for development it is envisaged that the potential for creative and innovative design directions can emerge in open collaborative design environments. This additional information is described and illustrated through a variety of documents that are particular to the way in which each domain of design thinks and works. For example the (1) problem; and, (2) design artefact as in Figure 2 hold particular significance to interaction design which contains user-centred design information and documents that are a part of a common set of practices and tools of communication, known to this domain. Alternatively, the (3) functional explanation; and, (5) interactive elements of a rationale instance are relevant to both interaction and software design. Information captured in the system architecture and information architecture documents provide not only a unique view of a component but one that is also applicable to the global view of a software system and it's surrounding interactive elements. Again, this is information that is conveyed within a familiar set of terms and models that communicate this knowledge to individuals who have expertise in these domains. The (4) visual design concept; however, holds specific relevance to the user interface design of a system that is strongly connected to both user interface and interaction design. The method of wireframing, that interaction designers use to visualise general elements in user interfaces, are also significant to the (3) functional explanation of a rationale instance.

Providing potential collaborators of open design projects with various types of design knowledge and artefacts allows individuals, from single or multidisciplinary backgrounds, a specific and general view of the design situation. This is achieved in terms that are relevant to the design domains represented within each rationale instance. It is envisaged that this will help to establish a comprehensive environment of activity that will facilitate collaboration and make understanding and learning possible. By building relationships between participants' expertise and activities, it allows them to focus on independent aspects of a component's design that will progressively require collaborative development as the design process advances. The diverse nature of design knowledge captured within each rationale instance also works to provide a shared view of the design activities that illustrate individual and integrated workflows across a number of project domains.

The relationship between the component for development shown in Figure 2, and the associated design domains for which it holds relevance is also visually illustrated in the interface, on the far left of the relationship column. The fields of interaction, interface and software design are connected with a dashed line and consequent circular markers to indicate their interconnected relationship to one another. This is important as it highlights the different areas of consideration that need to be acknowledged in the resulting ideas and design outcomes that are suggested for integration into a prototype application.

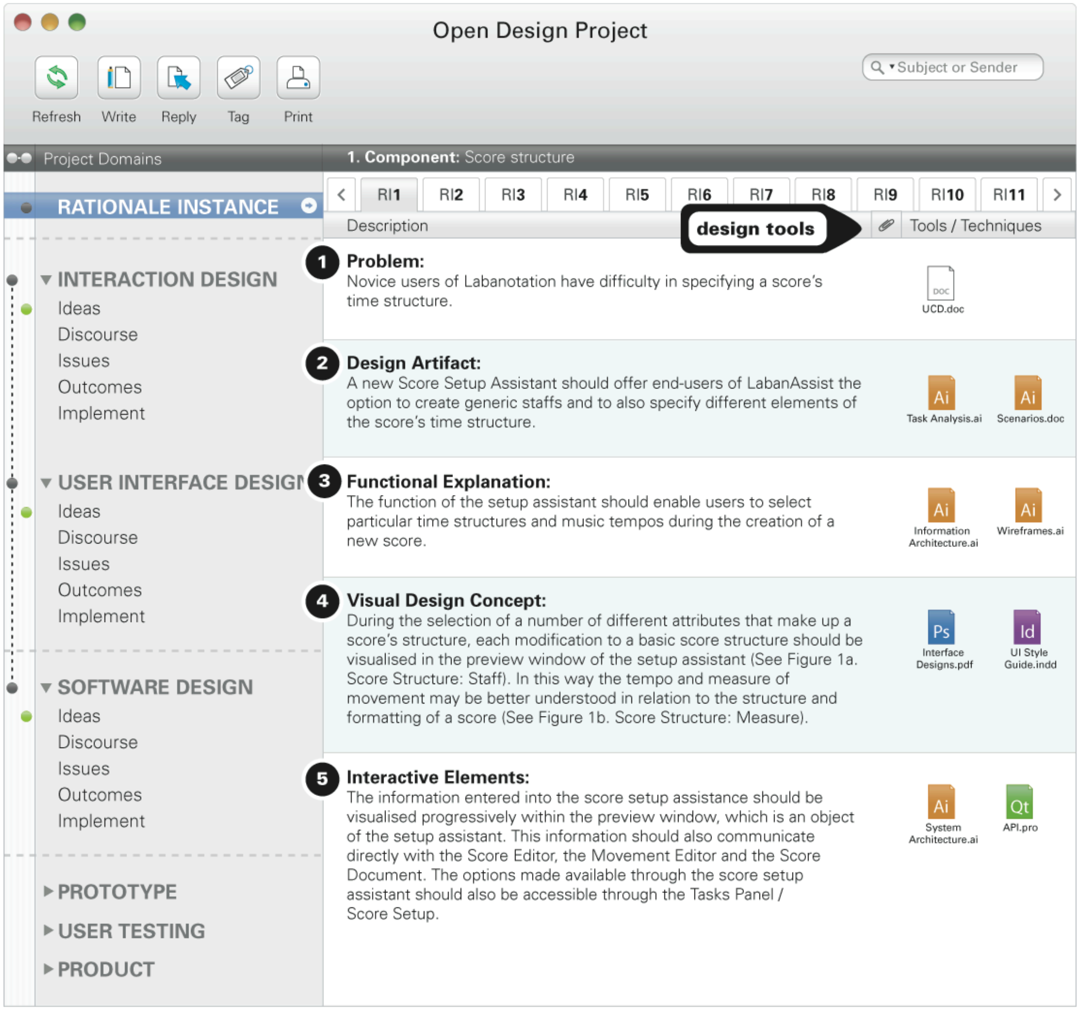

Fig. 2 *Rationale Instance of the component: score structure*

Negotiation and Evaluation

While rationale instances provide a potential starting point for the collaborative development of interactive products, design practices that manage the integration of a project's design elements are needed to ensure that the characteristics of newly developed directions remain consistent with the overall purpose and function of an open design product (Margaritis & Sgouros, 2008). The workflow structures illustrated in Figure 1a give shape to the collaborative development of numerous components that constitute the dynamic design situation. In this way the incremental design and development of each component, over a series of integrated design activities, works to refine the ideas and eventual outcomes suggested by participants to enhance a component's design. This is accomplished as the result of a gradual process of collaborative negotiation and evaluation.

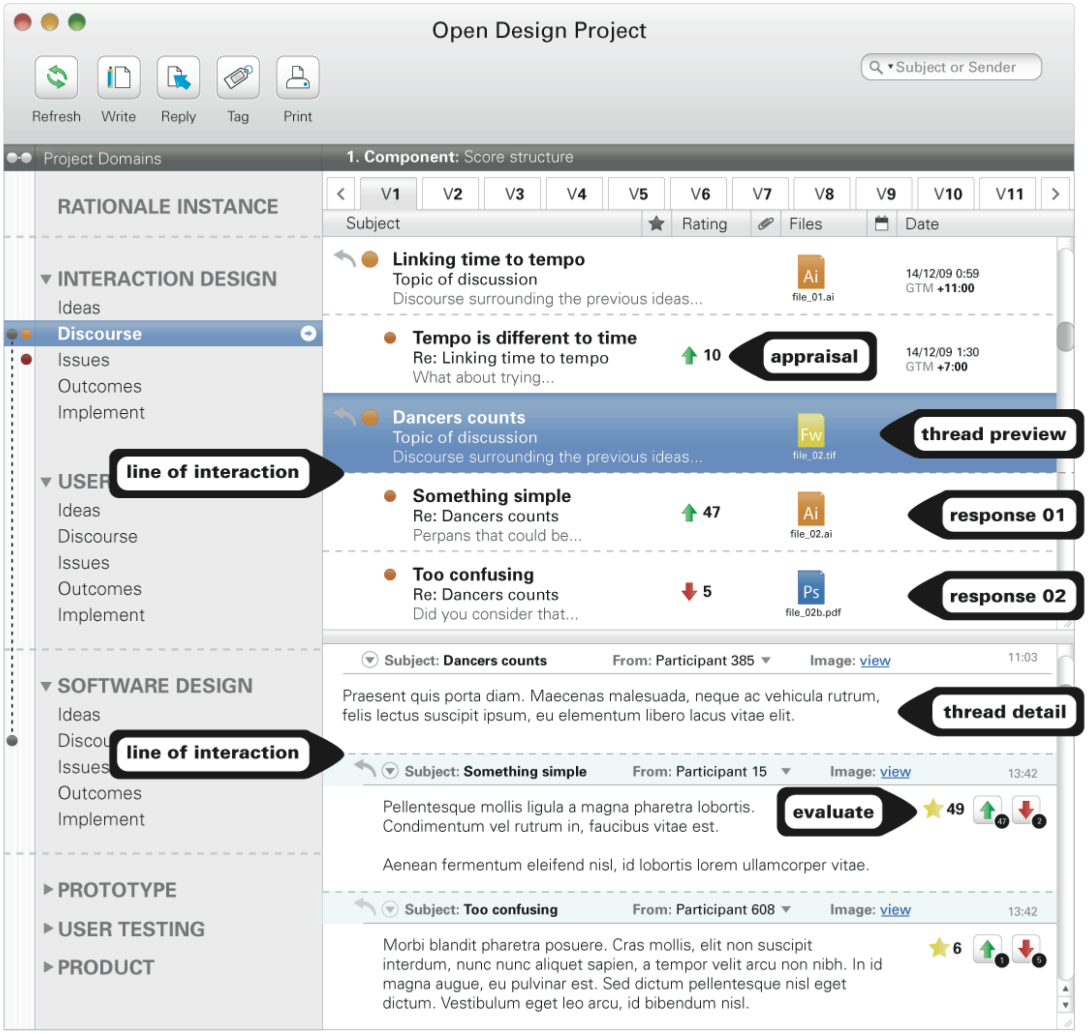

Fig 3. *Threaded discourse*

Threaded discussions, pictured in Figure 3 provide an avenue for collaborative activities and diverse dialogues to develop surrounding the ideas, a discourse (illustrated in Figure 3) of issues and outcomes of the component under development. A visual hierarchy of various subjects for discussion is given to each threaded discussion. This is done through the ordering and arrangement of their representation in the design of an interface by date of appearance or subsequent significance. The priority of each threaded discussion is determined as a result of collaborative appraisal and evaluation during which highly valued design suggestions are positioned at the top of the overview pane. The consequent responses to each thread are visually associated with the thread preview and thread detail by a line of interaction where each response is slightly offset to the right of the original subject of discussion. Individual thread previews and their associated responses work to connect collaborative conversations to design artefacts, whereas, the thread details provide an argument for a particular course of action to be taken. In addition to this, the ability to evaluate the value of each thread response is offered within the detailed view of a threaded discussion and the overall appraisal is illustrated in the thread preview.

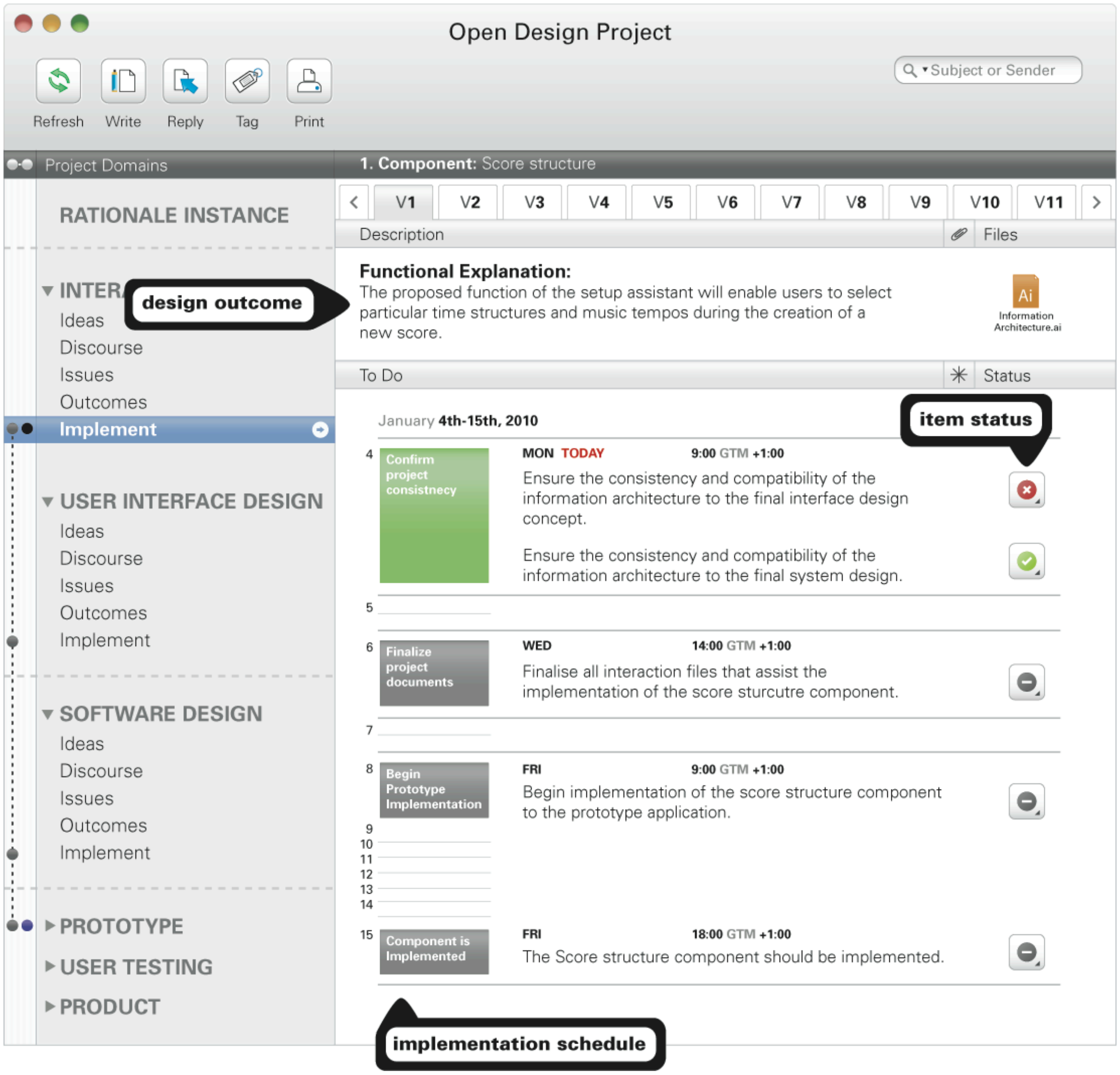

Fig 4. *Implementation to a prototype application*

The application of threaded discussions provides participants of open design projects with a concentrated focus of the design situation, across different activities. These activities are connected to the development of ideas, discourse and outcomes. The issues and implementation process (see Figure 4) of a product's components are fundamentally global in view. A designated site for the development of ideas enables the collaborative development of design components to develop in close relationship to the project domain in which different ideas are formed. Appraised ideas of certain merit are then refined and debated through discourse, for their ongoing value to the utility of proposed design outcome. The further evaluation and appraisal of continuing ideas are then viewed globally, as potential issues across all project domains, to assess if conflicts between the suggested design outcomes could arise. After the evaluation of a suggested component's fit to the overall design situation is corroborated, the potential design outcome is then re-examined within each project domain for its suitability to the purpose and function of the proposed product solution. Successful design outcomes are then offered up for implementation to a prototype application. By visualizing the progressive and collaborative development of ideas and suggested outcomes in relation to the decisions that support their advancement, participants could gain an understanding of how their involvement and activity gives shape to the evolving design situation.

Figure 4, illustrates the implementation schedule for successful design outcomes that have been collaboratively developed and accepted for integration in to a prototype application. It provides participants with knowledge concerning each project domain's contribution to the resulting design component. Interactive icons are used to illustrate the current status of the project's development to assist with the identification of the changing and unchanging elements of the implementation process.

Discussion

This paper focuses on the practical challenges involved in changing the activity of designing from a relatively closed design environment to one that is open and collaborative. A greater understanding of the issues of facilitating collaborative action in online communities enabled the creation of a number of interaction design guidelines. These guidelines shaped the interface design of a conceptual interactive tool that seeks to enhance the user experience of participating in open design projects.

Visually mapping the 'what', 'how' and 'why' of the design process, as a progressive series of connected design activities, can assist to establish an integrated system of use and collaboration across different design domains. However, without the formal evaluation of the proposed guidelines in comparison to the features of other open source projects or an evaluation of the proposed interface designs of the conceptual tool, the key value that the guidelines provide, are as a foundation for designing. This foundation is to assist in the design of interactive tools that seek to facilitate collaborative action. For the specific purposes of this research the guidelines gave shape to an environment in which a design project that embraces open source development as a part of the design activity, could be established. In light of this, the proposed guidelines offer a starting point for designers to further develop and improve upon the manner in which they can assist the design of collaborative action.

A visual representation of an open design project has been illustrated through a number of interface designs, which offers an example of the potential in which a variety of collaborators could better, identify and participate in interactive processes and workflows that constitute the overall design project. Furthermore, the circumstances for developing the design project are underpinned by various techniques and methods that work to supply participants involved in the development of open design projects with a collective tool set and shared vision for it's active formation.

As a continuing work in progress, it is envisaged that the proposed interaction design guidelines will be further developed and refined to address systems of notification that highlight the social status of participants and illustrate the changing elements of the design situation. Moreover, the aim of this research has been to contribute to a growing body of knowledge in design research that seeks to better facilitate open source collaborative action.

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Taylorisme, Fordisme et Toyotisme: comment le design management a construit les principaux modèles productifs de la théorie des organisations

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Abstract

Ancrée dans les sciences du management et la théorie des organisations, cette recherche établit un lien entre la recherche en design et les sciences du management. Elle vise à définir, en une perspective inscrite dans la complexité, les fondamentaux de la construction du territoire du design en théorie des organisations. Il s'avère de ce fait que le design est loin de ne constituer qu'un « outil négligé » sous forme d'appendice au service du marketing. Plus que cela, le design structure le champ de la théorie des organisations en étant présent au cœur des trois principaux modèles organisationnels, à l'origine du puissant impact transformationnel de l'économie et que sont le taylorisme, le fordisme et le toyotisme. Une exploration du design située au cœur des principaux modèles productifs montre à travers le récit de F.W. Taylor, de H. Ford et de T. Ohno que le design occupe un rôle stratégique majeur dans le développement, l'essor de ces modèles et l'impact transformationnel qu'ils ont eu sur l'économie. Et que loin d'être circonscrit au produit, le design s'inscrit dans une démarche totale qui va de l'atelier de production à l'outil de travail en passant par le service. A partir de là, il faut considérer différemment le design en management et en théorie des organisations.

Mots clefs : histoire du design; taylorisme ; fordisme ; toyotisme ; sciences du management ; théorie des organisations ; design management

Abstract

Rooted in management sciences and organizational theory, this research establishes a link between research in design and management science in order to define under complexity perspective the construction of design territory in organization theory. Design then is far than being a “neglected tool” and marketing appendix. More than that, design structures the field of organization theory by being present in the heart of the three major organizational models, sources of the powerful transformational impact of the economy, we mean Taylorism, Fordism and toyotism. An exploration of design at the heart of the main productive models shows through F.W. Taylor, H. Ford and T. Ohno narratives that design has a major strategic role in the development, expansion of these models and their heavy impact on economies worldwide. Design then is far from being limited to product design, design was part of a global idea ranging from the production workshop to the work tool and services. From there design should be considered differently within management science and organization theory.

Key words: design history; organization theory; taylorism; fordism; toyotism; management science; organization theory; design management

Cette recherche ancrée épistémologiquement dans les sciences du management et la théorie des organisations, se veut modestement une ouverture vers la recherche en design, de façon à initier un dialogue inscrit dans la complexité entre le design et les sciences du management. Nous entendons le design au sens de (Simon 96) le définissant comme la transformation des situations existantes en situations préférables.

En ce sens, à partir de la théorie des organisations qui structure le champ des sciences du management (Plan 2003 ; Hatch 2006), nous souhaitons montrer que le design est loin de ne constituer qu'un « outil négligé » perçu comme un appendice au service du marketing (Rath & Kotler 1983). Plus que cela, le design est présent dans le champ de la théorie des organisations en étant au cœur des trois principaux modèles organisationnels à l'origine du puissant impact transformationnel de l'économie à savoir le taylorisme, le fordisme et le toyotisme. Précisons ici que les modèles productifs issus de l'automobile offrent un terrain d'analyse privilégié en théorie des organisations de par leur impact sur d'autres secteurs de l'économie (Boyer, Freyssinet 2000)

Méthodologiquement, nous faisons une lecture analytique des récits de Frederick Winslow Taylor, Henry Ford et Taischi Ohno qui ont la particularité d'être tous les trois des ingénieurs impliqués dans la conception de leurs modèles productifs et théoriciens par écrit de leurs propres modèles, écrits que nous mentionnons bien entendu dans notre bibliographie. Nous mobilisons aussi le concept de « Silent design » (Gorb & Dumas 1987) qui développe l'idée selon laquelle le design peut se situer au sein d'une organisation, sans pour autant que cette dernière le définisse et le reconnaisse comme relevant de la pensée et de la pratique design.

Dans la veine des perspectives historiques interrogeant le rôle stratégique du design, des études significatives se sont penchées sur le lien entre industrialisation et design (Quarante 94 ; Sparke 1987 ; Walker 1989), sur l'apport fondateur du mouvement Arts & Crafts en grande Bretagne suivi de l'école du Bauhaus en 1919 (Mozota 2003) ou encore sur les bases de la pensée économique classique avec la pensée d'Adam Smith (Marco 2006).

Toutefois, aucune n'a interrogé les modèles productifs cités ici. C'est donc en une perspective qui porte sur le design dans son lien avec le management, que cette recherche fait le pari de montrer comment une myopie vis à vis du rôle majeur opéré par le design est en mesure de rendre extensible le champ du risque pour les organisations. D'une façon pratique, un tableau synthétisera la problématique design de chaque modèle productif suite à son développement avant qu'un tableau général ne reprenne les trois modèles en guise de synthèse.

Les interrogations qui se posent en ce contexte peuvent se formuler ainsi: Quelle place occupe le design dans le taylorisme, le fordisme et le toyotisme ? Comment celui-ci s'y construit ? et comment la compréhension du rôle du design au sein des principaux modèles productifs aide à repenser le lien entre le design et les organisations à partir de la notion de design management au sens de (Hetzel 93) . Ce dernier définit le design management comme étant un renouvellement des pratiques de gestion, selon une pensée systémique qui favorise la prise en compte par l'organisation et ses acteurs de la complexité et de la gestion de celle-ci.

F.W. Taylor pionnier du design management ?

Réduit à la caricature des « Temps modernes » de Charlie Chaplin, la pensée de Taylor présente de véritables accents de modernité (Hatchuel 1994), celui-ci est le premier à avoir bouleversé pour toujours le fonctionnement des organisations (P.Drucker 2007) et ses principes vont servir à la naissance du marketing. (Cochoy 1993) Or, que nous révèle la pensée de Taylor observée à la lumière du design comme processus inscrit dans la « solving problem theory» (Simon 1997)

L'étude du management selon le paradigme des principes scientifiques portera Taylor à s'interroger sur le modèle productif de l'organisation et à s'intéresser au design de l'outil de travail au sens matériel du terme. L'idée notoire ici s'inscrit dans le fait que l'efficacité du système productif ne peut se faire sans un examen précis et abouti des artefacts manipulés par les ouvriers. Taylor étudiera ainsi les moyens de penser de façon expérimentale les machines en usage à la Midvel Steel company : « (...) the writer (...) obtained the permission (...) to make a series of experiments to determine what angles and shapes of tools were the best for cutting steel," (Taylor 1911p.25)

Soulignons ici, l'attention accordée d'emblée aux angles et aux formes des outils de travail. Ils sont ainsi des constituants paradigmatiques majeurs de tout design liés à la construction de l'offre. Dans le développement de cette même idée, observant scientifiquement l'acte de pelletage, Taylor en vint à la conclusion que le design de l'outil de travail, qui était conçu en un esprit de « rule of thumb » (à vue de nez) ne comportait aucune marge de progression en une philosophie de progrès scientifique. L'acte de pelletage obéissait ainsi avant Taylor à une conception de la pelle complètement arbitraire car un unique fait s'imposait : seule la force physique du pelleteur était en mesure d'assurer une optimisation du travail.

L'observation minutieuse de Taylor démontrera dès lors que la productivité d'un pelleteur ne résidait pas uniquement dans la force physique de l'ouvrier, mais que celle-ci dépendait de la corrélation entre la matière à pelleter, le matériau de la pelle, la forme de celle-ci, sa longueur, le poids de la matière pelletée et enfin la force du pelleteur associée à une gestuelle relevant de ce que l'on appellerait aujourd'hui une ergonomie du poste de travail.

L'étude minutieuse de ces différents paramètres portera Taylor dès lors à repenser totalement le design de l'outil de travail qu'est ici la pelle. Celle-ci ne sera plus une pelle standardisée mais sera «segmentée» en différents modèles qui transformeront totalement le modèle productif objet de l'observation de Taylor : « Instead of allowing each shoveler to select and own his own shovel, it became necessary to provide some 8 to 10 different kinds of shovels, etc., each one appropriate to handling a given type of material (...)". (Taylor 1911 p.26)

La conception et le design de l'outil de travail allait ainsi être recréé en un design visant d'emblée l'efficience. Ayant défini que le poids moyen que peut soulever un homme en une journée de travail, se situait aux alentours de 21 pounds, l'artefact dès lors sera conçu de façon à ne soulever que ce poids. En ce sens, Taylor était parfaitement conscient du rôle majeur que le design de l'outil de travail pouvait avoir comme portée sur la performance de l'organisation: « A large shovel tool room was built, in which were stored not only shovels but carefully designed and standardized labor implements of all kinds, such as picks, crowbars, etc. (Taylor 1911 p.26)

Nous relèverons ici l'intérêt porté par Taylor au design modulaire architectural de l'atelier, ainsi qu'une idée majeure inscrite dans la standardisation, celle là même à l'origine de la rencontre du design et de l'industrie. (Quarante 94) La standardisation de même qu'un design exhaustif de l'outillage de l'organisation constitue ici le point d'ancrage de l'efficience tel que Taylor la conceptualise. Et c'est ici même que se situe le point de départ du modèle productif qu'est le taylorisme et le début de son extension. Il est possible ainsi d'imaginer comment en un vocabulaire actuel, le cahier de charges imposé aux fournisseurs de la *Midval Steel Company* influait et transformait radicalement des outils de travail et construisait de nouvelles offres.

En un autre aspect, il faut souligner que le design de l'outil de travail obéissait à une théorie processuelle du design (Simon 96) qui prend son envol dans la construction du problème (impossibilité d'optimisation du pelletage) jusqu'à la résolution de celui-ci par le biais d'une conception inédite d'un nouveau design de l'outil du travail favorisant une meilleure productivité. Sachant que l'organisation objet de l'observation taylorienne se compose de 600 pelleteurs, cela laisse deviner l'impact productif dû au simple design de l'outil de travail.

Taylor cite aussi en une idée de théorisation une autre expérience propre à la maçonnerie à travers l'étude d'un ingénieur : Frank B. Gilbreth. En ce sens, la pensée de Taylor montre que le design d'un artefact : à savoir l'échafaudage est le résultat de l'éclipse totale en amont du dit objet en maçonnerie. (Findeli & Rabhi 2005). Le travail de construction en maçonnerie sans la présence de cet objet obligeait le maçon à effectuer des déplacements incessants et inutiles vers le point de dépôt du matériel. Le design d'un support de travail sera dès lors pensé dans son interaction avec le maçon assurant ainsi une meilleure productivité tout en étant une innovation majeure :

> He studied the best height for the mortar box and brick pile, and then designed a scaffold, with a table on it, upon which all of the materials are placed, so as to keep the bricks, the mortar, the man, and the wall in their proper relative positions. These scaffolds are adjusted, as the wall grows in height. (Taylor 1911, p.30)

L'idée de l'interaction de l'homme avec les outils de travail à travers le rôle du design est en ce sens une idée capitale. Les formes et la mécanique des machines de la *Midval Steel company* ont été étudiées dans leur dimension ergonomique de façon à définir une harmonie entre le design, le travail de l'ouvrier et sa compétence productive. En une autre mesure, le design de l'outil de travail selon Taylor s'inscrit dans la durée en une idée portée sur l'innovation et le design permanent. Idée au cœur des problématiques actuelles du design et de l'innovation, (Hatchuel, Le Masson, Weil 2006) de la qualité et de l'amélioration continue (Mozota 2003)

> Experiments in this field were carried on, with occasional interruption, through a period of about 26 years, in the course of which ten different experimental machines were especially fitted up to do this work(.......)a very short time was needed to discover one or two types of tools which, though imperfect as compared with the shapes developed years afterward, were superior to all other shapes and kinds in common use...) (Taylor 1911, p.45)

En un autre aspect, Taylor mentionne avec conviction l'inscription du design dans la durée et son lien avec l'innovation. Ce qui offre la possibilité d'une amélioration de l'outil, prélude à de nouvelles formes de standardisation, qui ne peuvent qu'influer sur la productivité des organisations.

Ainsi, la pensée taylorienne dans son lien étroit avec le design, montre comment l'idée qui consiste à repenser avec force le design de l'outil de travail, porte en elle les germes des transformations majeures qui vont affecter pour toujours le management des organisations.

Songeons ici aux implications directes et indirectes de cette pensée, d'autant plus que Taylor est considéré comme le premier consultant de l'histoire (Mc Kenna 2006) et que dans la foulée de sa pensée, des agences conseil en « styling » vont essaimer sur le territoire américain (Mozota 2003) amorçant le design industriel qui connaîtra son apogée avec le fordisme notamment.

N'omettons pas ici, en un autre registre, le fait que les cas présentés à l'appui de l'exposé de Taylor étaient conceptualisés en un souci d'essai théorique. L'idée du progrès de l'organisation est manifeste à travers le lien étroit entre le design de l'outil de travail, le comportement organisationnel et l'efficacité personnelle.

En définitive, le design de l'outil de travail constitue le creuset à partir duquel des transformations majeures vont façonner l'histoire de la gestion. Partant de là, il n'est point possible d'évoquer ces transformations sans prendre en considération l'impact d'un véritable management du design.

En se centrant sur l'outil physique du travail, Taylor allait favoriser une gestion inédite de l'entreprise. Ainsi, il est possible d'affirmer au vu des éléments développés ici que Taylor par sa pratique peut être considéré comme le pionnier par excellence d'un management par le design bien avant que cette notion ne soit développée académiquement par (Farr, 1966 ; Gorb, 1990 ; Hetzel,1993 ; Topalian, 2002 ; Mozota 2003)

Entreprise étudiée	**Midval Steel company**
Paradigme à l'origine de réflexion design	« Principes scientifiques » du travail selon Taylor
Problématique design	Optimisation de la production par le design d'environnement et de l'outil de travail
Manifestation de la réflexion design	Redéfinition du design d'environnement Redéfinition du design de l'outil de travail
Méthodologie / Processus design	Observation / Examen / Expérimentation
Résultat managérial **Pratique**	Développement de la production Développement de nouvelles machines Invention de nouveaux outils Passage de la pelle unique à une gamme de pelles adaptées à la corrélation : Matière pelletée / Matériau Pelle / Physionomie pelleteur
Principal apport	Invention du design management Standardisation de l'outil productif Optimisation de la production

Tableau 1 : La problématique design dans le taylorisme

Le fordisme ou l’invention du design total:

L’aspect le plus significatif dans le modèle du fordisme réside dans le fait que la vision du design chez Ford obéit à un design global. Celui-ci s’étend du design de l’environnement du travail jusqu’au produit. Nous verrons l’importance de cette question pour Henry Ford dans son lien étroit avec le produit qu’est la *Ford T* notamment.

Ainsi, selon les principes tayloriens d’observation scientifique de l’entreprise, Ford étudiera l’architecture modulaire de l’atelier. Le design de celui-ci, sera de ce fait pensé dans ses moindres détails. En cet esprit, nous pouvons voir comment l’attention sera portée sur les liens entre construction architecturale, conditions climatiques dans lesquelles l’ouvrier opère, la réduction du risque industriel au travail et sa productivité : « One point that is absolutely essential to high capacity, as well as to humane production, is a clean, well lighted and well ventilated factory ». (Ford 1922, p.30)

D’un point de vue plus étendu, inscrit cette fois dans le design et l’innovation permanente, Ford décrira cette corrélation dans ses ateliers de Ford Rouge plant en ces termes :

> When we put up the older buildings, we did not understand so much about ventilation as we do to-day. In all the later buildings, the supporting columns are made hollow and through them the bad air is pumped out and the good air introduced. (...), during daylight, there is nowhere the necessity for artificial light. (Ford 1922, p.49)

Soulignons ici, le rapport mentionné par Ford entre le design du bâtiment, son éclairage et les économies d’énergie, qui ne peuvent que s’inscrire d’une façon étonnante dans la notion ô combien trop actuelle de développement durable.

Partant de là, l’atelier sera pensé en une vision orientée vers la qualité du design propre à l’espace de production. L’idée de l’assemblage de la voiture, qui a révolutionné à jamais le système productif des organisations, trouve son point de départ dans le design de l’atelier. Et ce, à partir d’une réflexion imbriquée dans le lien entre le déplacement de l’ouvrier, l’accomplissement de sa tâche et la réduction du risque ouvrier au travail.

En ce sens, Ford relate le fait qu’au départ, les pièces nécessaires à l’assemblage d’une Ford composée de 5000 pièces étaient récupérées par les ouvriers en des entrepôts variés. L’assemblage de la voiture était ainsi similaire à la construction d’une maison. Cette forme d’organisation amenait l’ouvrier à réaliser des déplacements multiples au sein de l’atelier, ce qui laisse aisément imaginer une importante perte de productivité.

A partir de ce constat, le design de l’atelier sera repensé totalement de façon à préserver l’ouvrier de tout déplacement superflu. Nous sommes donc devant un événement marquant et fondateur de l’histoire du design en sciences de gestion. Il s’agit de la définition d’une nouvelle construction de la performance reposant avec force sur le design de l’environnement du travail. En gommant les déplacements inutiles de l’employé, grâce à une modulation pointue de l’espace architectural, l’accélération de la productivité ne pouvait dès lors que s’enclencher.

Si le design d’environnement de l’espace de travail est une composante du système fordien, le design de l’outil retiendra l’attention de Ford de la même manière : « None of our machines is ever built haphazardly(...). Sometimes wooden models are constructed or again the parts are drawn to full size on a blackboard.” (Ford 1922, p.44)

Ford évoque ici l'usage du prototypage en recourant aux deux procédés que sont la maquette ou le dessin afin de concevoir un design abouti. Ce qui nous amène, au concept d'assemblage qui est au cœur du système fordien. Celui-ci se résume par ce qui peut s'apparenter à une formule : « The first step forward in assembly came when we began taking the work to the men instead of the men to the work ». (Ford 1922, p.35) C'est sur cette base donc que la célèbre chaîne d'assemblage fordienne sera conceptualisée.

Soulignons ici que le design de la chaîne d'assemblage est pensé en une interaction étroite avec le design architectural de tout l'atelier. Les composants du produit sont ainsi acheminés vers l'employé au point précis où celui-ci en a besoin, sans que ce denier n'éprouve le besoin de se déplacer.

En une autre idée, la surveillance de la température du four allait connaître une simplification déterminante : à la place d'un indicateur classique de mesure fahrenheit/Celsius, le design d'une ampoule s'activant à la bonne température, non seulement simplifiait au maximum la tâche de l'homme sur la machine, qui par un simple coup d'œil s'acquittait de celle-ci, mais surtout rendait la fonction accessible à tout ouvrier nonobstant sa qualification. Le design d'un signal lumineux qui peut sembler anodin vu de notre époque, replacé dans son contexte du début du siècle, est ici à l'origine d'une accélération productive : « We introduced a system by which the man at the furnace has nothing at all to do with the heat. He does not see the pyrometer--the instrument which registers the temperature. Coloured electric lights give him his signals." (Ford 1922, p.44)

L'une des idées les plus marquantes, lorsque le fordisme est interrogé dans sa corrélation avec le design, réside dans le fait que le design de l'outil de travail impliquait une gestion de la sécurité de l'ouvrier et la prévention du risque : « Every accident, no matter how trivial, is traced back by a skilled man employed solely for that purpose, and a study is made of the machine to make that same accident in the future impossible." (Ford 1922, p.49)

La sécurité de l'ouvrier étant assujettie étroitement au design de l'outil de travail, l'outil en question sera repensé en une idée d'amélioration continue, à partir de l'établissement d'une corrélation entre le design ergonomique de la machine et l'interaction de celle-ci avec l'homme et son espace de travail. Ainsi, le design de l'atelier conceptualisera des obstacles et des mécanismes empêchant l'ouvrier de se situer en un endroit présentant des risques : « Over the automatic conveyors are placed bridges so that no man has to cross at a dangerous point » (Ford 1922, p.49)

En une autre dimension orientée cette fois-ci sur le produit, l'optimisation du design dans ses différentes composantes centrées sur l'espace architectural et l'outil de travail s'avère être en corrélation étroite avec le design du produit final. C'est donc le design produit qui rentre en interaction directe et indirecte avec les autres composantes du design de l'atelier. C'est en ce sens qu'il faut situer la conception du fameux Modèle T à travers une réflexion qui place la conception du produit au cœur du projet de l'organisation :

> The big thing is the product, and any hurry in getting into fabrication before designs are completed is just so much waste time. I spent twelve years before I had a Model T which is what is known to-day as the Ford car that suited me. We did not attempt to go into real production until we had a real product. (Ford 1922, p.9)

Comment dès lors concevoir le design du produit ? Ford répondra à cette question en une dimension qui définit avec minutie le concept inhérent au design du modèle T. La théorie C.K. (Hatchuel, Weil & Le Masson 2006) montre en ce sens l'importance majeure de la définition du concept dans tout projet design et son rôle dans le succès du produit. Nous pouvons donc suivre ici comment le projet design de la Ford T qui a révolutionné et transformé en profondeur les Etats unis d'Amérique est pensé en une vision stratégique:

> I will build a motor car for the great multitude. It will be large enough for the family but small enough for the individual to run and care for. It will be constructed of the best materials, by the best men to be hired, after the simplest designs that modern engineering can devise. But it will be so low in price that no man making a good salary will be unable to own one-and enjoy with his family the blessing of hours of pleasure in God's great open spaces. (Ford 1922, p.32)

Cette vision stratégique de la conception (Hamel & Prahalad 1989) de la Ford T s'inscrit totalement dans la théorie projet du design (Findeli & Rabhi 2005) Nous pouvons y déceler la représentation qui a porté la Ford T au succès qui était le sien. Succès qui transforma un large pan de l'économie américaine. La Ford T détient à ce jour le record de la voiture la plus vendue dans toute l'histoire de l'automobile. Cette vision stratégique délimite donc d'une façon totale l'ensemble du design de la Ford T qui devait être pensée en une logique de compression des coûts et d'une certaine idée inscrite dans la simplicité.

La dimension service, en une idée marketing ne sera pas négligée, le design de la Ford T en amont devait donc prendre en considération un aspect très important : la facilité de remplacement et de réparation des pièces endommagées qui devait écarter toute opération complexe et coûteuse pour le client. L'idée donc d'un design inscrit dans la simplicité aussi bien en conception qu'en entretien et en réparation était ainsi au cœur du projet design de la voiture fordienne. Dès lors, il est possible d'affirmer que la pensée design de Ford n'est nullement fortuite mais bien inscrite dans une pensée élaborée et un management par le design qui s'étend à toutes ses dimensions.

De là, la pensée fordienne peut se définir comme un projet design manifeste dans l'accès de la classe moyenne américaine à la voiture. Ainsi, étape par étape, seront dessinés les contours d'un artefact, qui va construire un des plus grands succès industriels de l'époque moderne, sans omettre l'impact indirect de la Ford T sur la construction du réseau routier américain et le développement mondial de l'industrie automobile.

Enfin, le design dans son lien avec le style a aussi suscité d'une manière (logique) l'intérêt de Ford. La Ford T n'était nullement conçue en un produit unique, mais segmentée et positionnée en une gamme de produits selon une perspective ancrée dans le marketing naissant de l'époque. En ce sens, il est possible d'observer une « restylisation » annuelle de la Ford T de 1908 à 1927 marquée par des modifications dans le style de la carrosserie, des améliorations techniques, esthétiques et des différenciations nominales des différentes gammes.

Ainsi, il s'avère à partir de ce développement que le design est au cœur de la transformation qu'a apporté le fordisme en tant que modèle économique. Son idée est inscrite dans un design global qui ne se circonscrit nullement au style du produit mais qui englobe le design de l'environnement depuis la source de la production. Par la suite, il s'étend au design de l'outil de travail avant de porter in fine sur le design du produit final. Et ce en une logique d'interdépendance et de complémentarité.

Entreprise étudiée	**Ford**
Paradigme à l'origine de la réflexion design	Observation (principes scientifiques à la suite de Taylor)
Problématique design	Optimisation de la production par le design d'environnement de l'outil de travail et de la communication marketing
Manifestation de la réflexion design	Redéfinition du design d'environnement Optimisation produit/ communication marketing/outil de travail
Méthodologie / Processus design	Observation / Examen / Expérimentation Prototypage en bois /Dessin sur tableau noir Calcul du coût Vision stratégique du design produit
Résultat managérial pratique	Redesign du design environnement atelier: Éclairage, aération, ergonomie Réduction drastique du risque industriel de l'ouvrier: Sécurité de l'homme au travail Economies d'énergie Optimisation marketing du prix de vente de la Ford T favorisant une production de masse Invention de la chaîne de montage et plateforme d'assemblage automobile Remplacement d'indicateurs de machines à graduation complexe par indicateurs lumineux de couleurs , faciité de remplacements des pièces de la Ford T …/…

Principal apport	Invention du design management total: Design environnement/ Design produit/ Design communication Pensée design ancrée dans le service marketing: facilité entretien et remplacement pièces / Segmentation gammes et restylisation annuelle

Tableau 2: la problématique design dans le fordisme

Le Toyotisme post fordiste : le rôle du design :

Si le design s'avère être un paradigme fondateur du Taylorisme et du Fordisme, (l'évolution) du fordisme vers le toyotisme, se fera aussi à la faveur d'une nouvelle perception du design comme nous allons pouvoir à présent le développer à travers son fondateur qu'est Taichi Ohno. Toutefois, la prise de conscience de l'importance du design de l'espace de travail et de l'outil de travail est évidemment une idée dépourvue de nouveauté, puisqu'elle reste l'apanage des deux modèles développés plus haut. En revanche, il est intéressant de voir comment le toyotisme s'est construit en une dimension dialogique avec le design de l'outil de travail et de l'espace architectural et comment cette interaction a contribué à l'élaboration d'un modèle économique dont l'impact perdure à ce jour.

Ce fut donc le choc pétrolier et l'entrée en crise de nombreuses entreprises, qui révéla aux yeux du monde le toyotisme à travers la résistance de l'entreprise Toyota à l'avènement d'une nouvelle économie inscrite désormais dans une croissance terne. Or que nous montre ce modèle dès lors qu'on l'interroge à la lumière des théories sur le design.

Tout comme le modèle fordien dont il s'inspire, T. Ohno pensait fortement que si Ford lui était contemporain, il aurait abouti au « toyotisme » « Je suis convaincu que, s'il était encore en vie, il aurait inventé lui-même le système que nous avons mis au point chez Toyota (...) Henry Ford était visionnaire (Ohno, 1993 p.106).

Le toyotisme a érigé comme principe la lutte contre le gaspillage avec une idée ancrée dans la notion du « juste à temps », il est fort intéressant dès lors de constater que le design de l'atelier toyotien sera un paramètre important de la conception du toyotisme. L'idée ohnienne qui consiste à faire basculer l'ouvrier d'un univers mono-tâche à celui multi-tâche est en partie réalisée à travers un renouveau du design modulaire de l'architecture de l'atelier et des machines.

En cette perspective, lorsque les machines étaient disposées de façon à produire la même pièce en un nombre important d'exemplaires, le toyotisme se fixait comme idée de ne produire la pièce en question qu'à partir du moment où la production de celle-ci répondait au principe du « Just in time » autrement dit, la pièce doit être fabriquée au moment où sa fabrication est justifiée en un principe: ni trop tôt, ni trop tard. Ce qui se traduit immédiatement par de grosses économies d'échelle.

Cet aspect va dès lors contribuer à un renouveau du design de l'atelier toyotien qui va prendre en considération la nouvelle organisation:

> Nous avons mené à bien l'élimination des gaspillages en procédant à l'examen critique des installations disponibles, en réimplantant les machines, en améliorant et en auto-activant les processus mécaniques, en améliorant les outils, en analysant les méthodes de transport et en limitant au strict nécessaire les en-cours de fabrication. (Ohno, 1993 p.106)

A la source donc de la nouvelle productivité Toyotienne, un renouveau du design de l'espace architectural dans son lien notamment avec le design de l'outil de travail.

En un autre aspect, Ohno élaborera une notion intrinsèque à un des fondements du toyotisme inscrit dans la lutte contre le gaspillage. Cette notion, il la nommera « diriger avec les yeux» : « Pour que « l'auto activation » permette effectivement de dénoncer les anomalies, il faut que ce qui est anormal se distingue immédiatement, et à l'œil nu, de ce qui est normal. »

(Ohno, 1993 p.126)

Il s'agit donc d'organiser la production à travers une perception visuelle qui implique une remise en question du design de l'outil du travail, à travers la création de nouveaux objets. Cette remise en question se réalisera dès lors à travers deux principaux artefacts : le premier est « l'andon » constitué d'un tableau lumineux qui utilisant un triple système de couleur: vert orange et rouge fournit à l'ensemble des opérateurs une information utile et stratégique à propos de l'état de la production : le vert pour normal ; l'orange quand un opérateur sollicite de l'aide sur la ligne et rouge en cas d'anomalie. Le second artefact n'est autre que le fameux « Kanban » qui est un moyen de communication des besoins basés sur un ensemble d'indication à la source même du principe du « juste à temps ». La construction du principe de la direction par les yeux se réalisera dès lors à partir d'une forte modification de l'ensemble du design de l'atelier toyotien.

Ainsi, avant que le design ne s'étende à l'artefact qu'est la voiture Toyota, il est possible de constater que dans le creuset du toyotisme se situe une réflexion tournée vers le design de l'atelier et de l'outil de travail. Celui-ci s'avère être un constituant majeur du processus à l'origine du modèle dont il a été question ici. En ce sens, il n'est point possible d'ignorer le rôle que joue le design dans l'élaboration du modèle qu'est ici le toyotisme en une conception post fordiste.

Entreprise étudiée	Toyota
Paradigme à l'origine de la réflexion design	Optimisation pointue des couts de production et de distribution par le principe des « 5 zéros » : zéro stock, zéro délai, zéro défaut, zéro panne, zéro papier Réflexion pointue à propos de toute forme de gaspillage
Problématique design	Optimisation de la production par le design d'environnement et de l'outil de travail « Diriger avec les yeux » : l'anomalie doit être distinguée visuellement par des indicateurs spécifiques
Manifestation de la réflexion design	Basculement du travail mono-tâche à multi-tâche Renouveau du design modulaire de l'architecture de l'atelier et des machines Redesign de l'outil de production Implémentation de 2 indicateurs visuels clefs : *Andon :* triple tableau lumineux assignant la valeur « normal » à vert, « demande d'aide » à l'orange et « anomalie » au rouge *Kanban :* moyen de communication visuel des besoins « juste à temps » et outil stratégique fondateur du toyotisme
Méthodologie / Processus design	Examen de la chaîne logistique (Supply chain) Observation / Expérimentation Calcul du coût
Résultat managérial pratique	Optimisation de l'ensemble du design de l'atelier toyotien adaptable à une « direction par les yeux » Economies d'échelles stratégiques pour l'entreprise Toyota
Principal apport	Invention du modèle juste à temps Le design d'environnement et de l'outil de travail comme fondement du principe « Juste à temps » Optimisation coûts et économies d'échelles d'envergure

Tableau 3 : La problématique design dans le toyotisme

Modèles	Taylorisme Fordisme Toyotisme
Paradigmes à l'origine de la réflexion design	« Principes scientifiques» du travail (Taylor et Ford) Optimisation pointue des coûts de production et de distribution par le principe des « 5 zéros » (Ohno)
Problématique design	Optimisation de la production par le design d'environnement et de l'outil de travail
Manifestation de la réflexion design	Renouveau du design modulaire de l'architecture de l'atelier des machines et de l'outillage du travail Implémentation d'indicateurs visuels
Méthodologie Processus design	Observation Examen Expérimentation Prototypage Calcul du coût
Résultat managérial pratique	Développement de la production Développement de nouvelles machines Invention de nouveaux outils Economies d'échelles stratégiques
Principal apport	Pratique du design management total Le design d'environnement et de l'outil de travail comme fondement des modèles productifs clefs Le design source de l'optimisation des coûts des économies d'échelles et de performance

Tableau synthétique 4 : la problématique design dans les trois modèles productifs

Conclusion:

Que faut-il retenir de cette interrogation du design à la lumière des trois modèles productifs à la source de transformations majeures en management.

1 Le design est au cœur des transformations majeures de l'économie et des organisations.

2 Le « design produit » est le fruit d'une vision globale du design qui s'inscrit dans le design de l'atelier, dans le design de l'outil de travail et des machines et enfin sur le produit en une idée qui ne pourrait amputer le design produit du design inscrit dans l'architecture de l'atelier et de l'outil de travail.

3. Le design dans son interaction avec les sciences du management ne peut être pensé uniquement en une vision instrumentale, car il ne se situe pas à la périphérie des organisations mais en leur centre. C'est un facteur clef de la performance.

D'où l'importance de la prise en considération du design en une logique ouverte sur les organisations en considérant l'ensemble de la chaîne de valeur en management stratégique. En une acceptation large du risque (Guillon et al 2007), la non prise en considération du design en management est en mesure d'être lourde de conséquences dans un environnement hyperconcurrentiel (D'aveni 94) manifeste par une agressivité concurrentielle d'envergure.

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Ultra Low Carbon Vehicles: New Parameters for Automotive Design

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Abstract

As the influence of vehicle emissions on our environment has become better understood, the UK government has recently placed urgent emphasis on the implementation of low carbon technologies in the automotive industry through: the UK Low Carbon Industrial Strategy. The overall objective is to offer big incentives to consumers and support for the development of infrastructure and engineering solutions. This scheme however does not consider how the development of functional and experiential user value might drive consumer demand, contributing to the adoption of low carbon vehicles (LCVs) in the mass market.

With the emergence of the North East of England as the UK's first specialised region for the development of ultra-low carbon vehicles (ULCVs), ONE North East, as a development agency for the region's economic and business development, and Northumbria University Ideas-lab have supported a project to facilitate innovation through the collaboration of technology, research and development (R&D) and business. The High Value Low Carbon (HVLC) project aims to envisage new user value made possible by the integration of low carbon vehicle platforms with new process and network technologies. The HVLC consortium represents vehicle manufacturers and their suppliers as well as technology based companies and through an ongoing process of design concept generation the project offers a hub for innovation led enterprise.

Whilst new technological developments in areas such as power generation, nano materials, hydrogen fuel cells, printed electronics and networked communications will all impact on future automotive design, the mass adoption of low carbon technologies represents a paradigm shift for the motorist. This paper aims to describe how the mapping of new parameters will lead to new transport scenarios that will create the space for new collaborative research on user experiences supported by innovative technologies and related services.

Keywords

automotive design; low carbon; transport scenarios; sustainable design; user value.

In the late nineteenth Century the fastest cars in the world were electric. These vehicles reached over 65 mph, speeds not surpassed by fuel based cars until the early twentieth century. Since then over 100 years of improvement and innovation in the automotive industry has been focused predominantly on internal combustion vehicles that are responsible for the production of around a quarter of the UK's emissions of carbon dioxide (*Why is the car industry failing on climate change?,* n.d.). Today's car market, in developed countries, is about to undergo a cultural revolution that will open up new and promising scenarios for ULCVs (hybrid and totally electric vehicles) as we mainly utilise our cars in towns limited to daily mileages of less than 40 miles (*Pininfarina Bluecar*, n.d.).

Since the latest car power trains do not offer yet a significant combined reduction of CO2 emissions and fuel consumption over frugal diesel engines, as proven by some motor journalists (*Toyota Prius proves a gas guzzler in a race with the BMW 520d*, Rufford N., & Dawe J.), global competition remains wide open to create more capable and efficient vehicles to protect our global environment. Due to the massive investment required to create a traditional new vehicle, as Tata invested nearly $400 million in the Nano (*Tata: Still Reeling from Its Jaguar-Land Rover Buy,* Srivastava M.), advanced and economical power train technologies can enable even smaller companies to enter the LCV market by converting mainstream vehicles into the next generation of lean and efficient vehicles. IDTECHEX car analysts state that by 2020, it will be possible for some suppliers to offer hybrid cars and no price premium to conventional cars making a strong case why anyone would want the conventional alternative (*Hybrid And Pure Electric Cars 2009-2019*, n.d).

Within this highly technological and thriving context the HVLC project's drive is to obtain a share of this market as a consortium in order to provide design and engineering solutions through innovation and enhanced user value. It is worth noting that this represents a fundamental step for designers to embrace sustainable design through appropriate industrial collaboration in this emerging field, as the opportunity to innovate and drive the evolution of ultra low carbon vehicles in many aspects is going to modify the way we perceive and use cars, as refined products, but also make a real contribution towards lowering our road transport emissions on a large scale. In fact, it is expected this transportation revolution will account for 1.5-2 million electric vehicles (EVs) introduced in the medium term on the European market alone (*Pininfarina Bluecar*, n.d.).

The HVLC's agenda follows the same guidelines that Peter Mandelson, Secretary of State for Business, Innovation and Skills, and Ed Miliband, MP and Secretary of State, Department of Energy and Climate Change (*The UK Low Carbon Industrial Strategy*, July 2009) recently stated: 'The global market for low carbon goods and services is already worth around £3 trillion a year, and will probably grow by half that again by 2015'.

History of Electric Vehicles

Electric vehicles have been a neglected and side lined from the car makers' development and business agenda for nearly a century. This is apparent as EVs rarely feature in car history books. HVLC conducted some preliminary research to comprehend the whole evolution of EVs and then chronologically summarised it in table 1 and 2 by highlighting the most significant EVs' milestones.

1832-1839 First Cell Vehicle Scottish inventor Robert Anderson invents the first crude electric carriage powered by primary cells.	**1891 First Successful EVs** William Morrison builds first successful electric automotive in the US. **1897 First Electric Taxi** The new vehicle hits the streets in this year. The Pope Manufacturing Company of Connecticut becomes the first mainstream American electric automotive manufacturer. **1899 First Land Speed Records** Three records set in one year 57.6mph – highest	**1912 Charging Stations** Thomas Edison and Henry Ford decided to work together to make the electric car the main transportation in the US. Their goal was to have charging stations where people could "fill up" their cars around the country. **1912 First Electric Starter** Charles Kettering invents the first practical electric starter motor for the internal combustion engine, helping the beginning of its evolution.
		
1832-1839 **First primary cell vehicle**	**1899** **First EV land speed records**	**1912** **Thomas Edison`s EV**
	The Global Warming Time Line	
1841 Newspapers report Jean Baptiste Joseph Fourier's theory of global warming. However, many believe that the warming of the earth is a positive development.	**1894** Newspapers reflect on the past decade that brought about a revolution in labour industries. During the c20th, scientists will mark this time period as the beginning of the industrial pollution of the environment	**1913-1914** Swedish scientist Svente Arrhenius coins the term "greenhouse effect" and predicts that the slow warming of the Earth's climate. Many scientists dismiss the possibility of the theory. Arrhenius' prediction sparks speculation about the end of the world.

Table 1 the electric vehicle stepping stones – From its origin until the first world war

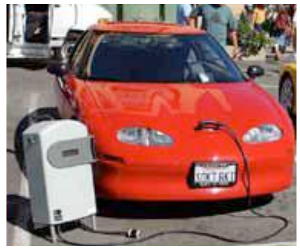
1971 Apollo 17 Lunar Rover (19 April) was the first vehicle on the moon. **1972 First Hybrid** Victor Wouk, (Godfather of the Hybrid), builds first full-powered, full size hybrid vehicle based on a 1972 GM Buick Skylark. **1974 Vanguard-Sebring Citi Car** Debuts at the Electric Vehicle Symposium, Washington DC.	**1996 GM EV1** The first modern production electric vehicle from a major automaker and also the first purpose-built electric car produced by General Motors (GM) in the United States. **1997 Toyota Prius** Toyota unveils world's first commercial mass-produced and marketed hybrid car in Japan	**2000** A few thousand all-electric cars (eg. Honda EV Plus, GM EV1, Ford Ranger pickup EV, Nissan Altra EV, Chevy S-10 EV, and Toyota's RAV4 EV) are produced by big car manufacturers, but are mostly available for lease only. **2006** A few pure electric cars and plug-in hybrids are in limited production, with new ones are on the horizon.
		
1974 **Vantguard-Sebring Citi Car**	**1996** **GM EV**	**2002** **Tesla Roadster**
	The Global Warming Time Line	
1950-1970 Development of new technology leads to an increased awareness about global warming and the greenhouse effect. New studies show that the level of carbon dioxide in the atmosphere is rising each year and pollution concerns begin to enter into everyday life.	**1984-1990** Theories about the greenhouse effect and global warming become more prevalent, and gain attention from mass media. However, many people believe the threat is not eminent and some doubt that global climate change is a danger.	**1997-2005** Worldwide conference on Global warming is held in Kyoto, Japan on December 1st 1997. 125 nations sign the Kyoto Protocol, committing to reduce pollution.

Table 2 The electric vehicle stepping stones – from the 1970s to date

Current Context

Global environment

As a result of more than 150 years of industrial activity, the amount of carbon dioxide in the Earth's atmosphere and temperatures have been rising dramatically because of the pollution caused by burning fossil fuels and the unstoppable deforestation process. It follows that glaciers are melting, plants and animals are being forced from their habitats, and the number of severe hurricanes, storms and droughts is increasing (*What is global warming?*, n.d.).

Now that the Obama administration has ratified the Kyoto protocol, whose key aim is to reduce greenhouse gas (GHG) emissions to an average of 5 % against 1990 levels over the five-year period 2008-2012 (*Kyoto Protocol*, n.d.), there is rightly an increasing pressure to embrace low carbon technologies. It must be also pointed out that the global car industry has overtly and covertly delayed the R&D of fuel efficient technology as well as non-fossil fuel based vehicles. Both the government and the car industry have realised that the dependence on non-renewable fuel sources is an area that needs addressing with a certain degree of urgency.

In order to tackle this difficult situation the European Commission has currently proposed to its member states to promote and stimulate the purchase of fuel-efficient vehicles and to invest in more research aimed at reducing car emissions to an average of 95g CO_2/km by 2020 (*CO2 and Cars*, n.d.). This is absolutely necessary since the transportation sector is a major contributor of GHG, as shown in figure 1, and because no nation can avoid the serious consequences of climate change.

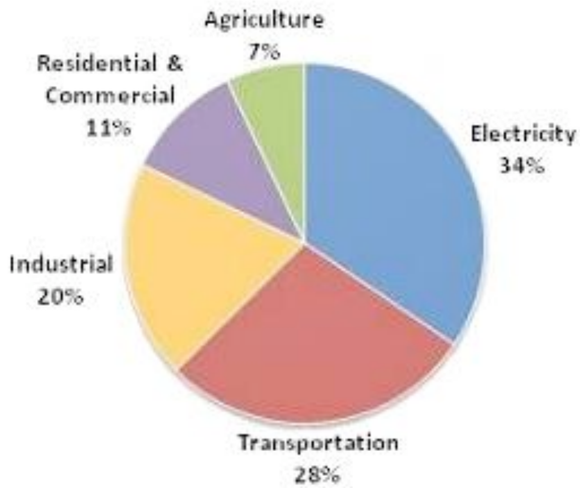


Figure 1 U.S. greenhouse gas emissions by economic sector (2007)

In order to further reduce global warming, in the next few decades, the world's energy systems will have to be transformed so that global emissions drop 50 to 80% (*World Development report 2010*, n.d.). This enormous challenge must be met by the transportation industry as well if we are to minimise the effects of global warming.

Government LCV Strategy

The UK government has recognised the need for research into LCVs technology and has accordingly responded by investing into three main areas:

1. Engineering: £23 million for low carbon vehicle innovation platform - phase 1.
2. Infrastructure: £100 million for low carbon vehicle integrated delivery programme £20 million for LCV public procurement programme.
3. Incentive: £250 million for the DfT EV consumer incentive package encourages consumers to buy electric by providing a £2000 - £5000 subsidy for low carbon vehicles.

The government has also recently released a projected scenario of personal transportation in the UK over the next 40 years, as illustrated in figure 2.

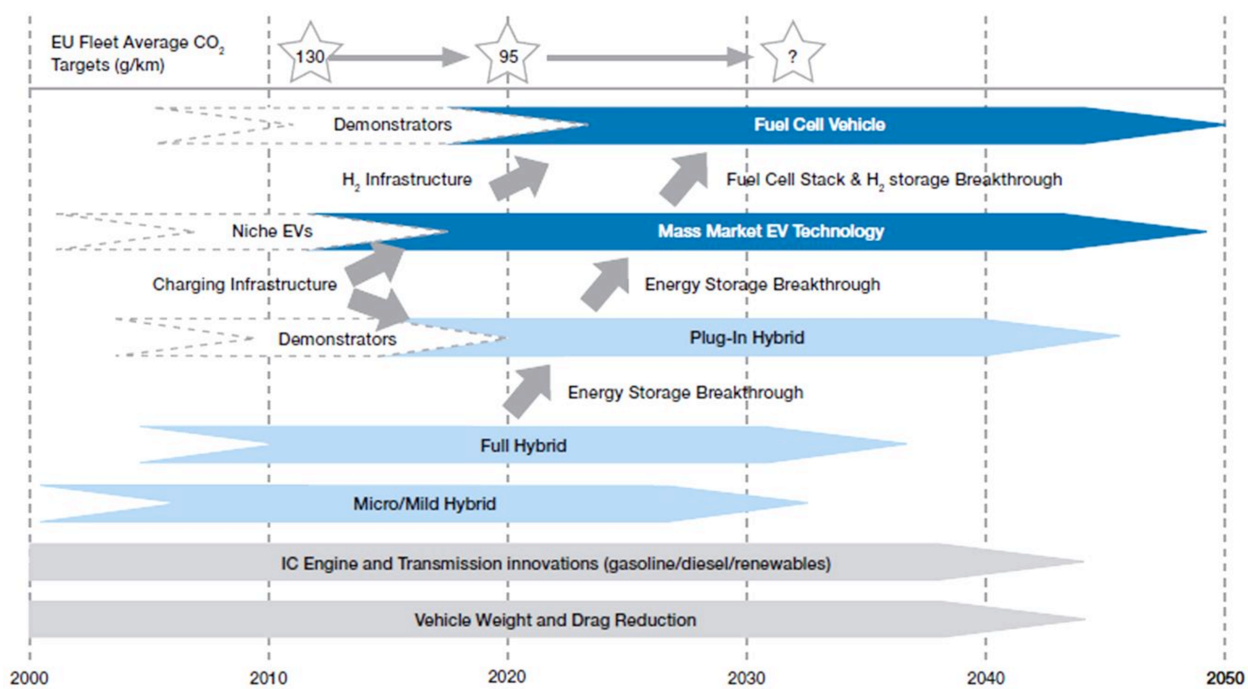


Figure 2 High-level technology roadmap for the UK's decarbonisation of road transport

The chart illustrates an unprecedented parallel development of different power train technologies. It also unmistakably points out how complex, varied and also uncertain will be the future car market, as various advanced LCV power trains will enter the market and become more competitive in terms of low emissions, energy consumption, reliability, and running costs. In addition, another major variable is represented by the subsequent development of adequate infrastructure through local governments to support those alternative means of transport and ensure they are a viable solution to tackle climate change. The complexity of this market will increase as over the next few years more obsolete and less efficient vehicles will be phased out leaving the consumer with a new wider spectrum of cars to choose from based on the user's needs and desires. It follows that styling, safety and branding will not be the only deciding factors in people's mind when it comes to acquiring a new vehicle.

Technology

As in the short term, none of these low carbon vehicle platforms will be resolved and mature enough to emerge from the other alternative power trains and set new standards, a lot of fierce competition between these propulsion systems developed by vehicle manufacturers and component makers will take place. This unusual phenomenon will offer car makers but also smaller design and engineering entities an opportunity to innovate and compete in the market place as the electrification of vehicles will significantly simplify vehicle assembly and procurement of components.

Analysts predict that electric vehicles will penetrate the market rapidly to constitute 35% of the cars made in 2025, 25% hybrids, 10% pure EVs (*Hybrid And Pure Electric Cars 2009-2019*, n.d). As a result, any motor manufacturer without a compelling line up of hybrid and full electric vehicles will be facing serious financial losses.

A recent study by the Swiss Federal Institute for Materials Science and Technologies has dismissed the pre-conceived idea, that driving an EV is simply relocating the problem to the production of electricity, by studying the entire life cycle of different modes of power for individual cars. Figure 3 illustrates the results of a comparison between an EV charged with the European electricity mix (mainly relying on thermal power plants), an EV charged with solar panels (renewable energy) and the usual combustion engine fuelled at the petrol station. Even in the case of the EU electricity mix, over 50% of the CO2 emissions are reduced (*The Bright Green Idea*, D. Rochat).

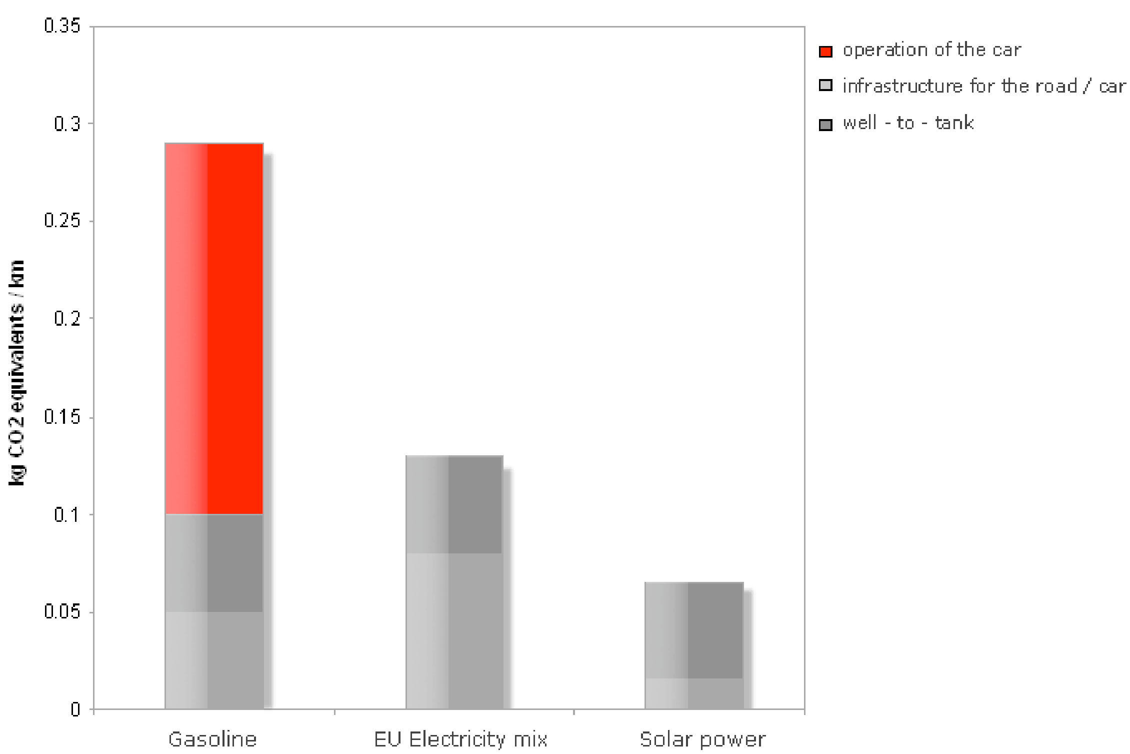


Figure 3 Comparison of greenhouse gas emitted for driving 1 km for three types of car

The High Value Low Carbon Project

HVLC Structure and Objectives

In response to the UK Government's focus on engineering and infrastructure the researchers have initiated a consortium-based project that aims to envisage functional and experiential user value made possible by the development of LCV technologies. The High Value Low Carbon (HVLC) consortium of industrial and research partners includes:

- 4 international automotive manufacturers
- 3 research centres
- 7 component manufacturers
- The regional development agency ONE North-East

By bringing together carefully selected organisations around the theme of LCV innovation, the consortium has enabled companies to interact and as a result a number of 'spin-off' commercial opportunities have been initiated. The aim of the project is:

- To provide a conceptual focus for an ongoing collaborative project involving technology companies and suppliers to the automotive industry.
- To develop high quality interior design concepts for future electric vehicles.
- To demonstrate how printable electronic technology can provide added value concepts in vehicle design.
- To explore the integration of hi-tech on-board info-entertainment equipment such as: screens, Internet enabled computer, mobile phones, cameras, etc.
- To provide a high level of security through the on-board Internet connection.
- To envisage additional user benefits made possible by battery technology.
- To pilot collaborative arrangements prior to the commencement of a substantial LCV project in 2010.
- To stimulate business activity and commercial collaboration.

Research questions

The aim to innovate and tackle the multi-faceted topic of EVs in an unbiased and rational manner led the HVLC team to formalise their reasoning through the identification of key research questions. As a result, the entire research project revolves around 4 fundamental enquiries that explore:

1. New intellectual property (IP).
2. New ideas for new products and services.
3. New methods and ways of thinking.
4. New knowledge about the sustainable future of the automotive industry.

These also represent the motives that drive the development of HVLC in a world where the struggling auto industry needs to seriously reconsider its priorities and product development strategies if it is to survive within future economic parameters.

Research method

The HVLC project is underpinned by a practical knowledge of transportation design and the automotive industry, the researchers being experienced transportation and industrial designers. Three third year BA (hons) transportation design students were employed on placement and the researchers directed their activities in support of the project.

A process of multiple perspective problem framing (English 2008) was adopted, firstly to explore parameters relevant to the development of viable LCV products and services. Secondly to describe potential user value revealed by the interrelationship of these parameters and thirdly, to explore potential opportunities for consortium companies to develop business collaboration (this has already led to a number of commercial 'spin offs' in other fields). Figure 4 shows an initial project-scoping map.

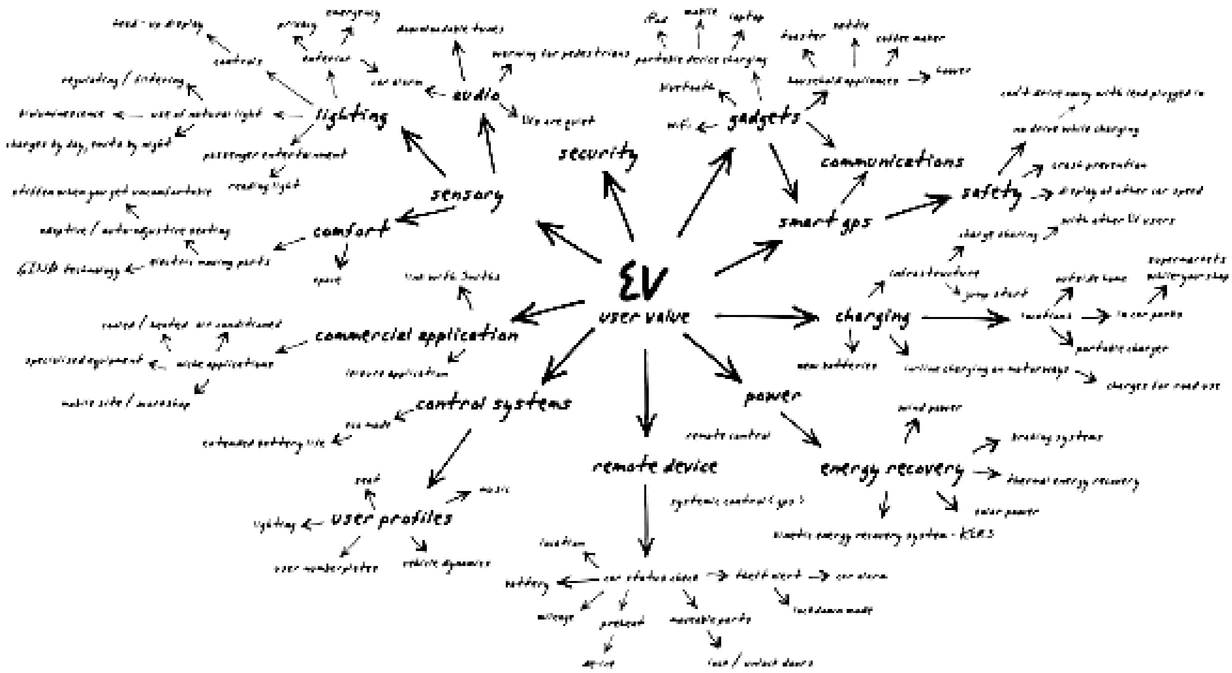


Figure 4: HVLC project-scoping map

This reflective tool was instrumental in the planning phase of the project as it provided the researchers with a clear appreciation of the design terrain and helped to compile the necessary background research to inform subsequent development of the chosen concept themes.

The research team organised regular monthly meetings with key personnel from collaborating organisations. Evolving concepts were presented with a view to stimulating dialogue across the consortium. The ensuing discussion was recorded and the issues arising fed the development of concepts as outlined below.

Project outcome

The following outcomes were achieved at the end of the project:

- A book describing new user benefits made possible by electric vehicle platforms in order to stimulate new business networks and commercial propositions.
- A showcase for new concepts made possible through the collaboration of technology companies and the automotive industry.
- A Presentation package and travelling exhibition used at the CENEX LCV ride and drive conference and exhibition at Millbrook vehicle proving grounds in September 2009.
- A dedicated website (www.highvaluelowcarbon.com) that operates as a hub for a consortium of companies engaged in collaborative low carbon initiatives.

Growth of the LCV market

The dynamics of the car market in developed countries are rapidly evolving as a number of major manufacturers like Honda, Toyota and Renault are launching fully electric (EVs) and hybrid vehicles (HEVs) on the market between 2010 and 2012. Lux Research's ongoing tracking of alternative power and energy storage opportunities found that in 2007, about 500,000 HEVs were sold, accounting for $484M worth of batteries (*Business Wire*, 2008). Plug-in hybrid electric vehicles (PHEVs) and pure EVs are scheduled for introduction in 2010, driving the market for all light electric vehicles, including HEVs, PHEVs, and pure EVs, to 3M units in 2012, leading to a battery market of $3.8B in that year. Although HEVs will continue to grow at 40% annually in the next five years, the next frontier is PHEVs, which need greater energy storage capacities to support longer all-electric ranges.

To further confirm this growth trend, BBC Research - Hybrid & Electric Vehicle Progress Review stated that the global market for large and advanced batteries increased from $8.4B in 2006 to $8.9B in 2007 and it should reach $11.4B by 2012. Research & Markets is projecting a healthy

$200M figure in annual US electric vehicle charging sales by 2015. These predicted figures provide a clear indication of the massive growth of the LCV industry which is still in its infancy and as such requires substantial funding and private investment to support its expansion.

EV Development

The development of the current and future ULCVs is represented by the introduction of EVs. The current obstacle in the EVs' technical evolution is strictly related to a complex series of technical factors which cannot be easily overcome without substantial R&D activities to evolve electric platforms within a well defined and widespread charging infrastructure. Other related parameters such as battery performance, light weight construction, vehicle range, etc. can be separately analysed but they would not necessarily provide a balanced account of the latest trends and challenges that the industry and society are currently facing. HVLC soon realised that the complexity of the EV development and its business success are dependent on a large number of variables which need to trigger other prerequisites in the right sequence to bring technical progress and as a result extensive mass production. Figure 5 shows this evolutionary cycle.

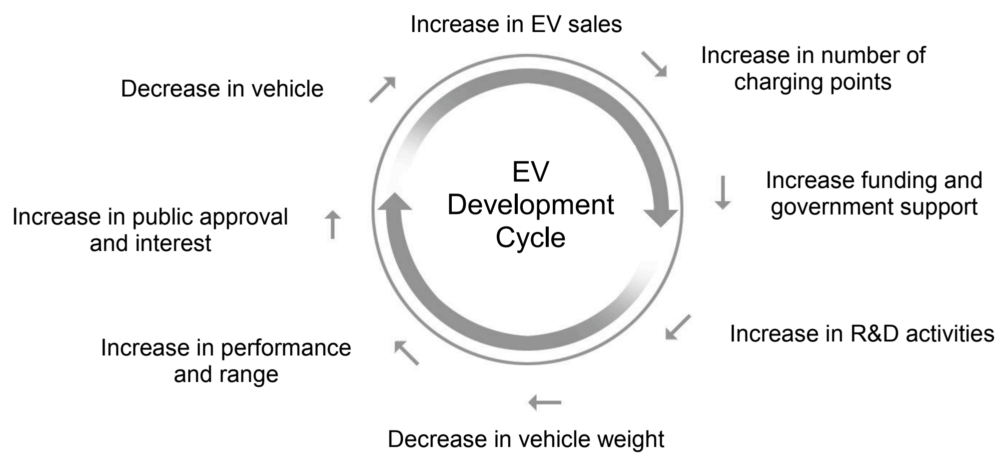


Figure 5 Electric vehicle development cycle

It is apparent that in order to sustain significant EV development and success in the car market some key technical aspects such as the increase of charging points and car range will play a major role. There is delicate balance of factors at play which is not only based on sheer engineering capability but also on design dexterity and marketing strategy to win public acceptance. Based on the government forecast, HVLC started its pilot project in May 2009 by producing a more specific forecast of EVs entering different market segments up to 2025 in order to acquire a better understanding of the whole scenario, as explained through figure 6.

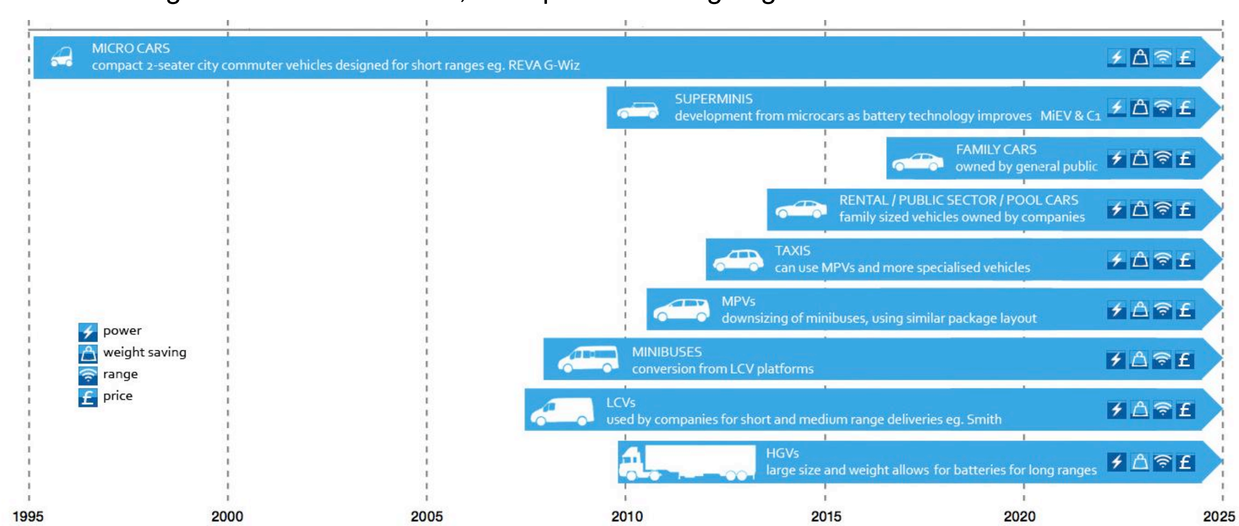


Figure 6 Projected scenario of electric vehicles entering different segments of the car market

Resulting concept themes

The HVLC project was exhibited at the CENEX LCV conference and exhibition at Millbrook proving grounds, Bedfordshire, UK in September 2009 and attracted significant interest from the fast growing low carbon vehicle industry. In order to summarise the project output various design concepts were grouped in the following manner as illustrated in figure 7:

Figure 7 HVLC banner presentation for CENEX exhibition

Battery Intelligence: Range (fig. 8)

In consideration of the comparatively short range of EVs as compared with internal combustion or hybrid vehicles, this concept is an attempt to visually express and better define the distance a given battery charge will allow the car to travel. It presents information to the user in a more meaningful and usable way, as shown in figure 8.

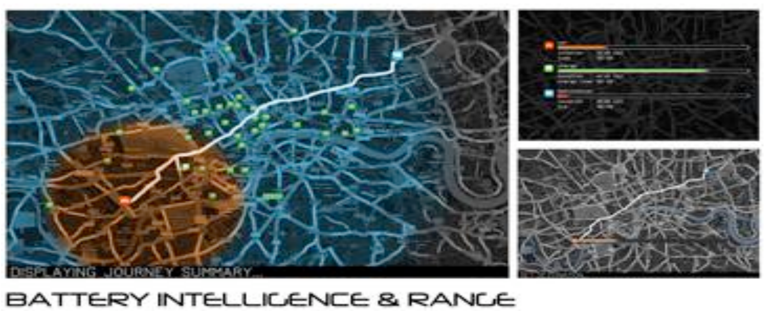


Figure 8 Battery intelligence & range GPS screen shots

Integrated into the GPS system, additional information, such as charge points and destinations, can be incorporated to calculate an optimum route, and recommend the minimum charge time at a given location.

Multi Battery (fig. 9)

This series of concepts explore the opportunities offered by the incorporation of multiple removable batteries inside the car, focussing specifically on recharging, charging away from the vehicle, weight minimizing, efficiency and journey planning.

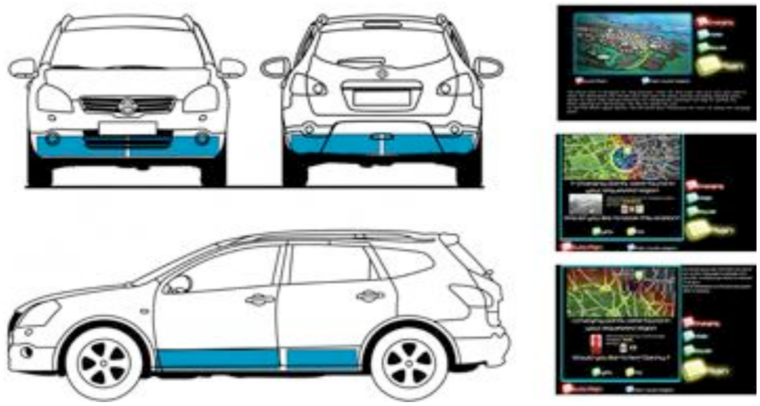


Figure 9 Multi battery concepts

Open Charging Zones (fig. 10)

The principle of Wi-Fi Open Zones is applied to the process of vehicle recharging to envisage possible concepts for new infrastructure. Charging zones for industrial and business use are considered along with possible billing systems and how home users might convert personal fast-charging stations for public use. Figure 10 demonstrates the concept through screen shots of a user-friendly interface.

Figure 10 Open charging scheme

Wireless Charging (fig. 11 & 12)

Nothing would be as frustrating as forgetting to plug your electric vehicle in at night and returning the following morning to find a set of flat batteries. With an emphasis on user interaction on a day-to-day basis, these concepts aim to break free from a reliance on the cable and plug and offer potential static and in-motion charging solutions.

Figure 11 LCV Wireless charging

Motion Charging

Taking wireless charging a step further, as schematically illustrated in figure 12.

Figure 12 LCV Motion charging

Charging point intelligence (fig. 13)

Charging points allow for far greater functionality than just the flow of electricity to replenish the battery. Through the exploration of possible charging scenarios and locations we envisage two-way information transfer between charging point and vehicle. These concepts focus on the content of the data available and the ways in which companies could process it to offer added value to the user, as Figure 13 describes.

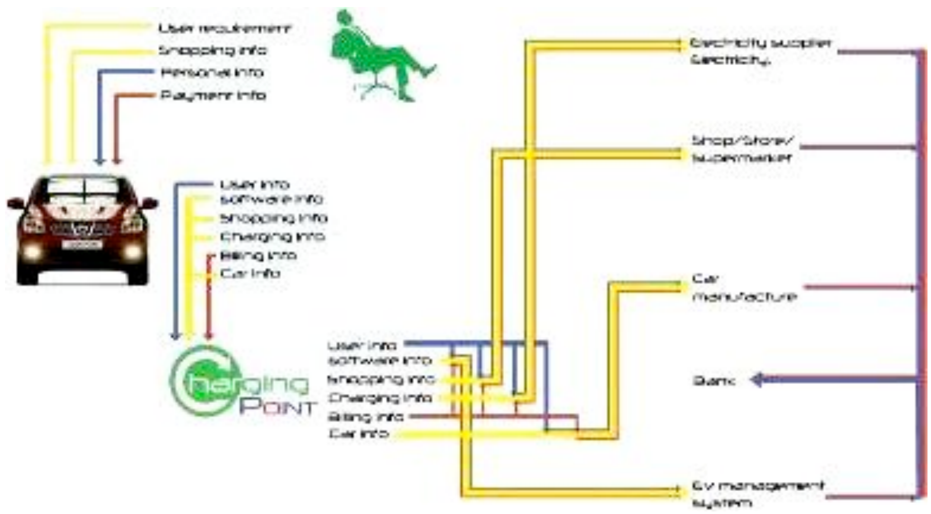


Figure 13 Charging point diagram

Electrolocation (fig. 14)

These concepts have been developed by studying the way that animals such as the platypus use electrolocation to build up a mental map of their immediate environment.

Figure 14 Vehicle's electrolocation

The application of printed electronics to body panels can provide relevant information about a vehicle's immediate vicinity, the driver can make more informed decisions and so drive with a greater degree of safety. By combining this technology with inter-car-communication, the driver can also be alerted to hazards by other road users.

Lighting (fig. 15)

Interior lighting can be developed to offer more than just good visibility. These concepts incorporate technology such as OLED lighting to enhance the experience of both driver and passengers.

Figure 15 OLED applied to vehicle windscreen

EV car rental (fig. 16)

Considering the price gap between comparative conventional engined vehicles and electric vehicles led the team to challenge the concept of vehicle ownership. Should the entire car (bodywork, engine and battery) or only certain parts be owned by the driver?

This group of concepts explores the implications of different states of ownership through the communication of car rental scenarios, these address issues of access, billing, security, duration of use, tracking, user interaction with the product and the service as a whole and integration with existing public transport systems. Figure 16 provides schematic explanation of such a scheme.

Figure 16 EV car rental scheme

Entertainment & sound systems (fig. 17)

By focusing on the user's experience of interacting with the vehicle, these concepts explore the integration of new and emerging technologies into the vehicle interior. The most notable are:

- The impact of the expansion of mobile wi-fi, enabling the vehicle user to access internet based services en-route.
- How the incorporation of printed electronics will lead to new and innovative application of lights, screens, touch-pads, sensors and solar cells.
- 'Audio partitioning' through the use of directional, flat-panel speakers that provide each user with an individual and customisable experience.

Figure 17 On-board entertainment and sound systems

Commercial Applications (fig. 18)

These concepts use printed electronics in the form of printed organic light-emitting diodes (OLEDs) to vary vehicle graphics, branding and advertising displayed on the side of light commercial goods vehicles.

Figure 18 Commercial vehicle featuring different advertising graphics

Conclusion

HVLC's strategic role and its relevance within the LCV field

Whilst political attention is focussed on finance, infrastructure and engineering, the LCV agenda lacks human centred design solutions that will embed low carbon vehicle technology into our society. Engineering R&D activities, while crucial, currently overshadow the potential offered by design to create the machine around the person. This presents us with the need to explore the functional, but foremost experiential user value that must be embodied in LCVs if they are to be considered viable and capable alternatives to petrol and diesel cars.

The HVLC team is concerned with the way users interact with products and systems, and the perceived worth given to this interaction. In addition, HVLC provides a strategic design approach that acts as a catalyst to juxtapose different technologies whilst retaining focus on the experience of the end-user. HVLC aims to seek further industrial partners in order to collaborate by offering transportation and industrial design expertise, as complementary disciplines, which are implemented across the main areas of engineering expertise provided by industry partners.

HVLC's Role as a LCV System Integrator

Ettlie (2006) iterated that the role of a new product strategy in the business unit has a significant impact on performance. This is particularly crucial in the development of LCVs as the auto industry spends 3 to 4 % of sales on R&D. It follows that the HVLC's mission is to assist the future LCV industry by driving innovative collaboration in regional industry as well as nationwide and overseas. This is accomplished by acting as a *System Integrator* for companies and emerging technologies as shown in figure 19.

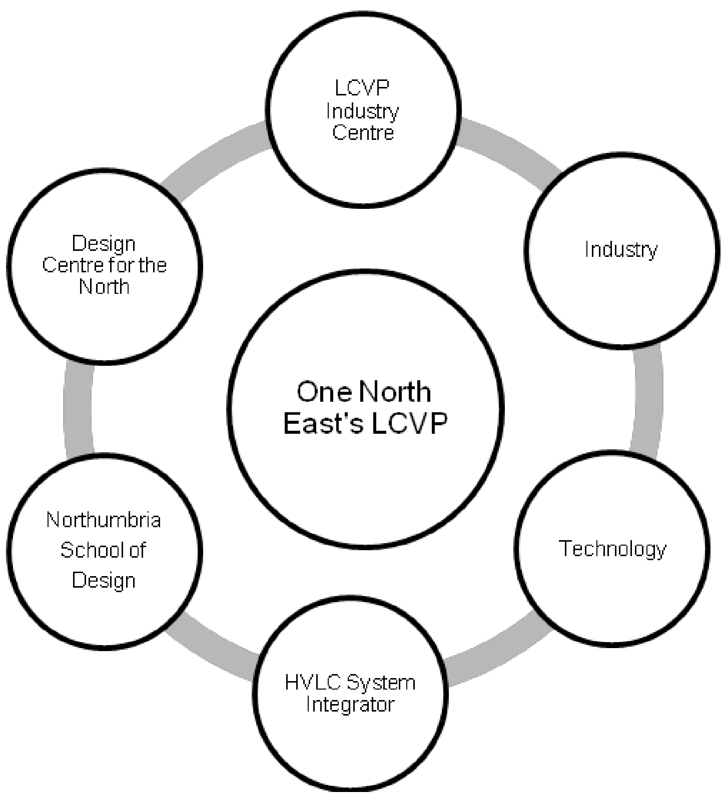


Figure 19 HVLC operating model

The researchers aim to develop HVLC as a creative *technical and design entity* offering value innovation management throughout design, engineering and marketing processes. Apart from the essential involvement of industrial partners HVLC aims to support all engineering and design R&D activities and overall carbon management of the manufacturing process with undergraduate placement students, post-graduate PhD and MPhil researchers to work on specific projects through the Knowledge Transfer Partnership (KTP) scheme and/or CASE Studentships.

To clarify the current nature of the LCV market Prof. Neville Jackson (Group Technology Director, Ricardo UK Ltd and Chairman, Low Carbon Vehicle Partnership) recently wrote that: 'Whilst the key market driver for lower carbon transport is regulatory, consumers have shown an increasing desire for the lower running costs and “greener” image of more fuel efficient vehicles. This has created a demand for new technologies and innovations that are both cost effective and, particularly for passenger cars, attractive, avoiding the perception that fuel efficient vehicles, by definition, are dull and boring. More fuel efficient combustion engines, vehicle innovations, electrification of drivetrains, including all electric and plug-in hybrid systems, are in development and will be introduced to the marketplace in a wide variety of combinations and products. These new technologies drive the demand for new supply chains, providing opportunities for new entrants to the automotive sector’.

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Author Biography

Stuart English

Trained as an Industrial Designer, Stuart has worked in the field of Design Innovation for 20 years. He co-founded Glenelg Product Design in 1990 and at Northumbria University has championed design learning innovation whilst leading BA and MA courses in Design for Industry and professional design practice.

Stuart's research challenges the designer's capacity to be both innovative in terms of product designs and design processes. His approach confronts theory with practice and vice-versa. His practice has facilitated new product development through an inclusive approach based on design led entrepreneurship. This addresses multi and cross-disciplinary contexts bounded by clarity of market objectives, and has led to numerous filed patents.

Matteo Conti

Matteo has been a senior lecturer in Transportation Design and an industrial placement tutor for the past 9 years at Northumbria University. During this time he also led the course between 2005 and 2007 whilst retaining his core roles. This Italian bi-lingual academic has been creating various successful industrial partnerships with prestigious design consultancies (Pininfarina, Bertone, IdeA Institute,etc.) to carry out collaborative projects and secure students' placements. His mechanical engineering background led him to initially pursue a career as a robot programmer/engineer applied to vehicle manufacturing and painting.

His passion for design culminated in 1999 when he obtained a first class degree in BA (Hons) Transportation Design from Northumbria University. During his graduate work experience, at Alfa Romeo he was offered an enticing lecturer position at Northumbria which he could not refuse. In 2007 Matteo was appointed External Examiner at Domus Academy in Milan, for the MA course in Car Design. Through HVLC Matteo's intention is to develop further specific design and technical expertise in the EV field by undertaking major industrial R&D projects.

Value innovation modelling: Design thinking as a tool for business analysis and strategy

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William Jackson, Iconet ltd, UK

Abstract

This paper explores the use of multiple perspective problem framing (English 2008) as a tool to reveal hidden value and commercial opportunity for business.

Creative thinking involves the interrelationship of parameters held open and fluid within the cognitive span of the creative mind. The recognition of new associations can create new value that can lead to innovation in designed products, intellectual property and business strategy.

The 'Ideas-lab' process is based on the proposition that a company's capacity for innovation is dependent on the way the business is able to see its problems and opportunities. In this process the attributes of a company and the experience of the researchers are considered as the parameters of a design problem. It is therefore important to acknowledge the commercial experience of the project researchers, all of whom have a proven track record in helping businesses develop, exploit and protect their know how.

Semi structured interviews were carried out with key individuals in 34 companies. The resulting data was assessed on a company-by-company basis through a process of multiple perspective problem framing, enabling key nodes, patterns and relationships to be identified and explored. A 'Cornerstones of Innovation' report was prepared to inform each company of the observations made by the researchers.

The paper describes the methods adopted and summarises the feedback from participating companies. Case studies are highlighted to demonstrate ways in which the process influenced the actions of particular businesses, and the commercial outcomes that resulted. Finally the researchers reflect on the structure of the Ideas-lab process.

Keywords
Value Innovation, Design Thinking, Multiple Perspective Problem Framing, Performance Management, Business Mapping.

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Theory

This paper is founded on two main areas of theoretical knowledge: Multiple perspective problem framing and organisational design. The 'ideas-lab' process described in the paper has been developed through the practical combination of these areas of knowledge in relation to the analysis of 34 companies. We will first summarise key theories and show how these contribute to the approach taken by the researchers.

Multiple perspective problem framing can be considered as a development of the radiant mind mapping techniques pioneered by Tony Buzan (Buzan & Buzan 1996). Buzan's technique involves the growth of a tree diagram from a single centre of enquiry and as such can be used to represent the designer's perception of an issue in context. However because this represents a single viewpoint potential opportunities or other ways of seeing can be hidden. Integrated mind mapping techniques can offer multiple centres of enquiry enabling alternative ways of seeing to be communicated in the same map. English (2008) describes multiple perspective problem framing as a way to 'reveal value by considering a problem or scenario in different ways. This multiple perspective approach to the framing of design problems and opportunities requires designers to acknowledge their own cognitive processing talents and capabilities in order to give form to evolving networks of ideas. In other words, the designer must develop ways to engage with and make sense of interrelated information so that it is not lost in a fog of complexity'. English claims that designers can use integrated mapping techniques to:

- purposefully develop and communicate their cognitive structure in relation to a particular area of investigation
- facilitate reflective self exploration that lifts the level of their own awareness and that of their clients and collaborators
- enrich their understanding of the problem since it considers the design space from different points of view
- 'pick the problem up' from any centre of enquiry - to move around the evolving design space and to envisage new ways of seeing
- reveal potential for agreement by integrating conflicting viewpoints.

Whilst such an approach is not uncommon in design process this paper reports on the use of multiple perspective mapping techniques to reveal hidden value in business, employing a creative process that as DeBono (1996) recognizes 'involves breaking out of established patterns in order to look at things in a different way'. The researchers carried out semi-structured interviews with key executives in each company. Data from the main interview (with a managing director or similar) was where appropriate triangulated with data from interviews with up to two other company executives. The resulting data was used to create 'integrated mind maps' (English 2008) that aim to articulate the 'value arena' of each company. This process involved the researcher who carried out the interviews reporting the data back to another researcher who simultaneously created maps of the value arena occupied by the company. It is important here to note the tacit knowledge brought to the process by the researchers themselves who combined have over 40 years experience in innovation and enterprise. This has implications regarding the replicability of the process outlined, in particular the mapping stage.

The second area of theoretical knowledge to underpin the research is that of organisational design and in particular the design of successful and high performance organisations. Galbraith's 'Star Model' (1995) (Figure 1) provides a framework for organisational design consisting of five policies:

- Strategy - determines direction.
- Structure - determines the location of decision-making power.
- Processes - describe the flow of information; they are the means of responding to information technologies.

- Rewards - influence the motivation of people to perform and address organisational goals.
- People policies - influence and frequently define the employee's mind sets and skills

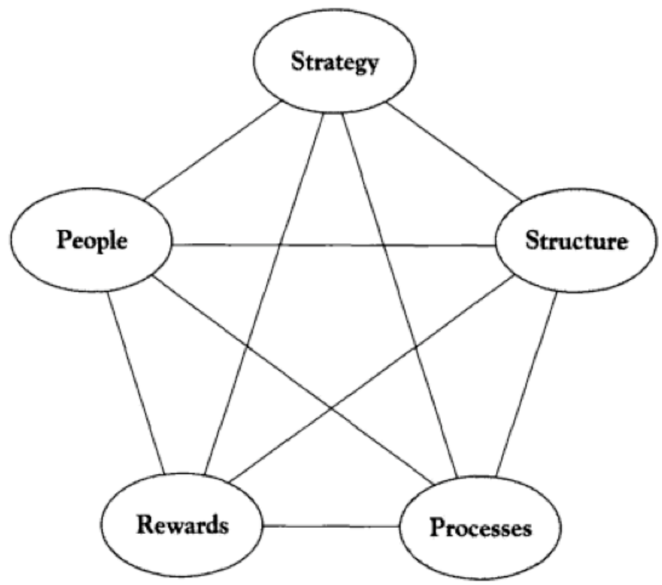

Figure 1: Galbraith 1995 'Star Model'

In Galbraith's model each of these policies can be considered as a separate centre of enquiry, however when they are combined the model can represent an integrated map of the company in question. Thus Galbraith's star model can represent (in general terms) a multiple perspective view of a business similar to the interrelating parameters of a design problem.

Since the aim of the ideas-lab process is to reveal hidden value in companies the researchers needed to be able to make practical judgements within each area of enquiry. It was therefore necessary to relate policies to performance in practice.
De Waal's (2006) analysis of 91 studies identified eight key characteristics of high performance organisations; organisational design, strategy, organisational process, technology, leadership, individuals and roles, culture, environment. De Waal claims that these elements 'seem to influence the ability of organizations to achieve high performance'. De Waal's research was reviewed and distilled leading to the following interpretation where prominent aspects of investigation are highlighted:

1. Organisational design – constantly realign the business in line with **changing internal and external circumstances**, **networked collaboration** across functional and organisational borders, sharing of information and knowledge within a consistent responsibility structure, responsiveness;
2. Strategy – **focus on value**, clear and challenging goals, common understanding of the strategic direction, balancing long- and short-term focus;
3. Organisational process – **innovate products and services**, rewards and incentives for continuous improvement, measure what matters, simplify processes and deploy resources effectively;
4. Technology – **Identify and exploit new technology** to gain competitive advantage;
5. **Leadership** – coach and **facilitate**, grow leaders from within, stimulate change and improvement, allowing experiments and mistakes, action focused decision making, long term orientation;

6. Individuals and roles – master **core competencies**, engage and involve the workforce. Align employer behaviour and values with company values and direction;
7. Culture – **Shared core values** and identity, adaptive performance-driven **responsibility**, transparency and trust;
8. Environment – enhance customer value creation, be part of a **value-creating network.**

Because the ideas-lab process aims to reveal hidden value in businesses and to develop strategies to commercialize this value, the aspect of strategy has been placed at the centre of the ideas-lab star model (figure 2). As Galbraith states (1995) "Strategy is the company's formula for winning. The company's strategy specifies the goals and objectives to be achieved as well as the values and missions to be pursued; it sets out the basic direction of the company. The strategy specifically delineates the products or services to be provided, the markets to be served, and the value to be offered to the customer. It also specifies sources of competitive advantage and strives to provide superior value".

The final theoretical point to make relates to the cognitive span of the investigator. Whilst de Waal has identified 8 possible centres of enquiry Whitehead (2007) suggests that when framing solution space, the designers mind is only able to span a maximum of six or seven concurrent issues and that the choice of these issues is critical to the potential for value innovation. These key issues are described as "cornerstones of innovation" (English 2007) because they represent the most significant parameters of the design arena. English states that *'Cornerstones of Innovation* recognise the designers cognitive 'span' of up to 6 or 7 key factors that in combination frame the problem. By concept mapping cornerstones of innovation the designer is able to model problem space at an optimum psychological size'.

Ideas-lab Centres of Enquiry
Based on Whitehead's (2007) observations the eight characteristics distilled from Waal's research were reduced to six main areas of enquiry orbiting around a central focus on value and strategy (figure 2). By doing this, the researchers were able to cognitively span all six areas of investigation simultaneously. The ideas-lab centres of enquiry as shown in figure 2 are as follows:

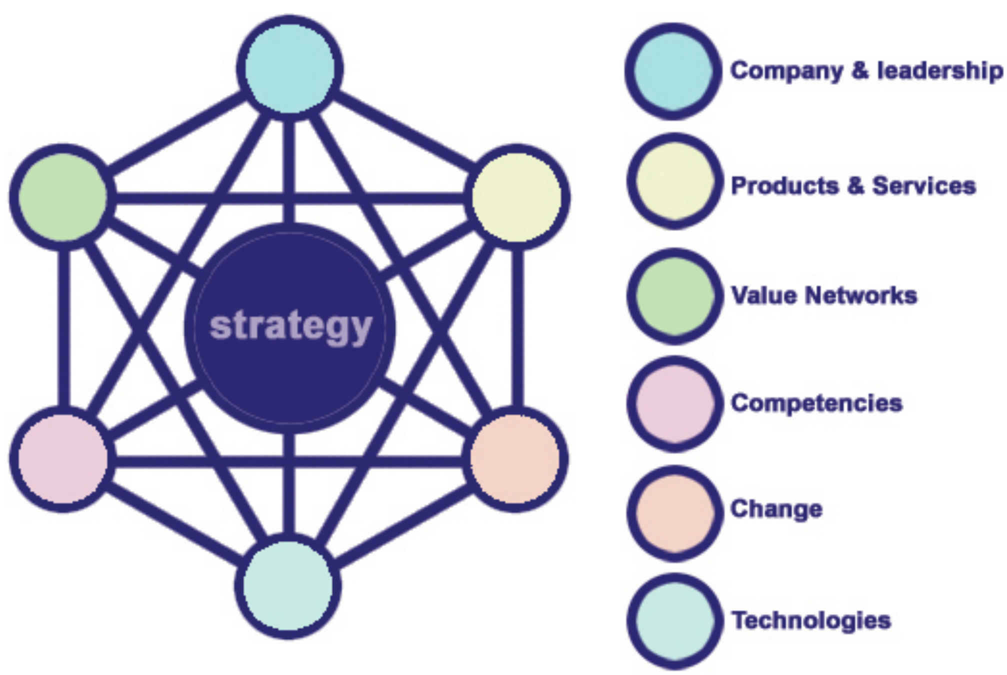

Figure 2: Ideas-lab Star – based on cornerstones of innovation model (English 2007)

(i) Company Leadership - Drive *(de Waal 2006, 5&7)*
History, status, assets and liabilities, turnover, revenue, management, vision, culture, structure, philosophy **(Shared core values).** What drives the company?

(ii) Value Creating Networks – upstream and downstream networks *(de Waal 2006, 8)*
Suppliers, partners, customers, competition, finance, differentiation, market characterization and networks. How and where does the company tap into networks of value to generate revenue?

(iii) Products and Services - Capability *(de Waal 2006, 3)*
Resources, Machinery, Development of products and services, associated costs, contract-work, standards, response, aftercare and value. What is the relationship between customers and products/services?

(iv) Technologies - Intellectual Property *(de Waal 2006, 4)*
Intellectual property portfolio, rights, maintenance, applications, improvements, development of value, marketplace. What does the company technology offer and how is it protected?

(v) Change – Opportunity *(de Waal 2006, 1)*
Environment, context & company, build value, R&D, business threats, market forces and opportunities. What is changing internally and externally and what opportunities does this open up?

(vi) Core competencies *(de Waal 2006, 6)* **- Individuals and Roles**
Expertise, knowledge, know-how, evolution, challenge, future.
What does the company know and what can it do?

The focus of the ideas-lab star model is on **strategy** *(de Waal 2006, 2),* this combines the value proposition with a route to market and can be used to calculate potential revenue. This provides a valuable tool that can contribute to a business plan with a view to securing finance.

Method

The ideas-lab process was initially implemented in 2007 through a collaborative innovation partnership between Northumbria University, Ward Hadaway Law Firm and the regional development agency, One North East. Following the success of this programme the process was made available as a service to members of NetparkNet virtual science park and directly on a company-by-company basis (2008-2009). Most of the 34 businesses analysed as part of this study are SMEs (Small to Medium Enterprises) with 5 – 250 employees although some larger companies were also analysed.
A list of generic questions was prepared to explore the centres of enquiry outlined above. The questions were tailored to each company and each analysis followed the same pattern taking approximately six man-days in each case.

Following initial company research and refinement of interview questions one member of the team (the scout) met with the client company on-site. Semi-structured interviews were undertaken with key individuals and data was recorded for each centre of enquiry. Data from the main interview (with a managing director or similar) was where appropriate triangulated with data from interviews with up to two other company executives. Meeting on-site also provided the opportunity for the researcher to tour the company's facilities and to record any additional data deemed relevant. Following this meeting the scout reported the data back to another member of the research team (the modeller) who, as part of the process, created a 'radiant map' for each centre of enquiry. This was done on a whiteboard or large piece of paper, sometimes using post-it notes, enabling single centres of enquiry to be overlaid using integrated mind-mapping techniques (figure 3).

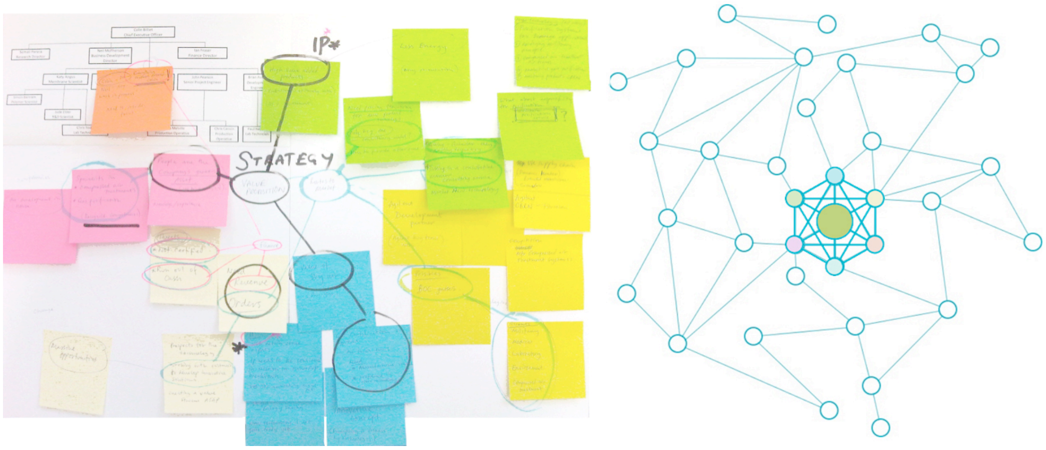

Figure 3: Left - showing an example of the mapping process. Right – showing a theoretical model of this process.

By creating a flexible viewpoint the researchers aim to reveal patterns within the data and relationships between centres of enquiry. The process aims to identify the foundation elements at the core of the company's value, these can include technologies, processes, know how, networks, intellectual property, company culture and structures. We have referred to the relationship of these elements as the company's 'Value Arena' that forms the foundation for any strategic recommendations on how to increase the revenue of the business. The results of the process were reported back to the interviewees in a 'Cornerstones of Innovation' (COI) report detailing:

- the company's value arena
- new ideas on how to increase the revenue of the business
- the value of the company know how and intellectual property, including guidance on its protection and development
- possible sources of professional and academic support that could assist in the implementation of any of the ideas outlined

Results

Table 1 describes the nature of the companies analysed by rating each of the above centres of enquiry from 1-10 (where 1 is the lowest score and 10 is the highest). ***Referring to Table 1:*** Following the mapping process, each centre of enquiry was given a mark out of 10 (columns i-vi); the marks for the six centres of enquiry were then added up and expressed as a percentage (column x). Columns (i) to (vi) represent a current assessment of each aspect of the company, column (x) provides an overall assessment of the value arena. The yellow blocked sections show the significant areas of opportunity identified by the researchers. Column (y) estimates the impact of the process on the value of the company calculated with respect to the following factors as detailed in table 2:

i) Value arena percentage mark
ii) Number of elements ideas-lab would assist
iii) Impact of ideas-lab per element
iv) Size of the company
v) Strength of the value opportunity & feedback

Table 1: Companies analysed against ideas-lab centres of enquiry.

Company No	Business type	No employees	(i) Company & leadership	(ii) Products &services	(iii) Value Networks	(iv) Competencies	(v) Change	(vi) Technologies	(x) Value arena %	(y) Ideas-lab value impact %
1	Management software	5	5	6	6	7	3	2	48.3	13
2	GPS systems	9	3	9	4	9	3	4	53.3	19
3	Road Bollards	6	9	9	9	9	9	7	86.7	5
4	NHS & legal software	12	6	7	8	9	3	1	56.7	6
5	Dehumidifiers & air con	240	8	9	9	9	8	7	83.3	1
6	Renewable energy	100	8	10	9	9	9	9	90.0	3
7	Wave energy	8	4	7	2	6	8	7	56.7	6
8	Mechanical design	5	1	7	1	9	3	7	46.7	15
9	Pipeline testing	50	7	8	8	9	4	8	73.3	7
10	Medical tuition tool	9	3	8	3	9	9	7	65.0	7
11	3D software & web	7	3	5	4	7	9	6	56.7	4
12	Policy & fund org.	250+	7	7	5	6	8	4	61.7	1
13	Battery products	100	3	7	5	9	9	9	70.0	2
14	Construction	25	9	8	9	9	9	7	85.0	5
15	Electrical manufacturer	8	8	9	8	9	7	7	80.0	8
16	Learning software	5	4	7	4	8	7	2	53.3	19
17	Organic chemicals	6	7	6	3	8	6	4	56.7	8
18	Waste treatment plant	5	7	7	6	8	8	2	63.3	8
19	R&D in crystal displays	40	6	1	1	9	9	6	53.3	14
20	Moulding company	55	7	9	8	9	2	1	60.0	3
21	Filtration	100	6	7	8	10	3	4	63.3	3
22	Surface analysis	20	6	5	4	8	6	6	58.3	4
23	Safety instruments	80	8	8	9	9	5	7	76.7	2
24	Surveillance products	5	3	2	4	9	5	8	51.7	11
25	Energy Turbines	20	5	9	9	9	6	7	75.0	5
26	Precision engineering	20	5	9	9	9	2	7	68.3	9
27	Modified fibres	5	1	3	4	6	7	5	43.3	18
28	Chemicals & materials	150	9	9	9	10	9	9	91.7	1
29	Filtration products	200+	9	9	10	10	8	8	90.0	1
30	Fibre waste management	5	1	5	2	8	2	7	41.7	16
31	Mobility products	7	4	6	3	6	4	5	46.7	7
32	Bio fuel	5	3	3	4	6	6	4	43.3	9
33	Renewable energy product	6	3	4	4	9	4	6	50.0	17
34	Dry air products	13	8	9	7	9	9	9	85.0	6

Table 2: Key to ideas-lab value impact.

Stage 1 multiplier	Value arena %
x1.2	40 to 55
x1.1	56 to 70
x1.09	71 to 80
x 1.08	81 to 90
x1.07	91 to 100

Stage 2 multiplier	Issues highlighted
x1.1	1
x1.2	2
x1.3	3
x1.4	4
x1.5	5
x1.6	6

Stage 3 multiplier	Difference between highlighted scores
x0.7	0 to 5
x0.9	6 to 10
x1.1	11 to 15
x1.3	16 to 20
x1.5	21 to 25+

Stage 4 multiplier	Employee weighting
none	0 to 50
x0.3	51 to 100
x0.2	100 to 200
x0.1	200+

Observations and Evaluation

Through the analysis of 34 businesses the researchers identified 27 value opportunities indicating that the process was 80% successful in revealing commercial value for the participating companies.

2 of the reports recommended that the company in question should not continue on its current path or should terminate further development of certain technologies. On the surface this may have appeared negative but the findings demonstrated that this prevented further funds being wasted and provided an opportunity to utilize the resources in a more focused and productive way.

5 of the reports could be characterized as an assessment of the key issues identified within the value arena. These 'health check' reports were used as an independent appraisal and as confirmation that the company management was on the right course. 2 of these reports included recommendations to contact specific funding organizations.

Company 15 commented *"The report highlighted in writing what the company had already thought which gives Peter confidence from an independent body to work out now how to go about implementing the course of action for some of the points raised."*

Shared responsibility

The ability to reveal hidden value through the process is predicated on the following issues:

i) Other than information available in the public domain, a company and its technology is likely to be unknown to the researchers before commencement of the process.

ii) Value is optimised if there is open communication and a willingness on behalf of the company to disclose all relevant information (under NDA where applicable).

As Company 26 recognised in its feedback *"The very act of discussing what we considered doing made us logically think about the company. Verbalising our thoughts cleared our thoughts."*

There is a shared responsibility for both researchers and company management to capitalise on the enquiry process. Since the researchers enter into the unknown in search of value opportunities it is unclear at this point what if anything will be unearthed. If the company concerned is not willing to fully participate or prevents a free flow of information the likelihood of the process revealing value opportunities is reduced.

Where the focus of the enquiry has been on technologies and change within the value arena, the COI report has always revealed a value opportunity centred on a technology and intellectual property strategy. Where the COI focus has been on company and leadership, recommendations have focused on policy and the means to stimulate change.

The commercial exploitation of the 27 value opportunities mentioned above raises the issue of funding and finance.

Financing the value opportunity revealed through the process
The ideas-lab process has been seen to reveal potential commercial value in 80% of companies. To date, value recommendations have been determined through the experience of the research team combined with the process. Where the opportunities identified have been positively assessed further action has been necessary:

- The researchers have developed a strategy document to support the implementation and development of the value opportunity.

- Where finance does not exist to support the implementation of the value opportunity, the researchers have directed companies to fund and/or grant opportunities or organizations that may be able to assist financially.

This is not an ideal solution as the value opportunity is likely to require support from seed fund or in some cases proof of concept funding. Invariably this leads to the need for due diligence, a costly process in both time and money for the fund bodies concerned. Further research is underway to assess whether the likely impact of a proposed value opportunity can be determined at a pre-investment stage. This work aims to quantify the value created and accurately predict the likely success rate of the proposed opportunity. It is envisaged that this will provide investors with a level of confidence and assist any decision involving a key point of change and any form of due diligence, either internal or external to the company; and would subsequently become a highly valuable tool. The researchers are currently developing networks within the venture capital community to trial such a tool.

Some common attributes of SMEs have already emerged. If the company wishes to progress with an identified value opportunity it should have both a high level of competency in it's specialist field and remain open to third party involvement to create both commercial networks and commercially focused decisions.

The larger of the medium sized companies tended to focus on their 'ordinary activities' and were not able to utilise resources for development activities. The smaller companies tended to have core technology with a clear development path, however management often lacked the ability to commercially exploit the technology. Many of these managers could be described as technical experts in their particular field with a background in research and development.

Implementation of value opportunities
Some of the participating companies have used the cornerstones report to form a strategy to raise finance for the value opportunity. For example, a renewable energy company (6) registered their intellectual property and implemented a commercialisation strategy devised by the researchers; this assisted them in raising a further £10m funding.

Anecdotal evidence would suggest that 1-in-3 companies adopted part or all of the strategy developed by the researchers. Company 20 stated, "We want to action the recommendations made". Companies 26 and 22 both recognised the impact of the programme on their own approach "The purpose of the document was to throw ideas at us and stimulate our thinking which is what it did" (Company 26) "We consider the report to be a contributing factor to our thought processes" (Company 22).
Through informal discussions the researchers are aware that companies (2), (6), (7), (20), (21), (22), (26), (27), (28) and (32) in table 1. have acted on at least 50% of the recommendations, with 3 companies adopting the recommendations in full. The researchers have discovered that the companies who do adopt demonstrate:

- a willingness to change and

- an openness to communicate

These attributes have latterly been incorporated into the company selection criteria.

Placing a financial value on the outcome of the ideas-lab process has been very difficult. On one hand it is easily argued that the process is exploratory and may in certain cases be little other than an independent appraisal, however, in 80% of cases, an opportunity has been identified and this has a monetary value. The value impact demonstrated by company 28 was just 1% however this would equate to £180,000 of company turnover as all recommendations were implemented. In addition to this, the company went onto request a study be conducted into uses of their new technology carbon nano-tubes. In another example identified above, the strategy developed by the researchers contributed to the company's ability to secure a further £10m development funding.

Creating a consortium based value arena for commercial collaboration

Whilst the concept of the value arena has been successfully exploited for the benefit of individual companies the researchers have also explored the use of multiple perspective techniques to frame consortium based problem space. By constructing a value arena that different companies can operate within, the researchers have been able to nurture collaboration and to create business opportunities between companies who might otherwise see themselves as competitors. A working example is the High Value Low Carbon (HVLC) consortium project, developed to stimulate business activity around the theme of low carbon vehicles. The HVLC consortium comprises:

- 4 international automotive manufacturers,
- 3 research centres
- 7 component manufacturers
- 5 technology companies
- The regional development agency ONE North-East

The HVLC project has enabled companies to interact within this particular value arena and as a result a number of 'spin-off' commercial opportunities have been initiated. By bringing carefully selected companies together in this arena, the consortium has attracted the interest of a major power supplier with a view to supporting a five-year collaborative programme.

Reflection and Conclusion

Figure 4 aims to summarise the relationship between the main ideas-lab centres of enquiry and the contribution of the process, described in the two central sections (figure 4) as 'value innovation'. Change creates opportunities for companies to develop both new IP and valuable new applications for their existing IP, however 25 out of 34 COI reports have been concerned with the lack of comprehensive intellectual property coverage, promotion and exploitation. Our experience to date indicates that companies are rarely unable to protect their know how. In fact there is only one COI report that identifies that a company was unable to secure their rights and this was due to market saturation i.e. competitive companies selling an identical product. More often, we have found that companies have the ability and resources to build the value of their intellectual property portfolio if they are made aware of how this can be achieved. In general our observations indicate that smaller SME's and start-ups consider IP to be very important, whereas medium sized companies are less concerned. There seems to be an understanding that the larger they become, the less important IP becomes. Comments include *"who is going to take us on?"* (Company13) or *"it is all about first mover advantage"* (company 5) or *"they* (the competition) *will patent hop anyway"* (company 17). Part of the ideas-lab role has been to reintroduce the importance of IP and the significant value it can generate with particular focus around licensing potential and alternative applications and markets. The ideas-lab research team specializes in this particular area and has an ability to cover a very broad spectrum of patentable technology. We have adopted the premise that, it does not matter what the company technology is, but that the company's core values and the way these values are exploited is critical.

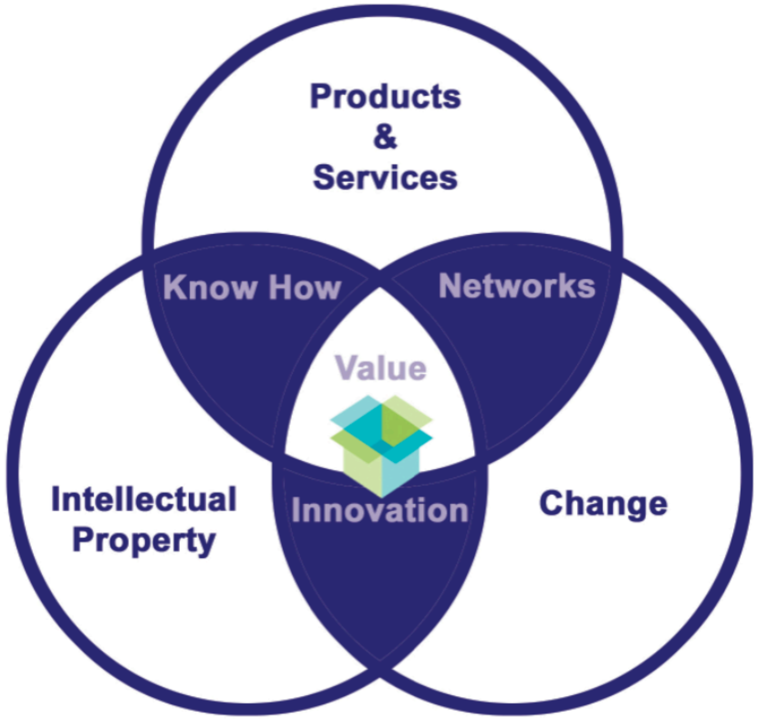

Figure 4: Ideas-lab value innovation model

The ‘fresh eyes’ approach whereby companies are analysed without prior knowledge or understanding of techniques or prior art has proved one of the greatest strengths of the process. A general enquiry question asks ‘What can you do with this technology?’ This question has revealed many opportunities regarding the development of new applications for existing technology utilizing the core IP and company strengths in different ways.

12 of the 34 companies (including 3 businesses with over 100 employees) were encouraged to develop their brand strategy and where appropriate product themes. The researchers found that some product ranges and services were poorly described and promoted to the intended customers, here a clearer marketing message was required to make it easier for clients and customers to see the specific value on offer and remember it. Numbers identified some products and some services were described by obscure names. Company 3 however, created a theme throughout their range, each product being named after a rank in the army, navy and air force such as admiral or colonel. The product range was instantly recognizable and stood out from the competition, more importantly these terms had entered the vocabulary of the company’s clients and the industry as a whole. 30% of companies did not own trademarks for their products and services, this was due to cost or a lack of understanding. Where brand names were identified, trademarks were recommended to prevent ‘passing off’.

30% of companies analysed were found to have issues directly relating to current management and the management structure. In two cases it was difficult to communicate these issues to the individuals involved and the COI report provoked something of an explosive reaction.

The ideas-lab process as outlined was found to be of most significant value to the following categories of company:

- **SMEs** wishing to diversify, expand or maximise the use of their technology and intellectual property

- **Start-up companies** seeking independent appraisal
- **Pre start-up or Spin-outs** focussed on commercialisation of new technology and intellectual property

This is possibly due to the strategic focus of the ideas-lab star model (figure 2) as outlined above. Company 22 summarized the value of the process, stating, "The Ideas-lab process helped us to recognise untapped commercial value in our technology and our expertise" whilst Company 28 endorsed the process describing it as “a valuable service which we thoroughly recommend". Many of the businesses analysed responded to the cornerstones of innovation report by asking the researchers for further assistance to capitalize on the value opportunities revealed by the process. In some cases this has led to the development of a second stage of involvement focusing on the implementation of strategic recommendations and in particular the relationship of the value proposition and route to market. Whilst the initial ideas-lab enquiry stage 1 (figure 5) is typically 6 researcher-days, stage 2 requires around 30 researcher-days over 2 to 3 months to develop a strategy that can be implemented.

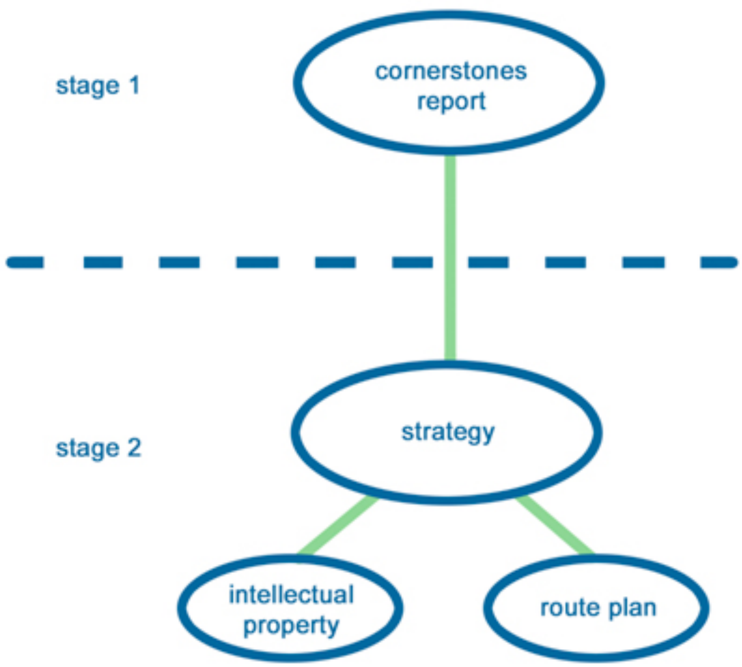

Figure 5: Ideas-lab two stage proposition.

This investigation has been focused on the commercial needs of business to capitalize on technology and know how in order to generate revenue. Through the process described the researchers have endeavoured to connect company technology and know how to commercial opportunities based on value proposition and route to market. The individual strategies were constructed around the ideas-lab framework and whilst every company was different, patterns and common attributes are beginning to emerge. The team aims to carry out further investigative research in this area.

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A specialist in design practice innovation Stuart is director of the Ideas-lab at Northumbria University. His work on relational problem framing has initiated new methods, new products and new IP through an inclusive approach based on design led entrepreneurship. This addresses multi and cross-disciplinary contexts bounded by clarity of market objectives, and has led to numerous new companies and filed patents.

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Looking to the future; a response to the challenges of design education in the 21st Century using C&IT

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Abstract

In response to increasing student numbers in practice based subjects, an ongoing project to develop online learning support materials for a BA (Hons) Fashion Design programme is exploring ways in which video based resources, in conjunction with virtual learning environments, can support practical demonstrations. Intended as complimentary learning support materials, rather than replacing face to face demonstrations in taught sessions, this project investigates the ways in which students respond to the learning materials, and preferences they show for the different methods of learning used within a practice based setting.

Keywords

Pedagogy, Fashion, ICT, Virtual environment, Usability, Experiential knowledge, Learning, Project-grounded research

Today, universities in the UK are experiencing new challenges in the face of increasing student numbers; traditional methods of learning and teaching are being reappraised in a context of higher staff: student ratios and the drive to increase efficiency. Universities UK (online 2009) state that there was an increase in student numbers of 47% between the academic years 1994/95 and 2007/08, and that the average staff: student ratio in UK universities is now 1:16.8 (online, 2010), and likely to increase. This is not a situation that is exclusive to art and design subjects, but it does raise some interesting challenges in subjects where traditional methods are undeniably staff intensive. In response to this, there is a necessity to re-evaluate these traditional learning and teaching methods, and to develop the future of design education.

There has been a significant amount of work done concerning the variety of ways that people learn in the broader context, notably seminal texts by Kolb (1984), Honey and Mumford (1982), Entwistle and Ramsden (1983), but there is also a developing field of interest in the pedagogy of art and design subjects in particular; studies discussing and analysing the particularities of the methods used in these disciplines have been conducted by a growing field of researchers, including Davies (2000), Drew (2002), Jackson (1997) and Swann (2002) to name but a few. Indeed, Swann's article *Nellie is Dead*, originally published in 1986, highlights the fact that the challenges facing design education today are not a recent phenomenon, but have been developing over the last few decades. Phenomenographic studies have been conducted by both Davies (2000) and Drew (2002) to assess design students' approaches to learning, and also to compare or contrast these approaches with students' approaches to learning in other disciplines. Davies and Reid (2000) draw comparisons with Gibbs' (1992) conceptions of closed (surface) or open (deep) approaches to learning and to teaching, and also question some of the methods used in design teaching as not explicitly encouraging an 'open' approach to learning. Clearly, in the context of the higher staff: student ratios of contemporary university life, there is a necessity to promote a greater degree of independence from design students than in the past, rather than continuing with the 'sitting by Nellie' approach that Swann (2002) questions. It is in this context that a pilot project began, with a view to enhancing the student learning experience within the Fashion Design BA (Hons) programme at the University of Leeds, by developing online resources to support student learning, while addressing the issue of reduced staff contact time per student in a practice based subject.

Rationale

With the ethos of "facilitating learning" rather than 'teaching', the idea of this project is to provide supporting information in an accessible environment that the students can use as and when they require it. It was deemed essential that the resources tied in directly with what was being taught in class, but also needed to be more 'flexible' than the traditional demonstrations. The emphasis of the project is that the online materials provide additional support material for students in practical modules, and are not intended to replace face-to-face demonstrations in taught sessions. The project also aims to address the need for students to acquire certain skills in order to be competent in their understanding of the design process, but also to promote a degree of independence in their approach to skill acquisition and practice.

Key to understanding the practice of Fashion Design, students on this programme undertake a module (in years one and two) in Garment Technology, which encompasses flat pattern cutting and sample or garment construction. Practical demonstrations form an important part of the learning process in this module, and are the basis of both the pattern cutting and the garment construction work, in conjunction with using worksheets developed for the module and textbooks. As the garment construction demonstrations traditionally take place around a sewing machine, space and visibility can be a problem, so students can fail to benefit from important details because they cannot see or hear clearly. Due to the nature of these demonstrations, they cannot be quickly or easily repeated due to the need for preparation time. The rationale for change in this project was therefore to improve support for these practical demonstrations by using C&IT to enhance the student learning experience.

Methodology

Initially a small number of video based learning resources were created to support student learning in studio based modules in Fashion Design, particularly at level 1. Initial experiments with videoing the demonstrations highlighted the need to modify the way that these demonstrations were carried out for video; it was very difficult to see what the operative in the video was doing in detail as thread and interlining colours blended in with the fabric, whereas on video the visibility of detail was crucial. Strong colour contrasts were found to work effectively on camera, so matching threads and interlining were substituted with contrasting colours. There also needed to be detailed planning of camera angles and close ups to highlight important points in the sample construction process. Professional help was sought to edit the videos, meaning that technical issues such as matching the pace of the visuals with the voiceover (recorded separately) were easy to overcome, as well as being able to enhance the video footage with effects and graphics, for example being able to highlight important aspects of the demonstrations.

The videos are viewed through an "accessible multimedia player" called Webducate AMP. Of particular interest with regards this project was the option for students to see and print a transcript of the audio script, as this provides a good level of support for a variety of learning styles as well as addressing accessibility issues. The videos can be paused, rewound and replayed as many times as each student requires, and can be viewed full screen if the text is not required by the side of the video. Taking into consideration the different learning preferences of the students on this module, it is intended that the online video demonstrations provide support for as many of these preferences as possible. VARK (Fleming & Mills: 1992) is an interesting tool which provides users with information on their learning preferences through a series of questions based around learning styles. VARK describes people as having learning preferences under the following headings:

- Visual (learning by videos, pictures, diagrams, graphs etc)
- Aural (listening to information)
- Read / Write (list-making, note-taking, essays etc) or
- Kinesthetic (trial and error, hands on practice, learning by doing)

Someone with a mixture of some or all of these preferences, is said to be 'Multimodal' (and 60% of the population are said to fit into this category). In the context of this project, students with Visual learning preferences will be well supported both in the traditional practical demonstrations in this module and also by the additional visual information in the videos (with the added advantage of being able to pause and replay the videos). Those with Aural preferences will benefit from verbal instructions both in class and also with the carefully planned audio script that accompanies the videos. For the Read / Write students, the online videos will be a real advantage, as there is no written information given with demonstrations in class, but there is a clear transcript of the audio which accompanies the videos. The students with kinesthetic preferences will benefit most from putting their knowledge into practice by making up the samples themselves.

The video demonstrations were made available to students through the University's Virtual Learning Environment (VLE) alongside other module learning resources, enabling them to become part of a package of online materials to support student learning in this module. Virtual Learning Environments are increasingly being used by universities to make module materials available to students online, as well as allowing tutors to provide materials in a range of electronic formats. An article in the Guardian newspaper (Hoare: 2006) states that *The distinction between distance learning and studying on campus is becoming increasingly artificial. While providers of distance learning such as the Open University are boosting the quantity and quality of face-to-face seminars, traditional bricks-and-mortar institutions are supporting students on and off campus through virtual learning environments (VLEs) based on commercial or open access platforms.* Certainly, in the context of higher student numbers, using C&IT to provide additional support to learners makes sense on a number of levels. Furthermore, in this digital age, these resources may be key to ensuring that students' expectations of support are being met.

The questionnaires

After the initial trial period of the pilot project, students were asked to complete a questionnaire during a taught session to gain feedback on their responses to the online learning materials. This method was chosen because of the ease of dissemination, and the higher likelihood of questionnaires being completed and returned during a taught session. The questionnaire allowed students to reply anonymously, and 29 students completed and returned the questionnaire. The questionnaire itself comprised a series of eight short sections, the majority of which required scaled responses rating difference aspects of the online materials, such as how easy the resources are to find, how the different methods of delivery for the module compare with one another, and how useful the different functions on the site were. There were also opportunities for further comments during the questionnaire to encourage students to share their experiences of using the resources, and therefore inform future practice.

Initial feedback from students using the online materials was generally very positive, indicating that students made good use of the online resources. When asked about whether the students had made use of the video demonstrations, 76% said that they had and a further 10% said that they were aware of the online resources but had had difficulty using them. Students' overall impression of the site where the video resources were accessed was generally good to excellent, with a strong positive trend. Again, there was a strongly positive trend when asked how easy it was to find the resources within the VLE site, with 36% saying that this was 'very easy' and a further 44% saying that it was 'easy'. Students were then asked about how useful they found each of the four video demonstrations available to them. Again, there was a strongly positive trend towards 'very useful' and 'quite useful', but with distinct preferences towards two of the four videos, as is seen in Figure 1 below.

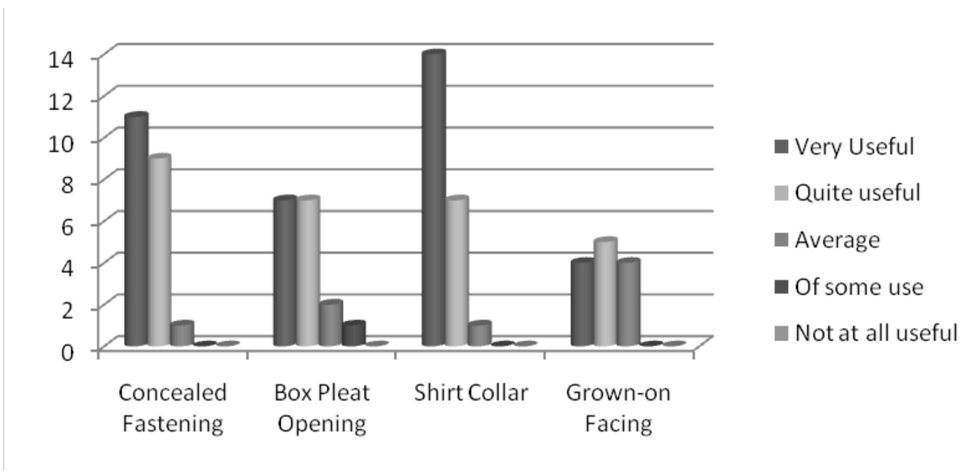

Figure 1. Student preferences towards the video content available to them

It is thought that this is because these two videos dealt with concepts that student found more difficult to grasp, therefore the opportunity to replay these videos helped them to understand the manufacturing processes involved in these samples. Indeed, when asked to give further comments in this section of the questionnaire, the following responses were given:

'Maybe more of the more complex methods could be added'

'Shirt collar was especially good'

'Shirt collar was useful'

Students were then asked about their learning preferences for the following forms of delivery: a) demonstrations in studio, face to face; b) video demonstrations, online; and c) text / voiceovers from the videos online. There was little distinction in the preferences shown between the different methods of delivery, as can be seen in fig. 2 below, but it appears that there was a slight trend towards students finding the video demonstrations easier to use than the demonstrations in taught classes.

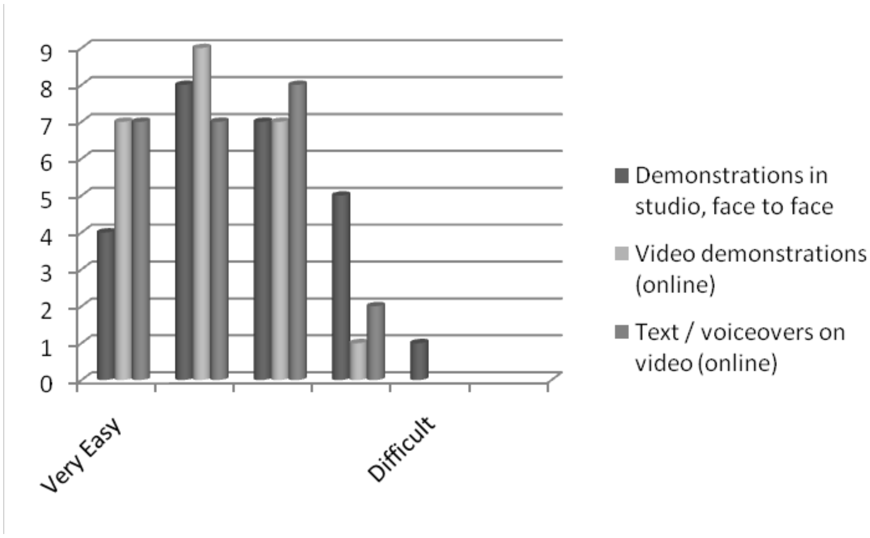

Figure 2. How easy do you find it to learn using the following forms of delivery for this module?

The transcript of the videos was thought to be ‘very useful’, with 73% of students selecting this option. A further 23% thought the transcript was ‘quite useful’ as seen below in Figure 3. However, when asked whether they used the option to be able to print this transcript, only 4% of respondent said that they used this option. This could indicate that written instructions are of most help when accompanied by visual information, but are not deemed to be as useful in isolation.

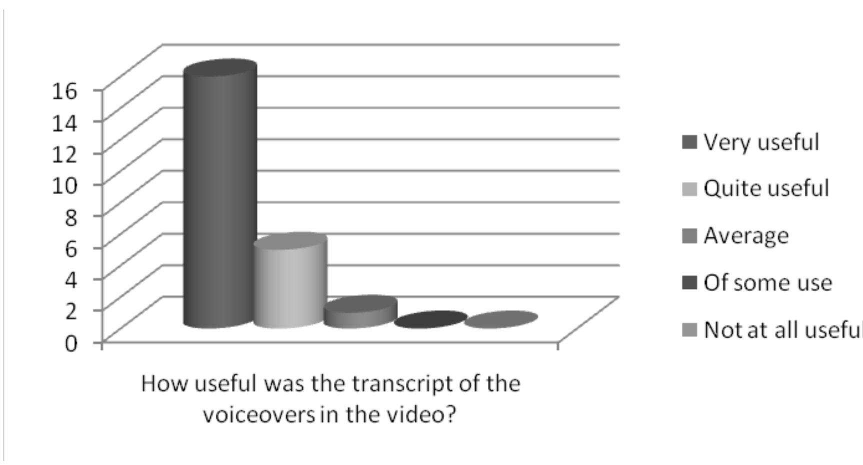

Figure 3. Students’ views on the written transcript of the audio voiceover.

When asked for comments about how the video demonstrations compared with face to face demonstrations in class, some of the comments given were as follows:

‘Able to go back and listen / watch again, so better in that respect’

‘You obviously couldn’t ask questions, but being able to replay parts was helpful’

'Much easier because during class demonstrations it's difficult to see an sometimes hear'

'Can go at your own pace, can repeat if unsure'

'It was easier to see what was being done'

'There was a clear view of what needed to be done. Detailed'

'Not as good as face to face but still useful'

'It was easier to understand as it seemed like a one on one demonstration'

'I prefer to watch a real demonstration'

Indeed, when asked for further comments about the advantages or disadvantages or problems that students encountered with the videos, responses were again very positive, with some students stating that they would like there to be more videos, or videos added on pattern cutting as well as the make-up of samples. Within this cohort of students, only one student stated that they had a visual or auditory impairment that might affect their ability to use web based resources. The student gave no further details about this, but did state that they found the site easy to use. Lastly, students were asked for any final comments about what they would like to see added to the online resources. Examples of the comments received include:

'more demos of different products'

'notes on techniques'

'larger videos'

'more written instructions for all'

'examples of [research] boards and some construction notes'

It is clear from the responses received that students made good use of the additional resources available to them, and that they wished to see the video resource expanded to include further demonstrations, as well as other online resources to support their learning in the garment technology module.

Due to the positive nature of this student feedback, further work was planned on the project. In the second stage of the project Health and Safety training videos were developed to improve Health and Safety provision for practice based modules at all levels of the Fashion Design programme, and with a view to improving students' understanding of how to safely use the three key pieces of equipment in the practical studio. Using the same format as the previous video demonstrations, three videos were planned, then filmed and edited with professional help. One feature of the VLE where the videos are accessed is that tests can be linked with the video files, to assess students' understanding of what they had just watched. In order to promote the use of these videos, 'adaptive releases' were set on the video files and the tests, so that students would not be able to access all other learning materials for the module (including video demonstrations which accompanied the garment construction demonstrations in class) until the videos had been viewed, and the tests completed. Students were asked to watch these videos and complete the tests during the first two weeks of the semester, with instructions on how to do so being given verbally in taught sessions.

At the end of the semester in which the second stage of the project was launched (2 years after the initial pilot project), the group of students involved were asked to complete an updated version of the original questionnaire, and 33 students responded on this occasion. This was a different cohort of students from the students questioned about the pilot project; they had no previous experience of the resources that pre-date the health and safety videos, tests and adaptive releases. In this cohort of students, only 56% of students stated that they had used the resources, 28% said that they had had difficulty using the resources, and 16% said that they had not used the resources. This is a lower uptake than in the first stage of the project, with significantly more students having difficulty using the resources. It is thought that the 'hurdles' put in the students' way, through the use of adaptive releases for the videos files and tests discouraged the use of the resources in some cases. It is worth noting that the ease of access to the 'learning support' files (which related directly to content in class) does seem to have had a significant impact on the percentage of students choosing to use the online resources; this should inform future practice, where more guidance will be given to students when introducing the resources.

Students' overall impression of the site where the video resources were accessed was generally average to good, with a slightly positive trend. Again, there was a slightly positive trend when asked how easy it was to find the resources within the VLE site, with 9% saying that this was 'very easy', 52% saying that it was 'quite easy', 27% saying it was 'average', 12% saying that it was 'quite difficult', and no students saying that it was 'very difficult', as seen in Figure 4 below.

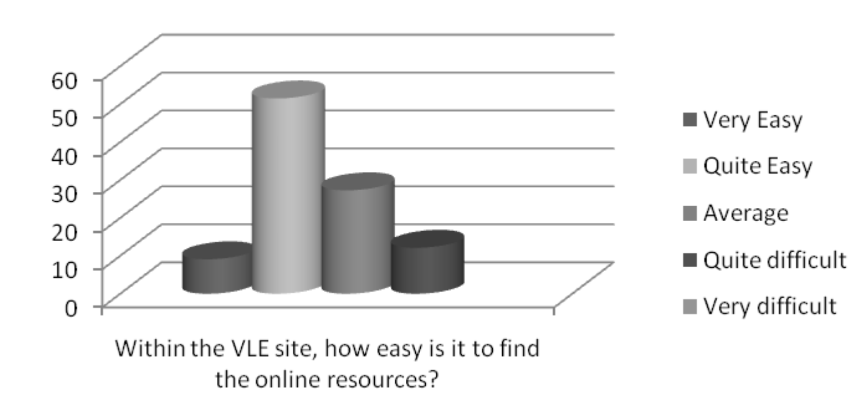

Figure 4. Students' opinions on ease of locating the resources online

Some comments received in this section of the questionnaire are as follows:

'Should be made easier to access and look for'

'Clearer layout and clearer instructions on where to go to find what you are looking for'

'More obvious links to online demonstrations'

It is thought that clearer signposting within the VLE itself, as well as written instructions offered to students in class on how to access the online resources could quickly resolve the problems that students have experienced. Students were then asked about how useful they found the four garment construction video demonstrations. As in the previous cohort of students, there was a positive trend towards the videos being 'quite useful', but the responses were slightly less positive than in the previous feedback. Again, the same preferences were shown towards two of the four videos that had been favoured by the previous group of students, as seen in Figure 5 below.

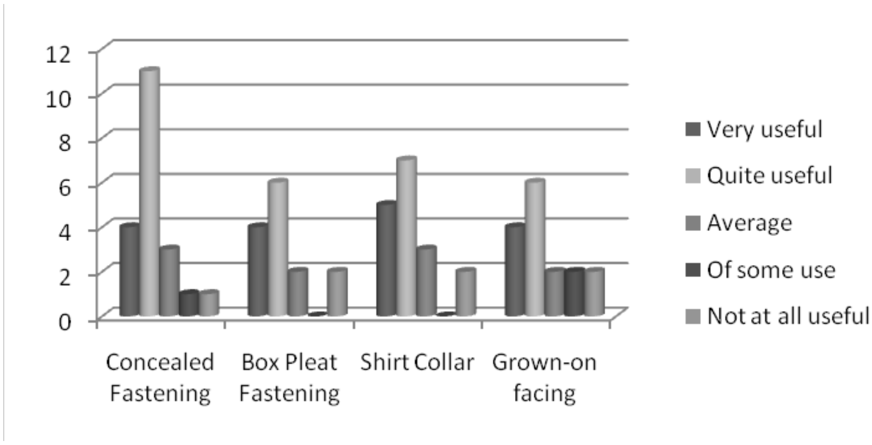

Figure 5. Students' preferences towards the video content available to them (second cohort of students)

In this second set of feedback, when students were asked how easy they found it to learn using the following forms of delivery: a) demonstrations in studio, face to face; b) video demonstrations, online; and c) text / voiceovers from the videos online, there was a slight preference for face to face demonstrations, followed by video demonstrations, and lastly text / voiceovers on the videos, as seen in Figure 6 below.

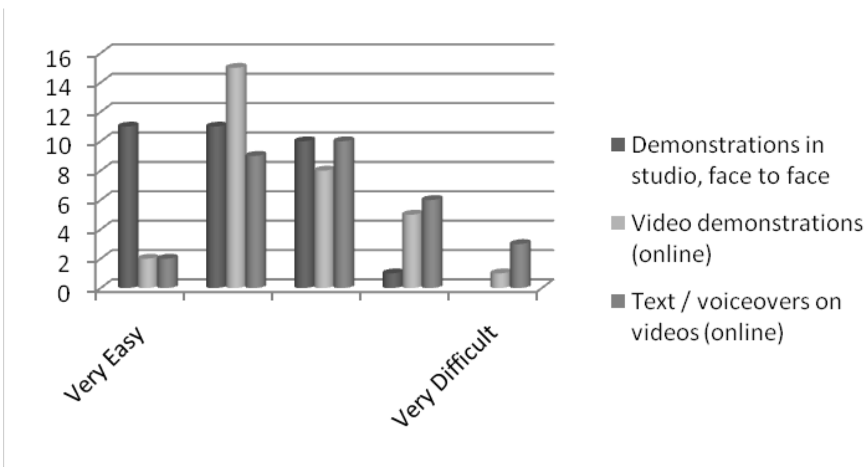

Figure 6. How easy do you find it to learn using the following forms of delivery for this module? (second cohort of students)

More students used the option to print the transcript in this set of data than in the previous set, although this was still only 23% of respondents. The transcript of the videos was thought to be 'very useful' by 33% of students, 'quite useful' by 41% and 'average' by 22%, with 4% of respondents finding the transcript 'not at all useful'. Again, this is a less positive trend than in the first set of feedback on the resources, as shown in Figure 7 below.

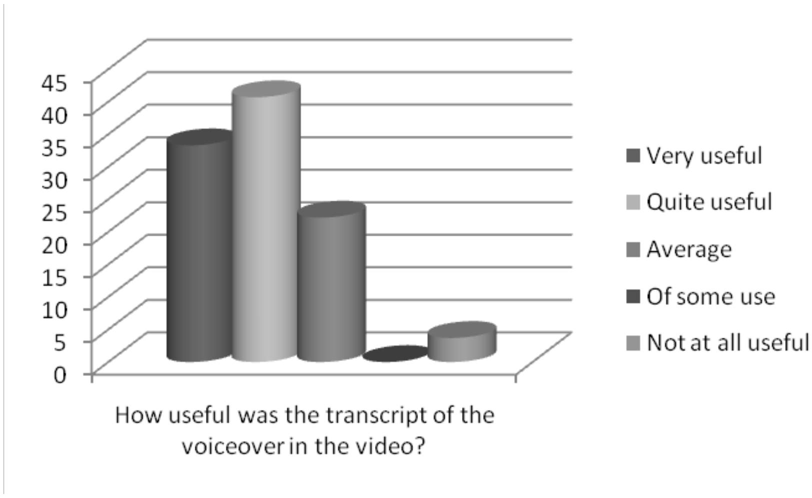

Figure 7. Students' views on the written transcript of the audio voiceover (second cohort).

Comments received from students regarding how the video demonstrations compared with face to face demonstrations in class include:

'It was good to have the transcript to remind me of the face to face demonstrations, but not as good on its own'

'Face to face was more applicable – mentioned problems that might occur etc'

'Easy to read and recap in case I missed anything during the tutored sessions'

'Was only more useful because you can follow it in your own time'

'I prefer face to face demonstrations as I can ask questions'

'I preferred the face to face contact however it wasn't always easy to see as everyone crowds round'

No students in this cohort stated that they had a visual or auditory impairment that might affect their ability to use web based resources. When asked for final comments about what students would like to see added to the online resources, these included:

'Examples of previous work'

'The construction of patterns as well as garments'

'Need all demonstrations on with written instructions'

'Access to all without having to complete tests'

In general, the second set of responses received from students was less positive than the first set. This may partly be due to students feeling that obstacles, in the form of the health and safety videos and tests, had been put in the way of them accessing the learning materials for the module. There were also some technical difficulties during the semester concerned in the second set of feedback, which limited access to the resources for some students. However, it is expected that by providing more explicit instructions to students on how to access the video demonstrations, these problems can be at least partly resolved. One important, and somewhat expected, point that comes from the student feedback is that students see the value of these resources as a support mechanism for the instruction they receive in taught sessions, and not as a replacement. The students seem to value the significance of having face to face contact with staff, and the two way discussion that this can and should promote. It is also important to note that there is a balance to be struck with any such web based resource; the materials should support and engage student learning in an independent and active way, rather than encourage passivity towards the learning process. Some students suggested that all of the demonstrations for the module should be made available online to support them, but conversely, by making only selected learning resources available to students, possibly by facilitating learning of the more complex concepts, this may promote a better learning environment, as students will need to make some leaps of understanding for themselves.

Conclusion

Using VLEs to support the learning experience of students in any discipline has clear advantages, but particularly in practice based subjects, where blended learning resources would seem to be particularly applicable. Using C&IT in this way can help to manage the need for additional student support outside of taught sessions, as information is available to students in an accessible and flexible environment, enabling them to take responsibility for their own learning. However; video based learning materials can be costly and time consuming to produce, so careful and strategic planning is needed to produce resources which will be of most use to the target audience. If the correct balance is achieved, then the resource can be of use year after year.

Work on this project is ongoing, with a view to developing a more comprehensive resource to support delivery of practical modules at all levels of the Fashion Design programme, and move towards a more contemporary and innovative approach to teaching practice based modules which are traditionally staff intensive.

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Influential Elements of Creativity in Art, Architecture, and Design Creative Processes: A Grounded Theory Analysis

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Abstract

Creativity in art, architecture, and design was investigated in this analytical study through the qualitative research methodology of grounded theory. A data set comprising published interviews with eighteen eminent creative artists, architects, designers, and leaders of creative organizations was analyzed to generate an initial grounded theory model for the creative process phenomenon of generating creative insights. Five influential elements to the creative process were identified from the analysis: sources of creativity that yield creative insights; strategies that instigate creativity; influential factors that drive creativity; individual and collaborative modes of working; and characteristic qualities of creative results. The analysis presented is part of doctoral research in progress in its early phase.

Keywords

Creativity, Design process, Design pedagogy, Art, Architecture

Creativity has been defined by cognitive psychologists as "the result of convergence of basic cognitive processes, core domain knowledge, and environmental, personal, and motivational factors which allow an individual to produce an object or behavior that is considered both novel and appropriate in a particular context" (Ward & Saunders, 2003, p.862). It is regarded as the quintessential element to the process of innovation, which is where creative ideas are actually implemented (Mumford and Gustafson, 1988; Amabile, 1996). A common approach to the study of creativity was presented by Runco (2004) in his review of creativity research in the past twenty years through the discussion of four creativity elements: the creative person, process, product (results), and press (pressures on creativity). In this study, creativity in art, architecture, and design is investigated with a primary focus on creative processes following grounded theory methodology and a generative research approach in the early phase of doctoral research that aims to foster creativity in design process and design studio pedagogy.

In cognitive psychology literature on creativity, creative processes have been approached through various theoretical and scientific models of cognitive processes. Some cognitive models include the generative and exploratory sets of processes of the Geneplore model (Finke et al., 1992, Ward et al., 1997) and the analytic-evaluative processes of Basadur (1995), Houtz et al. (1979), and Perkins (1981). Other cognitive models are concerned, variously, with the idea formation processes of random variations and combinations and the evaluation processes of the chance-based theories of Campbell (1960) and Simonton (1988), the interaction between the primary processes of problem finding, ideation and judgment and the contribution of the secondary components of knowledge and motivation by Runco and Chad (1995), and other processes involving perception and information encoding discussed by Mumford, Baughman, Supinski, and Maher (1996) and Smith and Carlsson (1990).

In contrast to cognitive psychology, Demirkan and Hasirci (2009) argue that creative processes in design research have not been investigated as much as would be expected. They remark: “Although creativity is considered as one of the key concepts in design, designers neglected to make research on creativity for many years” (Ibid., p.294). Christiaans and Venselaar (2005) suggest that reliance on concurrent verbal protocol analysis in mainstream design research poses difficulties for inquiry into processes of creativity. They also point to the need for design research methods that can correlate the performance of designers - creative results - with the nature of design activities - creative design processes.

In this research, grounded theory methodology was employed as a qualitative research approach in this early phase of research of creative processes by examining commentaries and perceptions of exceptional creative achievers. Grounded theory is defined as theory generated from data systematically obtained and analyzed through the constant comparative method (Corbin & Strauss, 2008). The creative process phenomenon of generating creative insights is interpreted from grounded theory analysis of the initial data set comprising texts of published interviews with eighteen eminent creative artists, architects, designers, and leaders of creative organizations. Five interrelated elements of creativity that have influence on the creative process were identified through the analysis. The five elements are: sources of creativity that yield creative insights; strategies that instigate creativity; influential factors that drive creativity; individual and collaborative modes of working; and characteristic qualities of creative results.

Research aims and questions

This discussion presents a grounded theory analysis of reflections on creative process by well-known creative achievers currently active in the domains of art, architecture, and design. This initial study is part of the early phase of doctoral research that aims to develop a theoretical and conceptual understanding of creativity in design and design processes and to propose creativity-informed methods and strategies to foster creativity in design processes in the context of design studio pedagogy.

This grounded theory analysis is guided by three research questions: What are the major sources of creativity in creative practices? What are the common influential elements of creativity in the creative processes of artists, architects, and designers? How could better understandings of creative processes from creative practices help inform design pedagogy on how to foster creativity in design studio environments? Although the doctoral inquiry is focused on understanding the creative process in design, the creative processes in art and architecture are also examined based on the assumption that artists, architects and designers employ similar cognitive and creative processes as they produce creative results.

Research Approach and Methods

Data set

Published interviews with eighteen creative individuals and leaders of creative organizations well known for their creative achievements in art, architecture, and design domains were selected for this grounded theory analysis. The data set presented in Table 1 includes five artists, nine architects and designers, and four leaders of creative organizations. The creative individuals and organizations were selected by the process of theoretical sampling (Corbin & Strauss, 2008), which is achieved by constituting a heterogeneous sample of people who have experienced the phenomenon (of creative processes, in this case) and thereby best contribute to the development of its theory.

Data sources

The data sources from which the data set was constituted are published texts of in-depth semi-structured interviews and reflective writings of eminent creative individuals. Table 1 lists the creative individuals, their creative domains, and their data sources. Funtagawa (2002) and Meyers and Gerstman (2007) are the two major sources of most of the interviews with the selected creative individuals. In addition to these collections, Lindsey (2001) provides a second source for Frank Gehry, and Catmull (2008) is the source for Ed Catmull's own commentary.

The published interviews are a feasible alternative for what could be a very challenging task of scheduling on-site and/or in-person interviews with these hard-to-reach creative individuals. In Funtagawa (2002) and Meyers and Gerstman (2007), it was advantageous to have a group of diverse creative individuals responding to a similar set of questions so that answers could be easily compared and analyzed for patterns. It was possible, for example, to compare the creative process of a photographer and a sculptor to that of an architect or an automobile designer. Another advantage is that the content of these books provides appropriate quantity and quality of creative individuals' reflective commentaries in response to the research questions.

Category	Name	Creative domain	Data Source
Artists	Chuck Close	Painting	Meyers & Gerstman, 2007
	Dale Chihuly	Glass sculpture	Meyers & Gerstman, 2007
	Julie Taymor	Film, opera, & Broadway-show directing	Meyers & Gerstman, 2007
	Ilana Goor	Sculpture & jewelry design	Meyers & Gerstman, 2007
	Ken Heyman	Photography	Meyers & Gerstman, 2007
Architects & Designers	Karim Rashid	Industrial & interior design	Meyers & Gerstman, 2007
	Milton Glaser	Graphic design	Meyers & Gerstman, 2007
	Roland Heiler	Industrial design	Meyers & Gerstman, 2007
	Arata Isozaki	Architecture	Funtagawa, 2002
	Daniel Libeskind	Architecture	Meyers & Gerstman, 2007
	Frank Gehry	Architecture, interior, & furniture design	Funtagawa, 2002
			Lindsey, 2001
	Tadao Ando	Architecture & interior design	Funtagawa, 2002
	Steven Holl	Architecture & furniture design	Meyers & Gerstman, 2007
			Funtagawa, 2002
	Zaha Hadid	Architecture, interior, & industrial design	Funtagawa, 2002
Organizations with creative leaders	BMW - Chris Bangle	Automobile design	Meyers & Gerstman, 2007
	Infosys - Nandan Nilekani	IT consultancy	Meyers & Gerstman, 2007
	Morphosis - Thom Mayne	Architecture and interior design	Funtagawa, 2002
	Pixar - Ed Catmull	CGI animated motion pictures	Catmull, 2008

Table 1. Data set of eighteen creative individuals and data sources

Grounded Theory Procedures

The research methodology employed to analyze this initial data set is grounded theory. In this qualitative method, the analytic process is based on immersion in the data and repeated sortings, codings, and comparisons that characterize the grounded theory approach. Analysis begins with open coding, based on the examination and sorting of text into categories. Corbin and Strauss (2008) describe open coding as the process of "[b]reaking data apart and delineating concepts to stand for blocks of raw data. At the same time, one is qualifying those concepts in terms of their properties and dimensions" (Ibid., p.195). Analysis of key quotes guided the development of code, category, and subcategory labels. Open coding ends when categories are saturated, i.e., when no more new information can be added to categories. In this study, 12 major categories were developed: expressions of creativity; perception in creativity; creative process; creative habits; creative work environment; motivations; inspirations; influences; characteristics of creative results; individual and collaborative modes of working; and creativity contexts.

Open coding is followed by axial coding, which is the process of relating categories to their subcategories and testing their relationships against the data (Corbin & Strauss, 2008). Derived from the analysis, axial coding is presented as a diagram that identifies: 1) the core phenomenon of the creative process of generating creative insights; 2) the sources of creativity that yield creative insights; 3) the strategies or actions that stimulate creativity; 4) the contextual and intervening conditions that affect creativity; and 5) the attributes of the creative results as qualities ascribed to creative processes.

The final step is selective coding. It is the integrative process of selecting the core category, systematically relating it to other categories, validating those relationships by searching for confirming and disconfirming examples, and filling in categories that need further refinement and development (Corbin & Strauss, 2008). Alternatively, propositions or hypotheses may be specified to state predicted relationships. In this study, selective coding is represented through the narrative descriptions of the five elements identified earlier through axial coding.

Throughout the grounded theory process, analytic and self-reflective memos are generated in response to the process of open, axial, and selective coding. Analytic memos are related to the process of writing down questions, ideas, and speculations about the data and the emerging theory. Self-reflective memos are related to writing personal reactions to the narratives found in research data (documents, texts, other kinds of evidence). During the writing process, memos provide a firm base for reporting and reflecting upon on the research and its implications (Corbin & Strauss, 2008).

Results of Grounded Theory Analysis

Figure 1 presents the grounded theory model for the creative process phenomenon of generating creative insights, based on analysis of the data set. The model presents five interrelated elements that play important roles in the creative process. The five elements include sources of creativity that yield creative insights, strategies that instigate creativity, influential factors that drive creativity, individual and collaborative modes of working, and characteristic qualities of creative results.

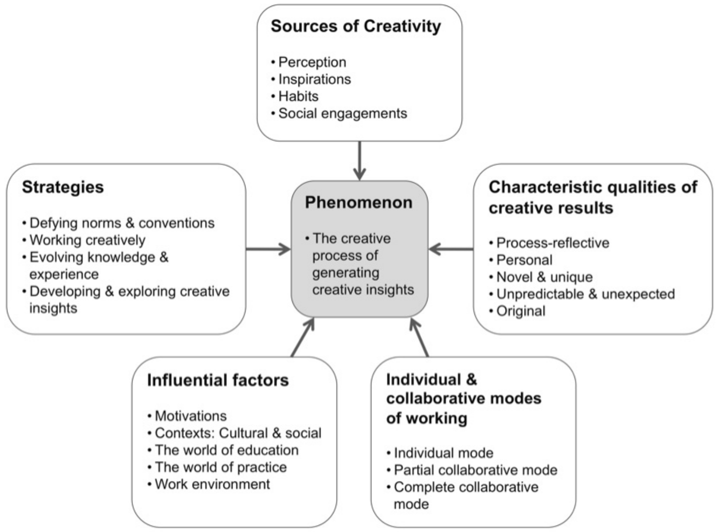

Figure 1. Five influential elements of creativity in art, architecture, and design creative processes derived from grounded theory analysis

The creative process phenomenon of generating creative insights

There is a general consensus among the creative individuals about what characterizes and constitutes a creative process. In general, the creative process is characterized as open ended, where anything is possible, and organic and non-linear, in which the process is not precisely planned and does not follow any pre-existing path. Creative process is perceived to be unpredictable where insights can emerge unexpectedly through mistakes or what Ilana Goor, a multi-media artist, calls "happy accidents." Dale Chihuly, a glass sculptor, considers accidents to play an important role in his creative process. He reports: "What may start as an accident sometimes becomes a valuable exercise and, by trying it over and over, can turn into something that you can control. So you might say that a lot of our work is the result of sort of controlled accidents" (Chihuly quoted in Meyers & Gerstman, 2007, p.38). This kind of work requires not only the ability to have a prepared mind to "see" or recognize the precursors of insights, but also the ability to choose what is important and worth pursuing as well as the ability to take risks.

The creative process is also perceived as a gradually evolving process where insights at the beginning of the process are not pre-conceptualized but rather emerge and constantly evolve – and are sometimes transformed into something completely different towards the end of process. This is expressed in relation to the process of iterations and reiterations with constant editing and refinement that requires lateral thinking, open mindedness, and flexibility for adapting to constant changes. Chuck Close, a painter, explains: "As I move along, I may do something that is wrong before it is right. Then I say to myself, 'Well, what do I need to do to move it closer to what I want?'… I put some color down, do something to it, and if I don't like those colors, I put in some other colors so my paintings gradually evolve to what I want... This is a very different thought process than conceptualizing something and then just executing it" (Close quoted in Meyers & Gerstman, 2007, p.140).

Sources of creativity that yield creative insights

Four sources of creative insights emerged from the data as major categories. These categories are perception, inspiration, habits, and the social engagement. In *perception*, creativity is conceived though the ability for the creative person to see, literally, more than what others see and the ability to perceive problems, challenges, projects, reality, and future, among others, differently than other people. These abilities are derived from the creative individual's cognitive capacity to break out of the habitual and preconceived ways of thinking, to see patterns of potential opportunity across many disparate things, to visualize a future by bridging gaps between different things that are unrelated, and to imagine and envision something new that is beyond the given for a particular project.

Other accounts for having different perceptions are related to the sudden acquisition of insights through new experiences of places or people. Daniel Libeskind, an architect, reports: "It was that instant encounter with the physical wall (of Ground Zero), with the sky, close to the bedrock, close to the space where thousands had died, and I saw the world in a different way" (Libeskind quoted in Meyers & Gerstman, 2007, p.52). Libeskind also comments: "It is often that I meet people by accident, or by chance, who give me a new way of seeing the world" (Ibid., p.51).

Inspiration is found to be another source for creative insights. Creative ideas, concepts, visions, and solutions are oftentimes stimulated as a consequence of either changing one's perception in response to experiences or meeting people – as mentioned above – or receiving new information from sources of inspiration. Three sources of inspiration are expressed by creative individuals in the data set. The first source is *process driven* where insights are surfaced through the incidents of mistakes and accidents. These incidents usually result through experimentations; drawing and prototyping; working with others; and from what annoys and what does not work during the process. The second source is *project specific* where insights are inspired through the discovery of a current project's sets of signs that are found, for example, in an architectural site or product constraints. Creative insights are also inspired by the knowledge and experiences gained from previous projects on which one worked or from successful precedential projects developed by other designers and artist.

The third source of inspiration is realized through the *direct encounter with the world.* This includes what creative individuals see or experience by coincidence such as objects, light, people's names; what they experience in their profession such as buildings, spaces, and products; what they engage with themselves, such as art galleries, music, reading a poem; and also what they experience through travel. Thom Mayne, a creative leader at Morphosis, remarks: "Traveling became a continual source of insight… there have been so many important moments for me… visiting the Mayan structures at Chitzen Itza and Coba… La Tourette… the densely layered spaces of the Saone House in London… this is the first time I had ever experienced architecture through smell and sound prior to vision" (Mayne quoted in Funtagawa, 2002, p.400).

The third source of creative insights is found to be originated through different *habits*. Ideas, concepts, visions, and solutions that sometimes emerge through the habit of externalizing ideas and first creative impulses through either intensive project-specific sketching at early stages of a process or through routine drawing such as the architect Steven Holl's one-hour morning paintings; open-ended drawing of ideas and observations from real-life experiences and thoughts, or from imagination. Chris Bangle, a creative leader at BMW, gives an example: "Like any designer, I take notes on what I see and think and make a lot of drawings. I fill my sketchbooks on what I see in life, what I think of and what I hear. I often sketch an idea that I think relates to something important at the moment and then I go back into the sketchbooks to refresh myself years later" (Bangle quoted in Meyers & Gerstman, 2007, p.168). These paintings, drawings and sketches are all considered second-memory banks of insights as well as references for future projects.

Other insights are developed through the habit of regular involvement and immersion in different creative cultures such as visiting art museums and galleries; attending concerts, theatrical performances, public lectures, and conferences; and experiencing buildings, spaces, and products. Other habits include collecting things of interest, being curious by reading about everything, and keeping busy with work as well as escaping time from work to do different things such as speculating, traveling, and meditating.

The fourth source of creative insights is rooted in the *social engagement* with other people. Different types of people reported as sources of insights. These are creative individuals admired by the artists, architects, designers and leaders of creative organizations who are influenced by throughout their careers; people they work collaboratively with whether in their own work environment or work environments of others; people they design for, such as clients and end-users; people they leisurely hang out with such as artists, musicians, and writers; and other people randomly encountered from life.

Strategies that instigate creativity

The phenomenon of the creative process of generating creative insights is explored here in relation to the strategies that the creative individuals developed to instigate creativity. Four core strategies were identified: 1) defying norms and conventions; 2) working creatively; 3) evolving knowledge and experience; and 4) developing and exploring creative insights.

Defying norms and conventions consists of three groups of strategies. The first group involves following and searching for new paths. Creative individuals expressed the importance of stepping beyond existing boundaries and rules to develop their own creative paths, alternatively defined as a different track of thinking and approaching problems and challenges marked by unconventionality that distinguishes the creative individual from others. One of their strategies includes not imitating others and staying away from influences that could blind the mind from thinking differently. Close explains: “The people who have been the biggest influence on me have contaminated my work, have contaminated my life and they have been hard to purge. When you love something, you want to incorporate it into your work. But then it’s not your work – it’s that other person’s work” (Close quoted in Meyers & Gerstman, 2007, p.137).

The second group of strategies is focused on challenging perception. Having the ability to be creative by “seeing” things differently involves the ability to break out or escape from the habitual or preconceived ways of thinking and working to discover things that are not apparent; and the ability to have a “prepared mind” to recognize and take advantage of accidents as they often lead to new insights. Perceiving differently also involves an ability for “visualizing a future that others don’t see.” Nandan Nilekani, a creative leader at Infosys, continues to elaborate: “In business, success comes when you see something – you see a pattern, and maybe you look at different things that are not really related – and when you look across those things you suddenly see a kernel of an idea” (Nilekani quoted in Meyers & Gerstman, 2007, p.55).

The last group of strategies under the core strategy of defying norms and conventions are related to having the courage to do what others normally avoid doing. These strategies involve audacity for taking risks; making mistakes; working with new, unconventional, or unfamiliar things; discarding used-up ideas even after spending a lot of time on them; and breaking rules. Strategies for dealing with rules include reinterpreting, ignoring, challenging, moving around, and not learning rules. For, example, in design creative processes, some individuals break the rules first to free their minds from conventionality, to discover new ways for approaching a challenge, and to find a creative insight; and then, they solve pragmatic problems later.

Strategies for *working creatively* represent the second core strategies that emerged from data analysis and they consist of two groups of strategies. The first group is related to the general means of approaching creativity in design practice. These strategies include combing and finding a balance between instinct and logic; experimentation and practice; and inspiration and pragmatics. They also include developing universal codes and guiding questions, those which help stimulate creativity without controlling the creative process, such as asking open-ended questions to locate the problem and asking questions nobody else can answer to generate a problem rather than to solve it. Other strategies also include taking time off from work allowing for incubation. Libeskind comments: “It’s not a time of escapism, but a time that I use to create buildings – which I do when delving into a poem, doing some music, walking on a street or just lying under a tree” (Libeskind quoted in Meyers & Gerstman, 2007, p.55).

The second group of strategies, however, involves specific strategies for working creatively with others. These strategies include forming teams with individuals that complement each other with balance in talents, skills, and in some cases gender; assembling interdisciplinary incubation teams that work well together; forming committees of creative peers that help teams with feedback on work in progress; and forming daily review sessions where everyone can share their work and comments and feedback on others in a positive way. Ed Catmull, a creative leader at Pixar, describes some benefits for the daily reviews: “Showing unfinished work each day liberates people to take risks and try new things because it doesn’t have to be perfect the first time” (Catmull, 2008, p.70).

The third core strategy is focused on *evolving one’s knowledge and experience*. Domain-specific as well as other types of knowledge and experience are found to play an important role in creativity. Across all creative individuals; some strategies include learning from bad work; immersing oneself in the field to gain up-to-date knowledge; learning through the bodily experience with buildings, spaces, products, music, and art, among others; and exposing oneself to different cultures, societies, and domains through travel and forming relationships with others such as artists, designers, and musicians. Some creative leaders such as Mayne from Morphosis and Catmull from Pixar stress the importance of maintaining strong academic contact for many reasons including staying close to innovations happening in academic research communities and attracting exceptional talents.

Strategies for *developing and exploring creative insights* constitute the fourth set of core strategies emerged from the grounded theory analysis. Some strategies for developing creative insights include working with initial gut ideas and other ideas generated through the different sources of creative insights. This includes, for example, ideas from the unconventional perception of “seeing” beyond the given; the habit of collecting interesting things and going to museums; the social engagement with artists, musicians, and co-workers; and the inspiration from an “angle of light that fell on a wall at a certain time of the day” (Libeskind quoted in Meyers & Gerstman, 2007, p.46).

Strategies for exploring with ideas, on the other hand, include testing and experimenting with the initial gut insights and selecting the ideal concept(s), idea(s), or solution(s) after developing a large number of alternatives. They also include discarding insights that do not work or evolve into creative ones even at later stages of the process; exploring insights through iterations; and involving others in the process.

Influential factors that drive creativity

Three types of interrelated factors were identified from the data analysis to have influences on creativity. These factors are: motivation; the contexts of culture and society; the contexts of the world of education and world of practice; and the work environment. The three factors are discussed here in parallel, for their possible mutual influences.

Three types of motivations emerged: intrinsic, extrinsic, and a combination of both. Intrinsic motivations are considered as the inner drive of passion, desire, curiosity, joy, thrill, and excitement for creating new things, seeing things manifested, and "living the dream." Extrinsic motivations include gaining confidence and support from others whether through public and private commissions, social acceptance, validations and acknowledgments, or success. The third type of motivations, however, emerges as the inner impulse and desire triggered by something in the culture or someone in society. This includes the pride and original contributions to the domain culture and society, the new experiences and positive influences on people's lives, and the creation of value whether business or social.

The three motivational factors of creativity can be nurtured or diluted through the three contextual factors of culture, society, and the world of education and practice. Some contextual examples given by the creative individuals include market and business support or resistance, in some situations, to innovation; society's conformity in schools, work, and the way of life; society's misconception and lack of understanding of the importance of time and fund investments in creativity; and the social consensus among creative communities for innovation. From the context of education and practice, there is a common agreement among many creative artists, designers, and leaders that the cultural context peripheral to education is as important as education itself. Motivations in this context can be nurtured through the students' exposure to different disciplines in and outside of school and the students' involvement with design practice culture and society.

In the work environment, however, a supportive environment is considered one that prioritizes creativity over authority of precedents, encourages interdisciplinary and democratic engagement and collaboration with others, and inspires learning and exploration. In Pixar, for example, Catmull explains: "What we do is to construct an environment that nurtures trusting and respectful relationships and unleashes everyone's creativity. If we get that right, the result is a vibrant community where talented people are loyal to one another and their collective work, everyone feels that they are part of something extraordinary, and their passion and accomplishments make the community a magnet for talented people coming out of schools or working at other places" (Catmull, 2008, p.66-67).

Individual and collaborative modes of working

Three types of modes of working emerged from the grounded theory data analysis: individual mode, partial collaborative mode, and completely collaborative mode. In general, working individually or collaboratively with others depends on several factors such as personal preference of whether collaboration can to be perceived as productive; the desired type of contribution whether it is for a task or idea contributions; and the nature of the process itself whether it requires one or several individuals. It is more common for artists to work individually than designers. In some cases, working individually is perceived to be more productive, e.g., Goor comments that "[w]hen you're with other people, it's wasting time. It's alright to talk and laugh and eat with them, but when you do something on your own you start really thinking and new ideas are developed" (Goor quoted in Meyers & Gerstman, 2007, p.210). For others, it does not make any sense to collaborate, for example, in taking photographs, painting, or sculpting except for collaborative type of projects and labor-related tasks and assistance.

In contrast to artists in general, designers tend to work more collaboratively with others. This collaboration, however, is partial for the majority of designers and the extent to which others are involved in the process varies. Most designers prefer working individually at the beginning of the process to focus and generate their own ideas through what they do best such as experimentation, sketching, and rapid prototyping and then involve others throughout the different stages of the process. Karim Rashid, an industrial designer, explains: "After the sketch stage, I sit with my senior staff, show them my sketches and tell them about my ideas. Then after listening to their opinions and their feelings about them, we edit them down to maybe five, six, or seven best ideas… Their [the interdisciplinary team's] contributions include defining and refining my ideas, doing the computer aided drawings, handling the presentation renderings and a lot of other follow-up tasks" (Rashid quoted in Meyers & Gerstman, 2007, p.232). Other designers, on the hand, only collaborate with others at certain stages such as the initial idea generation and problem definition stage or when there are specific needs or goals to be accomplished at different stages.

In creative organizations like Pixar and BMW and for some designers, on the contrary, creativity is always produced through a completely collaborative mode of working. Roland Heiler, an industrial designer, contrasts himself from other solo designers: "As for myself, I've always been a team player. I'm not one of those designers who like to point to a product and say, 'Hey, look what I've created'" (Heiler quoted in Meyers & Gerstman, 2007, p.118). The creative individual's role in this mode of working, however, is shifted from being the individual sole creator to more of a creative leader. Some of the leader's roles include bringing a fresh set of eyes to the team; providing the means for ideas to propagate and grow; building common understanding in the work place with a consistent design strategy and a clear vision; establishing clarity, accuracy, and coherence between designers and the others; and being sure to acknowledge the effort of everyone in the team.

Characteristic qualities of creative results

"Embedded in the work itself are indications of the process. You can see what colors are underneath and you can see what colors are on top… You see it unfiltered and untranslated, as decisions being made in front of your eyes" (Close quoted in Meyers & Gerstman, 2007, p.140). Close is reflecting on the qualities of his creative paintings. Process-reflectiveness emerges as one of the qualities of creative results that mirrors the creative process through which it is conceived. Other qualities are expressed as being individual or personal, in which the work reflects the unique thoughts and feelings of the creative individual; novel and unique, in which the work does not resemble anything that existed before; and unpredictable and unexpected, which reflect the expectations that drive the process. It includes the 'nuance of originality' as Rashid expresses it: "My agenda is that I need to do something original or I don't sleep at night… Every project I work on must have some nuance of originality. The nuance could be that I find a new production method, or a new function, or a new material, or a new book. But for me, there needs to be some level of originality" (Rashid reported in Meyers & Gerstman, 2007, p.229).

Conclusion

The phenomenon of the creative process of generating creative insights in art, architecture, and design was investigated in this study through grounded theory analysis of data set of published interviews with well-known creative individuals. The creative processes of eighteen creative individuals were examined in relation to the different elements that play influential roles in creativity. Through the systematic qualitative research methodology of grounded theory, five influential elements of the creative process were identified: sources of creativity, creativity-oriented strategies, contextual and intervening conditions, individual and collaborative modes of working, and the attributes of the creative results.

This initial study is part of the early phase of a doctoral inquiry on fostering creativity in design pedagogy and design practice. The findings from this analysis of the commentaries and reflections of well-known creative individuals in art, architecture and design, and creative organizations will be brought together with future studies to originate creativity-informed methods and strategies that foster creativity in design processes and design studio pedagogy. The grounded theory analysis contributes to the basis for discourse analysis regarding creative processes, that will be developed based on synthesis from the interdisciplinary literature on creativity. The discourse analysis framework will inform empirical research protocols and analysis to understand creative processes in design pedagogy as well as foster creativity.

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Epistemological Positions Informing Theories of Design Research: Implications for the Design Discipline and Design Practice

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Abstract
Design research is not simply concerned with speculations regarding the relationship of theory and practice. Design research also brings out significant questions regarding the nature of research and the position of the doctorate in university education. This paper presents analyses of examples of objectivist, constructionist, and subjectivist theories of design research. The assumptions that underpin their perspectives are outlined, their powers of generalisation considered. The implications for the position of the design discipline in relation to the greater academic community, and the characterisations of design practice that they contain, are drawn out. The paper concludes by considering the pedagogical implications of the role of disciplines in the knowledge building cycle between research and professional practice.

Keywords
Pedagogy; Philosophy;

The issue of designing in design research is significant because it poses questions about the nature of research in general. This aspect of design research is centred on the question of the relationship between what we do and what we know. There are many different ways in which this question is raised in the design research literature, and many useful answers have been given. However, the significance of these answers is difficult to establish because their terms of reference are often unclear. A large number of different terms have been used to refer to designing in research and these terms are often used synonymously as methodologies, approaches, perspectives, and philosophies as if they are all comparable (Niedderer & Roworth-Stokes, 2007, p. 7). A framework that organises the epistemological aspects of design research is needed to make meaningful distinctions between the different positions.

A Knowledge Framework

Michael Crotty (1998, pp. 2-9) frames the research process by epistemology, theoretical perspective, methodology, and methods. Epistemology is the theory of knowledge that defines what kind of knowledge is possible and legitimate. Theoretical perspective is the philosophical stance that grounds the methodological logic and criteria. Methodology is the strategy that links the choice of particular methods to the desired outcomes. Methods are the techniques used to gather and analyse data related to the research question or hypothesis. The four parts of the framework are arranged hierarchically so that all the different methods are contained within three epistemologies: objectivism, constructionism and subjectivism.

Each epistemology contains assumptions about nature of the world and these assumptions are in turn embedded in the particular methods. For example, research conducted using the method of participant observation is one of many embedded within the methodology of ethnography, which has been adapted by symbolic interactionism, which is one theoretical perspectives within constructionist epistemology. It follows that the assumptions about how we know what we know that are embodied within constructionist epistemology are also embodied within the findings collected through the method of participant observation.

Crotty's knowledge framework suggests clearly defined distinctions between the three epistemologies, but it is important to recognise that within each category there are strong and weak versions. For instance, phenomenological research is categorized as constructivist; however, it is a broad term that can encompass approaches that range from thoroughly objectivist to thoroughly subjectivist. Consequently, it is important to note that each epistemology represents a spectrum of approaches rather than a homogenous class. With this qualification in mind, it is useful to identify the assumptions that underpin each epistemology.

Objectivism maintains that a meaningful reality exists independently of the mind, that entities carry intrinsic meaning within them as objects, and that we can discover this objective truth if we go about it in right way. Constructionism maintains that meaning is constructed through our minds interacting with the world, which implies that people in different cultures or eras construct meaning in different ways even in relation to the same phenomenon. Subjectivism maintains that meaning is imposed by people's minds without the contribution of the world, there is no truth or meaning independent of the mind. Crotty's framework usefully connects the theory of research to the practice of research, places the opposition of quantitative and qualitative procedures at the level of methods, reveals the assumptions that underpin particular research models, and identifies the limits of their generalizations.

Epistemological Positions in Design Research

In our recent literature review (Feast & Melles, 2010), we analysed a series of articles concerning design research using Crotty's framework as a reference point. The articles included in the review were selected from a bibliography of approximately 300 journal articles, conference papers, book chapters, and state of the art reviews. The bibliography was developed from database searches, existing design research bibliographies sourced from the World Wide Web, and from research and teaching experience. The articles listed in the initial bibliography were then verified and their ability to be accessed checked. The remaining 150 articles were then ranked by relevance according to key words, and then by the number of times each article had been cited in www.google.scholar.com. Twenty-eight articles were reviewed with the aim to explore the complexity of the issue, rather than seek statistical generalization. We identified articles presenting broadly objectivist (Bayazit, 2004; Durling, 2002; Durling & Friedman, 2002; Friedman, 2003; Langrish, 2000; Melles, 2009; Mullins & Kiley, 2002; Owen, 1998), constuctionist (Archer, 1995; Biggs & Buchler, 2008; Biggs & Büchler, 2007; Cross, 2001; Dorst, 2008; Frascara, 2007; Hockey, 2003; Hockey & Allen-Collinson, 2000; Margolin & Margolin, 2002; Pedgley, 2007) and subjectivist (Candlin, 2000; Cazeaux, 2008; Dilnot, 1998; Frayling, 1993; Gray & Pirie, 1995; Newbury, 1996; Prentice, 2000; Rust, 2002) models of design research.

The objectivist position is illustrated by Ken Friedman's outline of the conditions for theory construction in design (Friedman, 2003). Friedman maintains that theory construction involves systematically building knowledge through converting tacit knowledge into explicit knowledge. The constructionist position is illustrated by Nigel Cross's model of designerly ways of knowing (Cross, 1999, 2001). According to Cross, this model of design research is concerned with developing design knowledge through intellectual reflection upon making and using artefacts. The subjectivist position is illustrated by Christopher Frayling's model of research for art and design (Frayling, 1993). Frayling claims that a cognitive tradition of direct making which constitutes research can be identified and that research following this autobiographical approach is concerned with personal development. Each model contains epistemological assumptions (Crotty, 1998, pp. 7-9). Objectivist research distinguishes facts from people's everyday meanings. Constructionist research places all meanings, scientific and non-scientific, on an equal basis; all are constructions and none is truly objective or generalizable. Subjectivist research concerns personal expression and its claims cannot form significant generalizations. In addition to affecting the status of research claims, epistemological positions locate the research in relationship to the greater academic community.

The epistemological positions locate design in either Isolationist or Situated relationships with other disciplines (Biggs & Buchler, 2008, p. 6). The Isolationist position claims that design research is somehow special and should be granted special criteria and regulations. In contrast, the Situated position maintains that because design is positioned in a comparative competitive environment, it must place itself in relation with its peers by finding commonalities with the academic community as a whole. By arguing that direct making is research, Frayling (1993, p. 5) separates design research from established paradigms of research, therefore, research following his model of research for art and design takes the Isolationist position. Cross's emphasis on individual reflective practice would appear to place his model of design research within the isolationist position; however, Cross (2001, p. 55) explicitly acknowledges that the design discipline must embed itself within the intellectual tradition of the university and demonstrate standards and criteria match those of the other disciplines. This model takes the Situated position. Friedman's (2003, p. 520) model of theory construction based on explicit statements as the basis of research in all disciplines aligns his perspective with the Situated position. The relationship between research and the academic community also implies particular pedagogical forms within doctoral education. Doctoral research undertaken in a subjectivist mode emphasises research as a personal journey that gains knowledge for an individual, while objectivist oriented research places emphasis on training in transferable research skills.

The three models of design research also imply characterisations of design practice. Friedman's designer is a professional knowledge worker who addresses problems in many different knowledge domains. For Cross, the designer is a reflective practitioner who attempts to understand the meaning of her own work. Frayling's model envisages the designer as a lone creative genius. The models characterise designing as problem solving, reflective practice, or direct making. Problem solving and reflective practice focus on designing as a process, whereas direct making concerns the crafting of objects.

Design practice and design research

The object-centered approach grows out of the guild tradition, which transfers a rich stock of tacit knowledge embodied in the skills and techniques passed down from the master to the apprentice through many years of ritual and imitation. This tradition produces a form of habituated know-how that allows the individual craftsman to respond intuitively to specific situations. This form of tacit knowledge remains an aspect of professional practice today, however, modern education can not afford the decades of training that are required for traditional guild style craft education (Friedman, 1997, para. 66). Today, design education is changing from the object-centered master-apprentice model of the guild tradition to the theory driven problem solving approach characteristic of a university discipline.

Recent ethnographic research into modern design practice has revealed that designers do not work as lone creative geniuses, more often designers work collaboratively in interdisciplinary teams (Arias, Eden, Fischer, Gorman, & Scharff, 2000; Bucciarelli, 1994; Chiu, 2002; Guinan, 1986; Lauche, 2005; Minneman, 1991; Olson, Olson, Carter, & Storrosten, 1992; Sonnenwald, 1993, 1996, 2007; Walz, 1988). This change in design practice implies that the object-centered approach to design that underpins Frayling's subjectivist model of design research, no longer represents the reality of professional design practice. Design research concerning design "practice" undertaken within Frayling's subjectivist approach would then be subject to a series of misunderstandings (Krippendorff, 1995; Poggenpohl, 2009, pp. 15-16):

- Designers are lone craftsmen that create an autobiographical design. This myth denies the history of design as well as undermining teamwork and collaboration. In addition, challenges that fall outside the craft education paradigm are neglected.
- Designers are not analytical and aim at holistic responses. This implies that designers cannot break problems into sub-problems, so tend not to ask interesting questions and are unable to criticise existing research.
- Designers do not write. This has the consequence that seminal ideas and prototypes are not recognised, literature on design remains disconnected and that the domain of design knowledge becomes colonised by other disciplines.
- Designers endlessly search for the "new". Without a robust foundation of disciplinary knowledge, ideas are endlessly repeated, the process of knowledge building is not understood, and the accumulation of knowledge is impeded. In addition, science in misunderstood as expounding truth and certainty rather than as an evolutionary process.
- Designers should be competitive both inside the design profession and outside it. This misunderstanding resists community building and isolates design from other disciplines.

- Designers focus on the practice of doing design. This focus on doing design means that designers tend not to analyse why or how they do what they do.

Object-centered design work has been concerned the aesthetic aspects of products and so has tended to work towards the end of the development process after many of the key decisions had been made. Design as a process is more complex and requires knowledge and greater depth of expertise than a solo designer can ever individually possess. This forces designers to move beyond surface concerns with aesthetics to investigating what people actually do, what they value, and how they understand things (Poggenpohl, 2009, p. 19). This human-centered approach requires that designers work with sociologists, anthropologists, psychologists, engineers, and other stakeholders to understand the interaction between people and their environments. This also requires that designers participate in decision-making at the beginning of the development process, where the parameters of design problems are still undefined, and collaborate with different stakeholders. This change towards collaborative work implies that the skills and knowledge that designers need in order to collaborate effectively with stakeholders are different than those that characterize the object-centered craft tradition. The necessity of collaboration requires designers to possess the analytical, logical, and rhetorical skills that form the basis of a profession supported by a discipline.

Disciplines support professions by providing analytical tools to question assumptions and by developing generalized explanations, principals, and theories that can be put to use by people in other times and places. Disciplines work by building knowledge within the domains of their inquiry by scaffolding new knowledge on previous knowledge though criticism, application, and reflection. This process requires a cycle between tacit and explicit knowledge (Friedman, 2003, p. 520; Wenger, 1999). Because tacit knowledge is embodied in craft practices and habitual behavioral patterns, it must be converted into articulate statements in order to allow the construction of theories that can be shared, contrasted, tested, and reflected upon. Generating empirical evidence and developing generalizable answers allows designers to address timely problems rather than repeat past mistakes (Poggenpohl, 2009, p. 14). Building a rich stock disciplinary knowledge is essential to design because it forms the foundation from which collaboration can proceed.

Michael Middleton (1967, p. 103) identifies a number of different forms of collaboration in professional design practice including: forms of association between individual people; forms of association between independent firms within a single profession or independent firms in different professions; single practices in which different skills and disciplines are associated; single firms that practice a large measure of devolution, either geographically among their various offices or in the creation of semi-autonomous teams within one office; and offices organized democratically rather then hierarchically, in which decisions are reached through discussion by the group rather than passed down through a chain of command. These different forms of collaboration can be differentiated in terms of their relationship to disciplinary knowledge as multidisciplinary, transdisciplinary, or interdisciplinary.

Multidisciplinary work involves different disciplines approaching a problem in parallel or sequentially without challenging their disciplinary boundaries; transdisciplinary work seeks to unify disciplinary differences in a holistic way; interdisciplinarity works by integrating different disciplinary insights and confronting their differences with the aim to produce a new understanding that takes those differences into account (Choi & Pak, 2006, p. 359; Repko, 2008, p. 20). True interdisciplinarity is very difficult to achieve and many self-styled interdisciplinary enterprises actually work at the multidisciplinary level. Multidisciplinary collaboration occurs, for instance, when a group of people from different disciplines cooperate by working together on the same problem toward a common goal, but continue to do so using theories, tools, and methods from their own discipline while occasionally using outputs from each other's work. While they work together, they remain essentially within the boundaries of their own disciplines, both in terms of their working practices and with respect to the outcomes of the work (Rogers, Scaife, & Rizzo, 2005, p. 266). Design practice that seeks to solve complex problems and develop new knowledge is necessarily interdisciplinary.

Interdisciplinarity is not anti-disciplinarity even though it recognizes the limits of a single discipline's power to solve complex problems. Because interdisciplinary work integrates different perspectives it is characterized by negotiation and argumentation, and so a strong foundation of disciplinary knowledge is needed in order to support effective communication, sharing, contrast, and evaluation of insights. Without a strong disciplinary grounding, designers working in interdisciplinary collaborative situations are disadvantaged because their ability to contribute lacks rhetorical strength (Poggenpohl, 2009, p. 13).

Conclusion

The increasing need to produce research in design is also influenced by economic necessity. Many university departments in Australia, New Zealand, and the UK, for instance, receive funding based in part on the levels of their students. Undergraduates count little, Masters students more, and Doctoral students most of all. Budgets are also affected by the amount of research each department produces, defined by the number of conference papers, journal articles, books and other outputs that each faculty member publishes. Accordingly, the demand to publish and supervise research has seen the concept of practice-based research quickly become embraced within many design departments. However, there is considerable variation, disagreement and misunderstanding across universities internationally regarding the nature of practice-based research and in particular how it relates to doctoral education in design. Consequently the rigor of practice-based doctorates has become the subject of significant debate and an important topic of major international conferences and publications.

The subjectivist position that all practice is research and that written text is unnecessary is often based on the idea that all designing is a form of creative investigation, therefore, a designed object can make an original contribution to knowledge in its own right. This corresponds to the understanding of the practice-based doctorate as a personal journey that gains knowledge for an individual. Arguably, a limited understanding of the nature of research coupled with a tradition of object-centered design practice has seen an attempt to elevate the designed artifact to the status of research and to accentuate the practice-based nature of design as the distinguishing characteristic of the discipline. The problem with the rush to legitimize practice-based research as the defining trait of the design discipline is that it may appeal to students and academic staff who have limited exposure to academic scholarship and an impoverished view of research methodology. This desire for disciplinarity through the emphasis on object-centered design in fact introduces a vicious cycle that undermines the legitimization of design through producing poor research and under-theorizing design.

Focusing on personal expression short-circuits the knowledge building cycle between research and professional practice. Unless research develops knowledge that can be tested, applied, and reflected on by other people in other times, it creates a gulf between research and practice, and reduces design to concerns with surface aesthetics. Subjectivist design research is based on the mistaken idea that design practice is opposed to the application of systematic methods and the erroneous belief that systemic inquiry is at odds with creativity. These factors contribute to limiting design practice to unique cases and the simple repetition of past knowledge. In order to move beyond ad hoc approaches to collaborative problem solving, research and theory is needed that develop broad explanatory principles that can meet complex, large-scale needs in comprehensive, sustainable, cost-effective, predictable and measurable ways.

Further research

Research concerning interdisciplinary collaboration in design practice has been a concern of the tradition of second-generation design methods, in particular regarding Horst Rittel's argumentative model of approaching wicked design problems (Rittel, 1984; Rittel & Webber, 1973). Rittel (1984, pp. 323-324) mapped out three paths for further research in developing the argumentative model of the design process: 1) Refinement of the argumentative model of the design process and the study of logic of the reasoning of the designer in terms of the rules for asking questions, generating information and making decisions; 2) Practical procedures for implementing the argumentative model, such as how to foster the process of group argumentation, how to select the group, and problems of the decision rules; 3) The technical manner of supporting the instrumental version of the model through administrative and computer based aids. Research into the second and third paths mapped out by Rittel has been particularly strong. Co-design and participatory design have developed significant research and techniques for implementing the argumentative model, with emphasis on incorporating users input into the design process (Sanders & Stappers, 2008).

Research in human-computer interaction has contributed to developing the technical means of support for the instrumental version of the argumentative model through software for the systematic management of information and computer supported cooperative work (Arias, et al., 2000). Arguably, empirical research within the first path concerning the study of the ways in which designers ask questions, generate information and make decisions has been less focused and comparatively underexplored. While there has been research on similar aspects in the fields of cognitive science, knowledge management and organizational studies for instance, there has been less research with a specific focus on design.

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Innovation Methods in Story-Driven Games: Genre Variation

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Abstract

The paper proposes a method for game design innovation in story-driven games, as exemplified by the development of the adventure game prototype *Rosemary*. This method selects a game model in which a specific variation is introduced. Developing a game where the interface, interaction design, rules, goals, and themes are all new can be overwhelming for the user as well as the developers, so using a pre-existing model can ground the development and help evaluate the success of the innovation introduced.

The design method proposed is called Genre Variation. This methodology relies on a particular story-driven game model as the foundation to introduce new mechanics. After selecting the model, the next step is identifying a design problem that has not been tackled before. Then the variation is implemented as a game prototype and evaluated, following the principles of iterative design. In this case study, the problem was designing the mechanics of memory, and how to turn remembering into a core mechanic of the game. This method is intended at facilitating game development within the limited resources of academia.

Keywords

videogames, game design, story-driven games, methodology, experimentation, innovation

Academic games research can take two basic approaches: critical and development-driven. The critical approach means studying pre-exisiting games, their formal qualities as well as their socio-cultural environment. Games research can also be integral to game development. Rather than expecting games (commercial or not) to bring about innovation, games researchers can work on expanding the design space of digital games. As Mateas and Stern (2005) put it:

"[... M]aking games is required to discover new regions in design space, to understand the relationship between the game architecture and design space, and to probe the local islands that have already been partially explored through previous desings".

The motto proposed by Mateas and Stern (2005), "build it to understand it," is useful to learn more about the dependencies of videogames on the technology (the game architecture), as well as to find the gaps in the design space where innovation can take place. A hands-on approach does not discount the value of theory and criticism. In fact, a well founded understanding of current game design helps identify possible avenues of innovation as ways of expanding the pre-existing islands within the design space.

In an academic setting, videogame innovation depends on a series of trade-offs. Academia has the freedom to choose what aspects to explore, without the time constraints that commercial developers have to deliver a product. Even when game researchers fail to produce a successful game, they can still learn something from the process and apply it to the next project. While academics do not have a large monetary investment to lose, they usually lack the resources commercial developers have. When the technology is available to universities, researchers cannot have as much time and people working on a single project as a commercial developer. Therefore, game research projects tend to be smaller in scope than most mainstream commercial games. If the scope of a game for research is not adequately defined, the projects are usually unfinished and unreleased, so the results of the research may either be incomplete or only available on paper, so that it is not possible to contrast them with the actual artifact.

An additional issue is developing games with a story component, which can be more resource-consuming than other videogame genres. Story-based games, such as computer role-playing games or point-and-click adventure games usually require a larger amount of assets: graphics, animations, sound and text.[1] The audiovisual aspects are essential to represent the story components, and the story is usually inextricable from gameplay—the plot unfolds as the player advances in the game. This also makes it difficult to use methods of rapid prototyping, since even a paper prototype (e.g. a pen-and-paper roleplaying game) can demand more preparation than an arcade game, for example, for which a few game tokens and a board may be good to start playing a first version of the game (see Fullerton, Swain & Hoffman, 2004, pp. 187-182).

The intersection of story and game in story-driven games has the potential to generate new narrative forms and novel gameplay experiences. Much has been written about the limitations of story-driven games and how they restrict the player for the sake of having the player complete a linear sequence of events (Aarseth, 2004). However, there is also the potential to generate new games that defy those limitations. Building experimental games can expand the design space of videogames, and story-driven games in particular.

This paper proposes a methodology to foster innovation in story-based games through development in an academic setting. The method is called Genre Variation, because it incorporates a new set of rules or system within the pre-existing conventions of a specific story-driven genre. This method is evaluated by examining the development process of the adventure game *Rosemary*. This game was made by a team of undergraduate students led by a researcher, and is available online (http://gambit.mit.edu/loadgame/rosemary.php). The method here expounded covers the process of inception, development and assessment of the game through playtesting.

Method: Genre Variation

The method consists of choosing a model within a story-based genre, and introducing a new set of rules within that game. Modifying a game is a known exercise to design games (Salen & Zimmerman, 2004, pp.18-19; Brathwaite & Schreiber, pp. 253-4). To turn the exercise into something productive, developers must have a design focus, defined by a series of parameters that delimit the design issues that they will be addressing (Salen & Zimmerman, 2004, p.16). The two main parameters that help define the design focus in the Genre Variation method are the game model and the design problem.

The Genre Variation methodology consists of three steps: defining the model, specifying the variation, and iterative development.

Defining the Model

The game model in which the variation is introduced must be very specific, usually defined by a game or series of games. In the present case study, the model chosen by the researcher was point-and-click adventure games which used the SCUMM engine (Script Creation Utility for Maniac Mansion), such as *Maniac Mansion* (Lucasfilm Games, 1987), *The Secret of Monkey Island* (Lucasfilm Games,1990b) or *Full Throttle* (LucasArts,1995). Other possible ways to define the model can be a role-playing system such as *Dungeons and Dragons 3rd edition* (Cook,Tweet, & Williams, 2000), or choosing a single pre-existing game.

One of the advantages of using a pre-exisiting model is that it is associated to a series of conventions, which players may already be familiar with. It also saves time in the inception of the game, since the model brings a set of design decisions that researchers can build on, such as the user interface, the navigation in the space, or the standard actions to interact with the game.

The SCUMM model uses a point-and-click interface (see Figure 1). The player selects an action from a list of verbs in a menu, and then selects the object or character on the screen in which to perform it, such as "take key" or "open microwave". The player thus constructs a sentence, which is a command for the player character. The player character then carries out the action or responds that it was not possible to do it (e.g. "I don't think that's a good idea").

Figure 1: The SCUMM engine model: *Maniac Mansion* (Lucasfilm Games, 1987)

In the SCUMM model, the player character does not die. That means that the game is not over until the player hs completed all the puzzles; the player can make mistakes without ending the game before experiencing the whole story. Thus, the player is free to explore the world and experiment in it, in order to figure out how it works. In other adventure game models, such as Sierra's AGI or SCI models, the player character could die in certain parts of the game if the player made the wrong choice. For example, in Sierra's *Space Quest: The Sarien Encounter* (Sierra Online, 1986), if the player forgets to fasten the seatbelt before starting a space trip, the player character will die and bring the game to a premature end. Eliminating the death of the player character encourages players to complete the game, rather than abandoning it after dying in the same area several times in a row for no clear reason. The game manual of *Loom* (Lucasfilm Games, 1990a) explains the design philosophy of the SCUMM games:

"We believe that you buy our games to be entertained, not to be whacked over the head every time you make a mistake. [...] We think you'd prefer to solve the game's mysteries by exploring and discovering, not dying a thousand deaths." (Loom game manual, Lucasfilm Games, 1990a, p. 7)

The SCUMM model provides a specific type of story-driven game: point-and-click graphical adventure, with menu-driven commands, which encourages the player to explore and finish the game, rather than being punished whenever the player makes a mistake.

Since SCUMM is a proprietary engine and not available for non-commercial developers, the team chose Wintermute, an engine that incorporates many of the SCUMM features. Wintermute is freely available online (http://dead-code.org/), although it is not open-source.

Game engines are a double-edged sword. They speed up the process of implementation of a game, thanks to ready made code and samples. Engines also enforce the conventions of a specific genre which are already built into the system: e.g. having a player character, and a point-and-click interface to command the character what to do. This allows making more complex games, since the developers do not have to implement every single feature from scratch. Conversely, the ready-made blocks can also get in the way of innovation, since often they reflect a series of design decisions the developers have no control over. For example, Wintermute did not incorporate a verb menu by default, so the programmers of *Rosemary* had to perform a series of workarounds to implement the menu-driven User Interface.

Specifying the variation

The next step of the method is identifying a problem within the design space, which can be addressed within the possibilities of the chosen model. The problem will be addressed creatively by introducing a variation in that model, adding or modifying a set of rules that will alter specific aspects of the game. These new rules can be a new set of mechanics, i.e. rules that refer to the way the player interacts with the game (Sicart, 2008), or a new way to generate behaviours within the game (e.g. reactions of non-player characters that depend on whether the player has been kind to them in previous interactions).

The methods to specify the variation can be multiple—from a systematic survey of games, to an ethnographic study of players of a specific game or genre. Different research approaches will help identify the shortcomings of the model.

For *Rosemary*, the variation arose from an game idea the researcher had, in which memories resurfaced by revisiting a place one has not been to in a long time. Researching through a variety of adventure games indicated that although memory had been frequently used as a theme in adventure games (Thomas Disch's *Amnesia*, Cognetics Corporation, 1986; *Trace Memory*, CING 2005), there were no specific mechanics that modelled how memory works. This became the research issue of the project, creating a game where "remember" was the core mechanic of the game, and a means to obtain information from the fictional world of the game. "A core mechanic is the essential play activity players perform again and again in a game." (Salen & Zimmerman, p. 316). The adventure games that have dealt with memory as a theme do not have "remember" as one of the main activities in the game. Remembering is usually reduced to providing the player with information that she was not aware of through a description or a cut-scene, but there are no specific interactions that model how humans remember information.

The novel system had to simulate the player character's memory, not the player's. Remembering as a core mechanic had to consist of helping the character recall information, things that the character already knew, but she had not thought of in a long time. The researcher established a further restriction: amnesia could not be used as a device, either in the story or as part of the mechanics. Amnesia is a trite excuse to equate the knowledge of the player with the character's, and has been used too often in videogames.

By defining the game model and the problem the variation will address, researchers can scope of the game by identifying the design elements that will need the most work. The goal is to produce a finished playable prototype at the end of a specific period of time, in order to be able to test and later demonstrate the innovation. Choosing a game model provides a set of design decisions that the developers do not have to make. However, these ready-made design decisions can also be an obstacle, since part of the innovation will likely consist of reforming or even tearing down some of these conventions. For example, in *Rosemary* it would not have been enough to add an action "remember" to the menu, because that alone did not reproduce a system to help the player remember; "remember" as an action required more nuance.

Iterative Design: Bringing the player into the game

The success of the innovation introduced cannot be determined without evaluating player's experience. A game is not whole until the player experiences it; the player's interaction completes the game system. Thus, the figure of the player must be taken constantly into account during development. Iteration and playtesting are inextricable from the Genre Variation method (and from game development in general).

Iterative design is a methodology that allows developers to include the player in the game design process, and it is one of the most popular approaches to current game design (see Salen & Zimmerman, 2004; Fullerton, Swain & Hoffman, 2004; Braithwaite & Schreiber, 2009). Salen and Zimmerman describe this practice:

"Emphasizing playtesting and prototyping, iterative design is a method in which design decisions are made based on the experience of playing a game while it is in development. In an iterative methodology, a rough version of the game is rapidly prototyped as early in the design process as possible. This prototype has none of the aesthetic trappings of the final game, but begins to define its fundamental rules and core mechanics. [...] This prototype is played, evaluated, adjusted, and played again, allowing the designer or design team to base decisions on the successive iterations or versions of the game. Iterative design is a cyclic process that alternates between prototyping, playtesting, evaluation and refinement." (Salen and Zimmerman, 2004, p.11).

Iterative design invites a constant evaluation of the game, helping both developers and researchers to reflect on the design process. It encourages experimentation (change the game, evaluate in playtesting, change again), which makes it a particularly useful methodology to build games as research. Every iteration is a small experiment, whose results are incorporated into developing the game further.

Rosemary's iterations were tested with players who were not familiar with the game. There were three formal playtesting sessions, spread out through the 7 months of development. In the first session, most of our 11 players were experienced and familiar with the adventure game genre; the second set of playtesters were a group of 20 teenagers, who did not seem familiar with the genre. These two groups tested the implementation of the novel mechanics. The last group of 13 playtesters helped us ratify our design decisions before finalizing the game. All players were observed by the researcher and the development team while playing, and responded a written questionnaire about their experience after they finished. The evaluation of playtesting was qualitative (evaluating how players understood the game) instead of quantitative (e.g. asking players to qualify different aspects of their experience in a scale 1 to 5).

The problem of story-based games is that they can be difficult to prototype rapidly.[2] Since gameplay is dependent on the story, the story must be at least outlined before starting to play. Putting together a rough paper prototype, with a board and a few tokens, is a perfectly valid method for many other genres (see Fullerton, Swain and Hoffman's (2004) examples of how to prototype a first person shooter). The preparation time needed for a rough prototype in a story-based game can take much longer, since it needs building a fictional world, how it works, and how to interact with it. The "aesthetic trappings" that Salen and Zimmerman mention are necessary to construct that world, even if they are assets borrowed from other games or early versions of the actual asset. The first prototype of *Rosemary* was ready after six weeks of development, which can be a long time for an academic project. Thankfully, the prototype was relatively successful; if it had not, the team would have lost much of the work done until that point.

The team who made *Rosemary* managed to incorporate iterative design by generating builds that added, eliminated or revised features. Temporary art and incremental expansions in the game helped advancing the production and evaluating it periodically. The following sections explain the iterative process of the game, focusing on the novel aspects of it: the memory mechanics that modelled how the player character remembers people and events.

Rosemary: The Development Process

The first step of development was determining how memory worked in the game, which is part of defining the variation on the mechanics. As part of the preparation for development, the researcher presented the team with different models of how memory works, such as Pinker's comparison of the human mind with a computer (2005). The developers also went through several brainstorming sessions, in which they reviewed different events and actions related to human memory that may serve as the premise of the game. For example, the team discussed the Rashomon effect, in which the same events are remembered differently by a series of witnesses; they also considered how Alzheimer affects memory, or how humans remember in fragments rather than holistically.

Mnemotechnics, i.e. techniques and principles to organize memories and improve recall, were the key to introduce novelty in the game. The techniques are already a system, which makes them easier to formulate as game rules. Of the catalogue of mnemotechnics, Quintillian's concept of the Memory Palaces appeared to be the most useful as a set of potential mechanics, as well as the most evocative to make a game (Quintillian, 1920, Book XI, Chapter 2). Quintillian's method was meant to help an orator to commit his speeches to memory by turning each topic of his speech into a symbol, which would be then placed in an imagined house or other space he was familiar with. The orator would then traverse the space mentally; by recalling where each symbol was, he reproduced the speech that he had prepared.

Quintillian's Memory Palaces provide a productive model because it is already formulated as a set of mechanics, i.e. arranging memories and associating them with specific locations in order to recall the information. The association of memory with moving through a space also made it a particularly convenient model for videogames, because its implementation can take advantage of the spatial properties of digital environments, as described by Murray (2001), which allow the player to navigate a virtual space. The Memory Palaces could also benefit from the SCUMM model, which encourages players to explore the the game and try arranging memories in different ways without getting punished.

Story Premise

The next step was coming up with a story premise that would suit the concept of the Memory Palaces. After a couple of brainstorming sessions, the team found an intriguing premise that would set in motion the events of the game. The player character finds a photo that evidences that her imaginary childhood friend was a real person. She comes back to her home town, which she has not visited in many years. Nobody lives there any more, so the player explores the environment to trigger off her memories. The goal of the game would be to find out what happened to her friend by remembering people and events that may yield the right clues.

Modelling Memories

The game design evolved from the concept of the Memory Palace and the story premise, so that story and design advanced in conjunction. The mechanics of remembering were implemented as two different features: comparing between the character's memories and the present, and the Memory Palace itself.

Comparing Past and Present

The player can compare what the town looks like in the time the character is in with the way that she remembers it. A switch allows the player to go back and forth between past and present; comparing both versions allows the player to find differences that lead to new information. This feature was relatively easy to implement programatically, although it also doubled the amount of time needed to produce the visual assets. Every background and object needed two different versions, one for the memory and one for the present. The team was very confident they could produce the assets in the alloted time; and the mechanic was novel enough in adventure games that the feature was greenlit. Unfortunately, the estimates of the artists in the team were too optimistic; the assets were produced for four different locations, but the amount of time it took to produce the background of each location made it impossible to expand the number of locations in the game.

The memory/present comparison combined well with the Memory Palace. The player character would remember things by interacting with the environment. When a specific object or person triggered a memory, a symbol representing it would appear in the Memory Palace, which the player could manipulate there. Conversely, as the player solved puzzles in the Memory Palace, new objects and characters appeared in the memories of the town, allowing new interactions with the environment. For example, solving one of the puzzles in the Memory Palace made a lunchbox appear in the memories, which allowed the player to find the lunchbox in the present. It fit well with Quintillian's observation about memory and spaces (1920): "For when we return to a place after considerable absence, we not merely recognise the place itself, but remember things that we did there, and recall the persons whom we met and even the unuttered thoughts which passed through our minds when we were there before." Comparing memory and present aimed at reproducing how remembering events, people, or things may help us see the present in a new light and understand current events better.

During playtesting, this feature proved to be rather successful from the beginning. In every testing session, most players understood that they were comparing two versions of the same location, and that they were past and present. In the second evaluation, when all the final backgrounds were in place, only one player out of twenty thought that the difference was day and night (see Figure 2). Otherwise it the mechanic was easy to understand and play with.

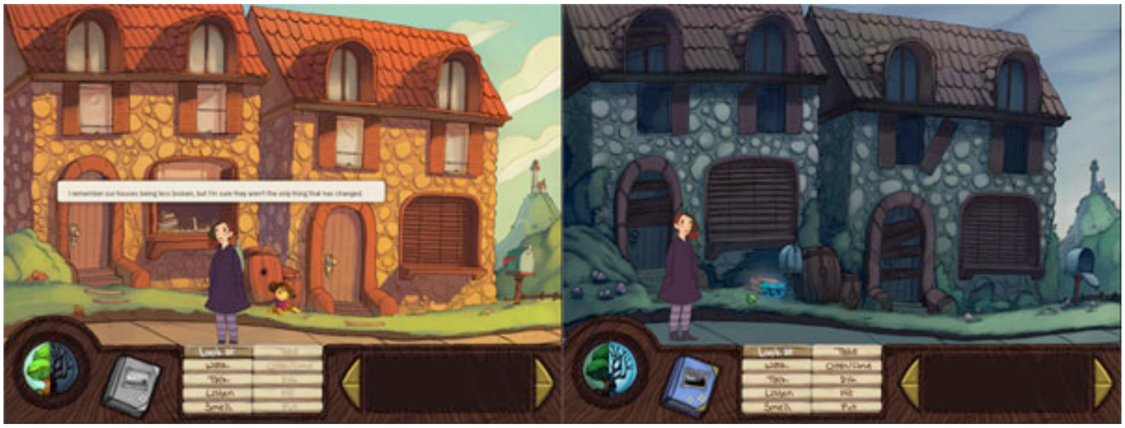

Figure 2: Comparison between memories and present in the final version of the game.

The Memory Palace

The Memory Palace represents the memories of the player character, where they are stored and arranged in order to allow the character to remember information. The mechanics of the Memory Palace primarily consist of arranging and connecting representations of memories.

The first version of the Memory Palace was presented as the interior of a tree house, where the character used to play with her friend (see Figure 3). This was a metaphor, not an actual location in the fictional world of the game. The tree house had a workbench at the front, where the memories would be placed in juxtaposition. If the memories were not connected, nothing happened; if they were, they would be cleared and a new memory would appear.

Figure 3: First version of the Memory Palace: the tree house.

This implementation was problematic, as the first playtesting session evidenced. Seven out of eleven players believed the Memory Palace was a real location in the game, not a metaphorical space—the outside of the treehouse was one of the locations of the game. The player could access the Memory Palace by clicking on one of the buttons in the menu at any time. The problem was that the button only appeared after visiting the outside of the tree house, in an attempt to introduce players to the game one feature at a time. Only four players understood the tree house as the representation of the memories of the character, the rest were not able to establish that relationship.

Another problem was how memories were connected. The player had to place the memories on the workbench; if they were related, they would disappear and make another memory appear in the tree house. In order to show the relationship between two objects, the player had to place them next to each other. Players were rather confused, because the puzzle that taught the the player the mechanics of the memory palace was connecting a trunk and a key. The point-and-click interface seemed to players to drag the key on the chest, trying to use them together, but that was not the right solution.

In short, playtesting evinced that the problems of the first version of the Memory Palace were its unclear metaphorical status with respect to the rest of the game, as well as a confusing interface, in the form of the workbench. Players figured out most puzzles through trial and error rather than understanding how the game worked, which was not the experience intended by the developers.

The re-desing of these mechanics kept the tree house metaphor (see Figure 4), but revised the mechanics of the Memory Palace. The player had to place the memories from the bottom of the screen on the right area of the house, such as a table or a shelf. When two related items were next to each other, they would stay in place, and make a new memory appear. The trunk and key pair was eliminated, since it did not make sense to put a key next to the chest to connect them. Arranging memories in space was closer to Quintillian's description, where the memory had to be in the right place in order to be able to remember. On the other hand, their implementation was somewhat problematic. While the mechanics were easy to implement, the visual assets were very specific. The place of every puzzle had to be defined beforehand; if any puzzle had to be changed or moved, all the visual assets had to be re-done. This would have hampered any further iterations and expansions on the puzzles.

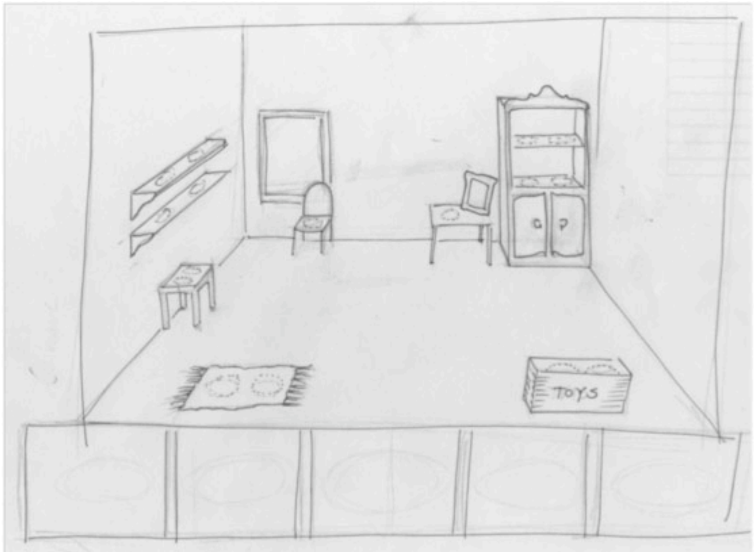

Figure 4: Sketch of the revised Memory Palace as a tree house.

The solution was keeping the mechanics (place the memory in the right area) and changing the metaphor. Rather than using an architectural space, the memory of the player character is represented by a photo album, where a photo stands for each memory (see Figure 5). Every page of the album has two empty slots to put the photos in. Each photography slot has a caption where four words were missing; each photo has two words associated with it, which would fill two of the empty slots. If two related photos are in the right slots, the puzzle is solved, the caption is be completed correctly, and a paragraph explains what the character remembers, providing more information to the player.

The photo album was a success during playtesting, since placing photos on their right slot was intuitive enough to most players; the Mad Libs-like type of mechanics provides further feedback to the player by indicating whether the photos are on the right slot. It was also a more appropriate metaphor—after all, photos are used as mementos of times past. In the final playtest, the photo album was interpreted in a variety of ways, which still helped players complete the game. Five out of thirteen players thought it was a journal where the character noted what happened to her; one interpreted it as "the puzzle of her life". Even if it did not use Quintillian's metaphor, it was also more true to the description of how it worked. After all the slots had been filled, the player can read a series of short stories that tell more of the past events in the town.

Figure 5: Final version of the Memory Palace as a photo album.

Evaluation of the Genre Variation Method

The Genre Variation method demonstrates that player experience is inextricable from the game design process, even when the initial focus of innovation is on the mechanics of the game. The game mechanics are inherent to generating player's experience, so that the degree of innovation and effective design cannot be assessed without playtesting.

Rosemary was a first experiment to evaluate whether it was possible to produce a brief adventure game in an academic environment. The innovation seems successful, since players quickly grasped the mechanics of memory by the second playtest. More significantly, younger players (15-17 years old) seemed to understand the novel mechanics better than the conventional mechanics of adventure games. These players thought that they could control the player character as if it were *The Sims* (Maxis Software, 2000), where the player clicks on a button and the character performs the action, rather than constructing a command by clicking on the menu and then the object on which to operate.

Genre Variation was a successful method to produce a story-driven game in a relatively short period of time (7 months during the academic term, 10 hours a week) with a small team (5 to 7 people at a time per semester). *Rosemary* can be completed in 15 to 20 minutes depending on the familiarity of the player with the adventure game genre. Providing a game that is polished and complete, albeit brief, also produces a much more welcoming attitude during playtesting, particularly in younger players.

The choice of game engine facilitated production, although it also created a series of bugs over which the development team had no control over. The most notable were some rare rendering problems, where the graphics would not load properly or display the wrong backgrounds. This affected the final polish of the game, although did not cripple playtesting.

The problem with this methodology is that it only evaluates one specific instance of the game, rather than comparing a set of different novel solutions to the same problem. This requires making several versions of the same game, or different games about the same problem, which is difficult with the limited resources of an academic laboratory. However, the experience of *Rosemary* has proved that early prototypes can also yield useful playtesting data. The new project based on Genre Variation the researcher is working on is based on building smaller prototypes, using different mechanics based on the same problem, which is modelling the logic of dreams. Each prototype takes the lessons learned on the previous one, and expands on the mechanics. The iteration happens in each game and from game to game, and they are all addressing the same problem.

The Genre Variation method aims at spurring creativity by helping define the problem that must be solved. Game design is thus similar to solving puzzles, a meta-game that developers can also play inventively.

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Footnotes

[1] An exception to the rule is interactive fiction (IF) / text adventure games, where all the assets are textual.

[2] Again, Interactive Fiction may be an exception.

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Reading the Tea Leaves: patterns of theorisation about design research

1. Introduction

Heterogeneity is regarded as an inherent and significant feature of the emergent and complex field of Design. This pluralism is recognised as an important factor underpinning design's increasingly significant role and position as an 'inter'discipline which is both integrative and an interface and has the potential to bridge traditional divisions such as the 'natural' orientation of sciences and the 'social' orientation of the humanities through a 'third culture' concerned with the 'artificial' (Jonas, 2000). It is also recognised as contributing to the increasing articulation and vibrancy of design discourse. However there is a critical need for greater relational understanding between different theoretical positions and research practices. This paper discusses ongoing research into the development of relational models based on an analysis and interpretation of different design research theories and reflections on how such hermeneutical models might inform the design of information resources about design research methodology.

There is a recognition in the approach taken to this analysis and modelling, that the pre-understandings of an author, of an analyst, reader or researcher, will affect the construction and the understanding of theories. A person using an information resource will approach it through his or her existing knowledge frameworks and historical understandings. This perspective, informed by information hermeneutics, recognises limitations in traditional computational approaches towards the construction of formal information structures as well as the need for greater relational understanding across the diverse concerns of the field.

2. Project context

The problem of design's theoretical complexity and lack of organisation has given rise to a number of different strategies, research groups and conferences that sought to solve, engage with or overlook the issue of heterogeneity. For example the Artificial Intelligence (AI) in Design group sought to develop formal design ontologies as ways of systematising and generalising design knowledge (Brown & Birminghan, 1997); Wolfgang Jonas's online event "Paradox endeavour to design a foundation for a groundless field"(Jonas, 2000) was based on the premise that design "is a groundless field, there cannot be eternal basics but rather arbitrary entry points."(unpaged) and sought to develop understanding through discourse; The 2008 "Undisciplined" Conference by the International Design Research Society, recognised dynamic shifts in the field but deferred the possibility of articulating them, claiming that "Designing seems to be moving into a new era, the disciplines that have framed our work are reshaping themselves, new kinds of designing are emerging and we are not yet able to define these new and hybrid professions." (http://digitalcommons.shu.ac.uk)

A number of limitations caused by, or associated with, the dynamic pluralism and theoretical heterogeneity of design research have been recognised. They include: the difficulty of representing this complex field to people outside the discipline (Buchanan, 2007), the resulting tendency to represent and practice design research through the ill-fitting frameworks of other disciplines (Jonas, 2007), a limitation of understanding and utilisation of the potential and range of available methodological approaches among design researchers (Cross, 2006), inhibition of the development of the discourse of design across different design research communities and approaches (Margolin, 2002), problems concerning the organisation of design knowledge in information systems (Poggenpohl, 2000) and a restriction of the development of new approaches that are needed to address complex contemporary problems that require multiple perspectives (Navarez & Feher, 2000). These problems have led to an acknowledged need for more dialogue and relationality between different theories and approaches. For example, Dorst (2007) has suggested this will require the identification of core assumptions that underpin existing ways of working, and from this, anomalies could be identified and “footholds for a further development” recognised (p.1). Complexity has been recognised as a distinctive attribute of design, arising from the dynamic interactivity of relationships. The need for greater relational understanding across the complex field of design research prompted this inquiry, with contextual and methodological issues that have underpinned this research being the focus of this paper.

3. Methodological Issues

Hermeneutics, as an interpretative activity, has been recognised as a way of approaching design’s diverse frameworks and multiple identities and challenge the fundamental dualisms that have been part of designs formative identity (Coyne and Snodgrass (1991, 1997). Within the methodological framework of this project, two different levels of hermeneutical processes can be recognised: one is concerned with the hermeneutical interpretation of texts, the other with information hermeneutics. These relate to phases of the project that are outlined in this paper; the first concerned with an analysis and comparison of design theory texts; the second with the identification of patterns across theories that might be used to form semantically based information structures. This approach, which builds from theories and perspectives from within the domain, must be distinguished from attempts to develop unified theories of design based on notions of a stable disciplinary core, fixed vocabularies and formal taxonomies. Such approaches have sought to create totalising, theories into which all aspects of design knowledge can be categorised. Buchanan has written:

> Many investigators are tempted with the prospect of a single monistic vision of design, but the diversity of potential monisms suggests that pluralism is an unavoidable reality. The pluralism of design research suggests that design is a field comprised of many fields, each shaped by its own problems and lines of investigation (2007, p.56).

The hermeneutical approach taken in this research recognises that the pre-understandings of an author, and those of a reader, will affect the production and the understanding of a text. In particular the history of design research, its various institutionalisations and the ideas that have informed its different methodological and conceptual developments, underpin our different understandings and interpretations. The significance of historical context is critical here, not only to the interpretation of older theories, but to an understanding of the present: “Any present is never just its present situation, but always also a particular version of the past that makes sense of the version of the future that the present is working on” (Tonkinwise, 2006, p.55). This recycling and dynamic of theories and methodologies of design research has been recognised by Jonas as a generational cycle: “We have ‘theory generations’ which are not ‘true’ or ‘false’ but ‘fashionable’ and ‘appropriate’ or ‘outdated’ and ‘inappropriate”(1999, unpaged). In this context the basis of the discipline of design is considered as a history of theories or discourses about design, rather than a history of objects, famous designers or styles. This perspective recognises the field of design research and its discourse as inherently unstable, but productive, because of this dynamic. Buchanan, (2007) has also identified this cyclical and historically inscribed process of design research theory building: “They have risen and declined in popularity but they have all persisted and been available when one or another embodiment of a strategy has temporarily run dry or has suggested further problems for which a different strategy was needed. Their interplay accounts for much of the vitality of the field” (2007, pp. 56, 57). However the history of design research is unevenly recorded and access to historical material to help better contextualise and understand design research theories, and enrich the broader discourse of design research theory is still limited.

This project has involved the identification, analysis and modelling of some twenty design research theories. These were selected from a review of over eighty texts produced between 1983 and 2008, which were drawn from across the spectrum of writing about design; from books, journals, conference papers, websites and theses. The selection of texts was made to represent a range of authorial perspectives and to include a variety of different theoretical understandings and approaches to design research, representing a broad historical and epistemological spectrum. A number of factors were taken into account when making the selection of texts for detailed analysis. For example, texts had to address the field or parts of the field of design research. They could not be based on specific design research projects, case studies, problems or applications, as such approaches tend towards description and generally provide a limited basis for research theory building. Texts focusing primarily on other areas of design as a discipline such as design practice, design history, design management, design education or design policy were also disregarded. While recognising that much can be drawn from these domains and productively related to the discourse of design research, such dimensions were beyond the scope of this initial inquiry. Other factors, which also influenced the selection of texts for more detailed analysis, included: the level of ontological or epistemological focus in a text – that is the author’s consideration of the nature or organisation of design and its knowledge, whether an author sought to give an overview of the field rather than detailing a personal observation or favoured methodological approach, the clarity and level of consistency across a theory was taken into account, the impact and significance of a theory - identified through citation, the standing of the publication and the profile of the author - was also taken into consideration. Research theories from other disciplines were excluded, unless such approaches had been significant in the development of design research, or had been adapted, reframed and used effectively in the field of design research.

Once an initial ten texts had been identified and analysed, some further criteria for selection were developed in relation to the overall range and focus across the group of selected texts. For example, further consideration was given to the relative depth and richness of some theories in comparison to the breadth and relative thinness of others. The selection of texts was not made systematically in that there was not an attempt to represent every major theoretical text or possible approach to design research, nor to create a definitive mapping of all the literature across the field. Rather, a representative selection was made of texts that, as a group, presented a diverse range of theories through which different approaches, understandings and relationships between different conceptualisations could be traced and explored. This involved the selection of a number of different texts that represented a range of theories and approaches so that the potential development of a relational overview, built from patterns identified across the dynamic and heterogeneous field of design research, could be explored .

This approach can be described as an a-posteriori approach, based on literary warrant. That is, information categories are developed from a study and analysis of literature from the field. Frohman (1983) has identified two different approaches to semantic analysis: Firstly, categories can be given a-priori as part of the meaning of a term for a concept. Such categories can be determined before examining the literature of a field and are usually based on established ontological beliefs or associated epistemological schema. The second approach locates categories within the specific discourse of which the associated term is part. Thus semantic relations are formed a-posteriori and can only be determined after an examination of the literature. Within the field of information science, such categorisation is regarded as more adequate, because it is contextually related, but less likely to be universal. The issue of “the degree to which the categories devised by human ontologists should be thought of a universally applicable or objective, as opposed to artifacts of particular contexts” has been recognised by Legg (2007, p. 425) as having “…bedeviled philosophical ontology from the beginning.” This issue continues to underpin debates about formal and applied ontologies in information science, and underpins debates about canonicalization and decentralisation, in relation to the development of new information technologies like the semantic web.

It also resonates with the fundamental ontological schism, based on overarching binary models, that informs much design research theory, described by Coyne and Snodgrass, (1991) as design’s dual knowledge thesis. In particular, the polarity between the rational, systematic approach of design science and that of intuitive, tacit, practice-based, approaches has underpinned much discourse about design research over the last forty years. Victor Margolin (2002) has suggested that such divisions are part of a history of institutionalisations and disciplines: “… between those practices that have traditionally been recognised as intuitive and aesthetic and hence located in schools of art, and those seen as technical and thus founded in colleges of engineering and computer science departments.”(p.29). He suggests that these divisions are cultural rather than epistemological, and that “the different ways of valuing aesthetics and technical knowledge are deeply embedded in the culture at large and have prevented greater communication among designers.” (p.31) The need to interrogate and re-negotiate these fundamental dualistic underpinnings and find new ways of articulating and researching design outside the confines of these historical divisions, has been recognised by a number of design theorists and has led to the development of some more nuanced interpretations. Certain models engaging with the nature of design research, the objects of its study, the ways design research is conducted or the form and nature of the knowledge it produces, have moved beyond this longstanding, dualistic framework. However research and literature which attempt to relate, critique or systematically analyse this body of design research theory are still limited.

The development of design research and its associated discourse has seen a significant growth in the quantity of published research findings. While the focus of much design research has been on processes of designing and the development of methods and tools to enhance the efficacy of design processes (Dorst, 2007), inquiry into other aspects of design is growing. However research and the development of the broader, reflexive discourse about the nature and scope of design research is still fragmented. This has made it difficult to organise, access and articulate the growing body of 'design knowledge' generated through design research, beyond specific professional or paradigmatic frameworks. A singular framework can't represent the diversity of design research approaches and understandings. This diversity places design research in a unique position, to engage and develop interdisciplinary understandings and methods to support cross disciplinary teams that are necessary for the development of new or improved technological and systemic approaches. To fully engage in any interdisciplinary process, design researchers need to be able to understand and draw from different disciplinary approaches as well as from emerging, designerly ways of thinking and researching. Nelson and Stolterman (2003) have noted:

> "Every chosen form of inquiry – intuitive, artistic, scientific, logic or a composite thereof – will lead to a specific body of knowledge. The chosen form of inquiry influences both what constitutes knowledge and how knowledge is gained. Each particular approach is based on some fundamental assumptions concerning what it means to create knowledge" (p.38).

However, the choice of approach to design research is often based on individual experience or institutional conventions, rather than through the review or identification of the most appropriate research process, or the questioning of fundamental assumptions behind a given methodological approach. While bodies of theory have developed in relation to specific forms of design inquiry there has been little focus on the development of relational understanding across these different areas and approaches. This project seeks to engage with design research theories and analyse them in order to try and understand, trace and relate the different conceptualisations, strategies and process that they articulate.

4. Mappings

The process of recording the analysis of a text, in terms of its key concepts and arguments, was made using concept mapping software, a process that enabled a level of structural and semantic representation. Jonassen, Beissner and Yacci (1993) suggest that structure is a way of identifying and representing the nature of patterns and relationships of entities. Structural knowledge has been described as a way of describing the knowledge of how concepts within a domain are interrelated. Concept maps are also known as semantic frameworks or networks. John Sowa (2000) defines semantic networks as "graphic notations for representing knowledge in patterns of interconnected nodes and arcs."

Concept maps, based on the work of Novak and Gowin (1984) into human learning and knowledge construction can be built using software called C Map tools. Concept maps were developed as a method for representing and communicating knowledge in Novak's early work on evaluating knowledge acquisition in science education. The structuring of concept maps is based on concepts, as primary elements of knowledge, and propositions, as relationships between concepts, to form a semantic unit. They can be used to produce an adjustable visual map representing the main concepts, concept relationships and thus ideas conveyed in a text. Two kinds of relations can be recognised using this approach to building a representational structure: between concept (c) – preposition (p) – concept (c), or between preposition (p) – concept (c) - preposition (p). These forms of mapping are not the same and offer quite different diagnostics. In developing robust C Maps both sets of relationships need to be considered. The c-p-c approach focuses on the relationship between subject and object, while the p-c-p approach tends to focus on the flow and location of concepts within the overall argument. In this flow an object in the first semantic unit can become the subject in the next. This mapping process attempted: to trace the ideas and flows of particular theoretical arguments made in texts, to identify certain similarities and distinctions across groups of theories and assist the identification of patterns and the development of composite models across groups of theories.

While attempting to 'map' particular theories as C Maps the actual terms and conceptualisations of authors were maintained as far as possible, so that the models were more proximate to concepts and arguments of a text. However, following the initial mapping of individual texts, some propositional terms were adjusted to facilitate comparison and relationality within and between different texts. These adjustments were made for purposes of clarification, rather than deliberately change meaning, however it is acknowledged that any such adjustments are interpretive and thus involve the researcher's own understanding in the development of the knowledge model.

5. Evaluating interpretations

Snodgrass and Coyne suggest that the main criterion for the hermeneutical assessment of a model is the degree of correspondence it has to what it models (1992, p.69). However, models are representations and so are necessarily incomplete. The models were considered in two respects: Firstly in relation to C Maps made about the particular design research theories of an author. It was recognised that any such modelling can only be an interpretation, and will involve assumptions about authorial intent and limitations of understanding on the part of the researcher. That is, such a modelling process cannot be completely objective. The intention was to approach the text openly, to try and find out more about the context it was produced in and to represent and reflect on key ideas and outline the argument of a text. This intention guided decisions made about the selection of key concepts and the form of the argument through the identification of propositions. This process saw the C Maps adapted over a number of readings with shifts in understanding of a particular theory occurring during this process. Secondly, through composite C Maps, which were developed to identify and represent common approaches and concepts across theories. This required the types of conceptualisation and reasons for associating particular concepts a cross different theories to be clarified and articulated. The process moved from an analysis of specific theories to a more associative interpretation of ways these theories could be correlated. The relevance of the C Map models was judged through an iterative process of correlation between the model with the original text or groups of texts. Most models required several re-readings, adjustments and stages of remodelling, until the level of correlation was considered to be satisfactory. That is, until it was felt that the main argument of the text could be traced in the C Map.

During a further process of evaluating the results of the analysis and identification of relational areas between different theories, consideration was also given to other writing about approaches and attitudes to research made by tertiary educational theorists who were involved in research about the nature and perceptions of academics towards research. Some strong correlations were identified, supporting the conclusions of the analysis of design theories. Angela Brewer (2001) and Gerlese Akerlind (2008) suggest that researchers, both within and across different disciplinary fields, have specific conceptions of the value and approaches they take to research. In particular Akerlind (p.22) identifies approaches that delineate academic's views of the nature of research which she summarises as: intentions, outcomes, questions and process. These were considered in relation to the shared conceptualisations that were identified through the analysis of design research theories in this project. This comparative approach indicated some fundamental perspectives on the nature of research and values ascribed to the activity of research, that were shared by groups of academics across different disciplines and institutions, and approaches taken to the theorisation of design research. These perspectives would seem to indicate that individual sensibilities or contexts might influence the way researchers understand research, and that this can be quite distinct from a disciplinary perspective. While these are informal categories they suggest some types of pre-understandings that can be correlated not only to the ways some design research theorists have framed or modelled particular theories about design research, but to different ways design researchers may tacitly understand or approach research. In this context it was proposed that these types or categories of models of design research could provide more personalised pathways - related to a researcher's implicit approach to research rather than their explicit understanding of theories about the domain of design research - through which information can be accessed and explored.

Capurro and Hjorland, (2004) have recognised the difference between the representation of information "in domains that have a high degree of consensus and explicit relevance criteria," - like science- and domains - like design - that "have different conflicting paradigms, each containing its own more or less implicit view of the informedness of different kinds of information sources" (p.395). They describe this domain analytic approach as hermeneutic because any understanding is determined by "the pre-understanding of the observer" (ibid). If these ways researchers, in general, tend to describe their approach to research can be correlated with an analysis of design research theories, these frameworks may provide a useful and usable way for design researchers to access information about design research: "With the statedness of a part of a community background in a system, the inquirer can match his/her questions and backgrounds of pre-understanding against it" (Capurro, 2000, p.4). Information hermeneutics has provided insight into ways that the problem of the limited forms of representation and accessibility to design research knowledge might be approached.

This inquiry was concerned with understanding design research theories and the ways relationships between theories might be modelled or represented as systems of theory, or theories about theory. The process of identifying relationships and common approaches between different theories and groups of theories was not aimed toward the development of a unified or meta-theory, but was guided by a recognised need to represent the pluralism of design research methodology, to inform the creation of a resource that could be accessed through multiple perspectives. These perspectives would be relevant to the prior understandings and knowledge of the researcher about research and the design discipline. A meta-theoretical approach implies a cohesive, overarching model that has not been, and may not be possible in a diverse and heterogeneous human science like design The C Map models – as models of theories by particular authors and as composite models of groups of types of theories - were developed to represent the ideas and forms of particular design research theories and the commonalities and divergences between different theories. This approach was developed to better represent the pluralistic understandings and approaches to design research. This hermeneutical approach to knowledge representation can be contrasted to logic based models which have tended to dominate approaches to design's ontological and epistemological framing. Coyne, Snodgrass and Martin have suggested that models are metaphors which cannot be assessed by logic but by the criteria which apply to matters of interpretation: "… the semantic and disclosive functions of models are not founded on their logical structures but on their metaphorical structures. Models are metaphors and metaphors convey their meanings by way of a hermeneutic understanding"(1992, p.56). They suggest that such hermeneutical metaphors should "replace the logic based models that have driven design research over the last fifty years" (1992, p.69.) Logic based models are built on assumptions of realism and fixed definition, while metaphors are interpretive - they do not claim to be the same as the actual thing they represent. As interpretations they are never closed or sealed. This metaphorical approach would seem to be more closely aligned with a conception of design which must always remain open to possibilities.

6. Conclusion

Through a process of relating, comparing, mapping, analysing and remapping theories, different strategic approaches and conceptualisations of design research were identified. While the emergence of these groupings across a number of different theories confirmed certain patterns of approach, there were some hesitations about the relevance and robustness of the identified categories. There was little work done in this field with which to compare these results. The value of this categorisation is being considered in terms of the way it might be used to inform the basis of a practical application in the form of an information structure and system to organise and relate information about design research theory . According to Gadamer, (1976) the validity of an interpretation can be gauged through the degree to which it gives rise to new insights and new disclosures of meaning, and the way it stands up to the test of its practical application. Snodgrass and Coyne, (1992, p 68) also recognise the importance of application: "The assessment of the validity of a metaphor or … model proceeds by an appeal to its potential deployability, arrived at by projective anticipations and not by objective logic or subjective intuition” (p 69). The strategy being taken to further test this analysis is through the development of a design for an information structure. Through this approach, different types of ‘informed-ness’ can be explored to support the organisation and access to information and to introduce more relational understandings.

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The Complex Field of Research: for Design, through Design, and about Design

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Abstract

The concept of design research is evolving through the literature, on-line discussions, and conferences. They revolve around defining what research is and where it belongs in design education and practice. This paper provides a framework for understanding the approaches to design research that builds upon existing overviews of the field provided by Bruce Archer, Richard Buchanan, Nigel Cross, Christopher Frayling, and Ken Friedman, among others. It begins with a brief history of design research to provide a foundation for understanding that research has been an integral part of the field of design since the early twentieth century. It then discusses the difference between clinical, applied, and basic research, providing an overview of the variety of approaches in each area. It is intended to serve as a guide to the discussion and provide a map of the literature. It is not intended as a detailed description or evaluation of the approaches or to serve as a vehicle for learning the methods, techniques, or theories of design research.

Keywords
design research; applied research through design; clinical research for design; basic research about design.

This paper, which is based on a literature review, presents a range of viewpoints about design research and provides a taxonomy with the objective of reducing some of the confusion and crosstalk. It gives a brief historical overview to indicate the context of the discussion and relationship of the various approaches. It is intended to serve as a guide to the discussion and provide a map of the literature. It is not intended as a detailed description or evaluation of the approaches or to serve as a vehicle for learning the methods, techniques, or theories of design research. It begins with a brief history of design research in the twentieth century.

A Short History of Design Research

In his book, *Designerly Ways of Knowing*, Nigel Cross provides a concise background of events in the twentieth century that contribute to the contemporary discourse about design research (2007a: 119-127). He conjectures that the systematic 1920's Modern Movement designers, such as Le Corbusier, established the groundwork for the1960's Design Methods Movement. It was believed that design methodology could prescribe an orderly, systematic procedure for arriving at a design solution through "diagnosis followed by prescription" (Downton,2003: 39; Gedenryd,1998). According to Henrik Gedenryd, the 1962 Conference on Design Methods established design methodology, the procedures or methods for designing, as a valid scientific research subject (1998: 19). This view was disseminated by other design thinkers including Christopher Alexander, John Chris Jones, Buckminster Fuller, and Herbert Simon (Alexander,1964; Downton,2003; Jones,1970; Simon,1969; Zung,2001). In 1966 the founding of the Design Research Society in England, and later initiation of the Design Studies Journal further supported this perspective. The approach remained influential throughout the 1970's and persists to today. More publications dedicated to this sort of design research emerged; *Design Issues* in 1984, *Research in Engineering Design* in 1989, the *Journal of Engineering in Design* in 1990, *Languages of Design* in 1993, and the *Design Journal* in 1997 (Cross,2007b: 47; Downton,2003: 41).

1981 Bruce Archer published *Systematic Methods for Designers* providing guidelines for generating objective knowledge for "design, composition, structure, purpose, value and meaning of human-made things and systems" (Bonsiepe,2007: 27). Archer describes the science of design research as:

- systematic because it is pursued according to some plan;
- an enquiry because it seeks to find answers to questions;
- goal-directed because the objects of the enquiry are posed by the task description;
- knowledge-directed because the findings of the enquiry must go beyond providing mere information; and
- communicable because the findings must be intelligible to, and located within some framework of understanding for, an appropriate audience (1995: 6).

In contrast, in the early 1970's some design researchers, including John Chris Jones and Christopher Alexander, began to reject the design science approach. Rittel and Webber posed the most severe challenge with their concept of wicked problems, which pointed out, among other things, how inadequate a sequential structured methodology was for understanding complex design problems (Cross,2007b: 42; Gedenryd,1998: 57). There are ten characteristics of "wicked problems" that make them ill defined, including the impossibility of formulating an exact problem due to the complexity of evolving variables that make it difficult to arrive at one definite solution (Buchanan,1992; Downton,2003: 43; Rittel,1973: 161-167). Wicked problem theory presented an alternative to the scientific approach that had been attributed to design research.

According to Cross, "method may be vital to the practice of science (where it validates the results) but not to the practice of design (where results do not have to be repeatable, and in most cases, must not be repeated, or copied)" (2007b: 43). Cross also notes that, in 1983, the late MIT professor, Donald Schön "explicitly challenged the structured doctrine underlying much of the 'design science' movement, and offered instead a constructivist paradigm[1]" (Cross,2007a: 123). Schön says:

> I begin with the assumption that competent practitioners usually know more than they can say. They exhibit a kind of knowing-in-practice, most of which is tacit…Indeed, practitioners themselves often reveal a capacity for reflection on their intuitive knowing in the midst of action and sometimes use this capacity to cope with the unique, uncertain, and conflicted situations of practice (1983: viii).

Schön was developing his theory much like a social scientist does, based on an analysis of actual design processes, rather than forcing them to fit into prescribed and structured methodologies. Simultaneously, social science researchers were beginning to apply ethnographic field research into the work activities and local knowledge of technologically connected work communities to help designers better understand the needs of their users (Frankel,2009a; Wasson,2000:380). These approaches continue to influence industrial designers today.

[1] A constructivist or interpretive paradigm, defined by Denzin and Lincoln is " a relativist ontology (there are multiple realities)… and a naturalistic (in the natural world) set of methodological procedures" (2005: 24). The main goal is to come to understand the relations between people, their activities and their physical environment. In the words of Frederick Erickson, a constructivist approach is to see the familiar through different eyes by continually asking "Why is this_______(act, person, status, concept) the way it is and not different" (Erickson,1984; Frankel,2009b).

Buchanan says, “What I believe has changed in our understanding of the problem of design knowledge is greater recognition of the extent to which products are situated in the lives of individuals and in society and culture” (2001:14). Now, according to Buchanan, a significant challenge is “to understand how designers may move into other fields [such as the social sciences] for productive work and then return with results that bear on the problems of design practice” (2001: 17). This idea seems radical in comparison to preceding approaches to design research, but represents the crux of complexity in current design research considerations.

As noted earlier, today’s prevalent interpretation of design research focuses more on processes for prescribing designed products and fails to provide an explanatory framework for the subjects of design content, the designer, and the design context (Dorst,2008: 5). According to Forlizzi, Stolterman, and Zimmerman the design community is taking note and design research and design practice are evolving “new design theories and new theories of design” (2009: 1). This paper aims to chart the prevailing design research theories discussed in the literature, but first it is important to establish a common ground by discussing design and design research.

Design and Design Research

There is no single common definition of design and some definitions even seem to contradict each other. Many design theorists talk about the activity of design as separate from the artifact and the designer, albeit undertaken by designers. Guy Julier places a material culture emphasis on “Design”– as the designed *artifact* which has been raised to elite cultural status in the media and business interests (2008: 103). On the other hand, Sanders, sees design as a distributed collaborative *activity* for researching conceptualizing, and developing improved or innovative products in which the designer no longer plays an expert role (2008: 13). Indeed, the word “design” is both a verb and a noun (Friedman,2000: 8; Gedenryd,1998: 43; Glanville,1999: 81; Julier,2008: 4; Lawson,2003: 3). The verb comes from the Latin root *designare* meaning to specify and the noun comes from the root *signum* meaning sign or specification (Gedenryd: 42). Therefore in this paper, design is an activity for planning and implementing new products, which includes the byproducts of the processes involved such as drawings, models, plans, or manufactured objects.

The research activity related to design is exploratory, and is both a way of inquiring and a way of producing new knowledge (Cross,2007a: 52; Downton,2003: 1). According to Buchanan the approaches to new design knowledge can be broken into the three categories recognized by universities, corporate and governmental funding agencies (Buchanan,2001: 17; Friedman,2000:18). These form the basis of the taxonomy presented here and are discussed in greater detail below:

Clinical Research

Clinical research focuses on design problems that are specific and individual cases requiring information for that unique situation. For example, the design of a particular walking aid for one company would require research specific to that project, that would involve gathering wide-ranging information about users, environments, materials, and competitive products. This sort of research may be documented in a case study or journal article. The common trait of case studies is that they assemble information or data that may give insight into problems that reach beyond the individual case (Buchanan,2001: 18; Friedman,2000).

Applied Research

Applied research focuses on investigating general classes of design problems or products. The common trait of applied research is the [systematic] attempt to gather from many individual cases a hypothesis or several hypotheses that may explain how a class of products takes place, the kind of reasoning that is effective in design for that class (Buchanan,2001: 18). An example of applied research occurs in the area of inclusive design, which focuses on classes of design problems that may exclude users of different abilities (Keates & Clarkson,2003). This sort of research, developed through long-term academic investigation, often generates the kind of knowledge that designers can apply in their clinical research (Downton,2003). Buchanan thinks that applied research is critical to advancing the understanding of design because it can establish connections among many individual cases (2001: 19). Buchanan and Friedman both stress the importance of systematic inquiry (Buchanan, 2001: 18; Friedman 2000: 19).

Basic Research

Basic research focuses on empirical examination of fundamental principles that lead to developing theories about design that has far-reaching implications for the discipline (Buchanan,2001). Bruce Archer developed a series of design topics worthy of basic –and, in some cases, applied– research investigations: *Design taxonomy*, for example was to focus on the classification of phenomena (observable activities) in the design area; *design praxiology* referred to the nature of design activity, its organization and its apparatus; while *design epistemology* was to be concerned with identifying special designerly ways of knowing, believing, and feeling (in Margolin,2002: 247). Nigel Cross adds another category to Archer's list: *design phenomenology* which is "the study of the form and configuration of artefacts" (2007b: 48).

Bruce Archer had a strong influence on several design researchers; especially on Nigel Cross who uses Archer's lecture notes to provide a current description of what good research is:

Purposive:	based on identification of an issue or problem worthy and capable of investigation
Inquisitive:	seeking to acquire new knowledge
Informed:	conducted from an awareness of previous, related research
Methodical:	planned and carried out in a disciplined manner
Communicable:	generating and reporting results which are testable and accessible by others (2007a: 126)[2].

Since Cross points out that these features are not unique to design research, the next section looks at those that are much more closely aligned to design.

Design Research Strategies

This section attempts to align the approaches discussed in the literature, building on the previous discussion about clinical, applied, and basic research areas. The literature refers to three categories of design research, attributed to Sir Christopher Frayling who apparently derived them from Herbert Read (Archer,1995 as transcribed by Rust in 2009; Frayling, 1993:2; Friedman, 2008; Newbury, 1996:2). They are: research for design; research through design; and research about design (Archer,1995; Cross,2007a; Downton,2003; Findeli,1999; Frayling,1993; Friedman,2003; Jonas,2007). These map closely with the three categories of clinical, applied, and basic research.

[2] Cross does not mention "replicable" which involves coming to the same conclusions when repeated. This is a concept that is not well received in the field of design, as mentioned earlier.

Clinical: Research for Design

Downton, whose book, *Design Research,* is organized according to Frayling's three categories, calls this area "research to enable design". This research area provides the information, implications, and data that designers can apply to achieve an end-result in their design projects (Downton,2003; Forlizzi et al.,2009). Downton describes this category as primarily prescriptive research methods for specific and feasible design solutions. He gives an example of a Cadillac design team that purchased and dissected a BMW to examine its inner workings (2003: 20). He also identifies some kinds of data that apply to clinical design research: "establishing pertinent regulations & standards, finding the appropriate formulae, finding meterological data, finding performance specs of materials or equipment, obtaining data on human physical characteristics & understanding human behaviour" (2003: 22-28).

According to Archer, "There are circumstances where the best or only way to shed light on a proposition, a principle, a material, a process or a function is to attempt to construct something, or to enact something, calculated to explore, embody or test it" (1995: 11). He calls this approach "Action Research" (also called practice-led research by Rust, 2007, activity-based research by Kumar and Whitney, 2003, design-oriented research by Fallman, 2005, and action research-by-project by Archer, 1995), after Frayling, or "systemic enquiry conducted through the medium of practical action; calculated to devise or test new, or newly imported, information, ideas, forms or procedures and generate communicable knowledge" (1995: 11). The practical action approach includes usability testing or user testing, in which methods are used to "measure a [specific] product's ability to satisfy the needs of the end user (accessibility, functionality, ease of use) while also meeting project requirements (budget, size, technical requirements)" (Visocky O'Grady,2006: 52).

Notably, research for design is the category of research that most practitioners and many academics associate with the term "Design Research," perhaps because it has the most potential to contribute to successful design outcomes (Dorst,2008; Friedman,2003; Roth,1999). This singular focus warrants some explanation. According to Friedman, " in today's complex environment", a designer is charged with rapidly progressing from identifying problems to realizing solutions, usually in multi-disciplinary teams. He argues that, in addition to traditional visual and material skills, designers require the capability to analyze, synthesize, organize, and evaluate within specific and uniquely different clinical situations. Design practice is therefore closely linked to research training even though "no single individual can master this comprehensive background stock of knowledge" (2003: 511). As noted earlier, since design research is a more recent phenomena in academia few practitioners have been trained in research methods (Friedman,2000: 15; Roth,1999: 18). In this category, both quantitative and qualitative research methods may be appropriate (Roth,1999: 22- 25).

Quantitative research involves objective and systematic data collection and analysis in the form of quantitative measures that are statistically valid, and fits well within a design science paradigm. Quantitative research is associated with unbiased logic, measurement, and separation between the researcher and the subjects (Sanghera,2007). In this case the size of the sample population has to be large enough to be able to accurately predict and generalize the results to the population at large (Ladner,2007). Roth provides some examples of quantitative research: written surveys; demographics; statistical analyses; anthropometrics; structural testing; and standardized tests (Roth,1999: 23).

According to Denzin and Lincoln, editors of the *Sage Handbook of Qualitative Research,* "qualitative researchers study things [and people] in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them" (Denzin & Lincoln,2005: 3). Qualitative research can include: observation/notation; personal interviews; diaries and self-reporting; video ethnography; focus groups; contextual inquiry; and activity analysis (Denzin & Lincoln,2005: 3; Roth,1999: 22). Qualitative research is subjective since it focuses on describing and interpreting people's meaningful experiences though the eyes of the people involved and it does not matter how many people are included in the sample (Ladner,2007). Qualitative research is associated with discovery, description, understanding and shared interpretation in which the researcher-personal biases and values- is part of the process (Sanghera,2007).

Design consultants Jenn and Ken Viscocky O'Grady note that researchers may use primary research methods (original research that they generate) or secondary research (research findings that have been previously published by an outside party) (2006: 19). They also explain the concepts of formative (aids in problem identification and problem solving) and summative (aids in framing and deciphering the outcome of an investigative process) research (2006: 20).

Many of the methods briefly mentioned in this section could generate findings that are relevant beyond the scope of one clinical situation, but often they are inadequately developed in practice. How does this practical research become knowledge in the field of design, especially when the particular processes employed in contractual research for design are often protected by non-disclosure agreements? The discussion about research through design begins to address this issue.

Applied: Research through Design

The literature is divided about the meaning of Frayling's ambiguous phrase "research through design" (Jonas,2007: 190). Findeli differentiates it from research for design by associating "through design" with theory and "for design" with practice (1995: 2). Jonas considers research through design the only genuine research paradigm because it is here that new knowledge is created through an action-reflection approach (2007: 189-192). In this approach, the emphasis is on the research objective of creating design knowledge, not the project solution. This may also be called project-grounded research and/or research-oriented design (Fallman,2003; Findeli,1995: 2; Jonas,2007: 192). According to Schneider, research through design may combine the practice-based research approach of practitioners with reflection and a research question that "is not restricted to the product on which research is being conducted" (Schneider,2007). His view is similar to that stated by Friedman:

> Design is both a making discipline and an integrated frame of reflection and inquiry. This means, that design inquiry seeks explanations as well as immediate results"(2000: 20).

The most important aspect of research through design is that it seeks to provide an explanation or theory within a broader context. Buchanan calls this a "Dialectic Strategy" (2007: 57). To Downton, the value of this kind of investigative theory is that it explains and also becomes " a vehicle for acquiring and shaping knowing" that assists in future design activities (2003: 77). Buchanan calls it "Productive Science" and includes the study of form and function in relation to human activity, as well as the study of materials (2007: 63).

This category is unique for several reasons: it is derived from and valuable for practice; it is growing rapidly; both practitioners and researchers are contributing significantly to the literature and on-line discussions; the discussion is extensive, addressing hundreds of approaches; and much of the subject matter has been derived from the social sciences, business, and marketing. Systematic design methodologies form much of the literature in the research through design category (Buchanan,2007; Cross,2007b; Dubberly,2005).

In recent years, human-oriented design methods feature prominently as a separate area of research in the current design discourse (Hanington,2003; Roth,1999; Rothstein,2000; Sanders,2006, 2002; Squires & Byrne,2002; Woo,2007). In her evolving map of design research methods, Sanders represents the range of attitudes towards human-oriented design, from the expert mindset and the participatory mindset, in both research-led and design-led inquiries. In the more traditional expert approach, such as in human factors (also called ergonomics), she says design researchers see themselves as experts and they see the people they are researching (and designing for) as "subjects," "users," "consumers," etc. Whereas the Scandinavian inspired participatory approach sees design researchers collaborating with the people, who are being served by design, as co-creators in the process (2008:13-15). Other human-centered research areas that fit into her model include "design and emotion" that investigates people's emotional interactions with products (Design & Emotion,2009; Green & Jordan,2002) and "experience design" that focuses on the relationship between people and their experiences with products, services, events, and environments (User Experience,2009; Woo,2007: 3-4). Brenda Laurel's book, *Design Research: Methods and Perspectives* is one of many that present human-oriented methods adapted "from the applied social and behavioral sciences and/or from engineering: human factors and ergonomics, applied ethnography, and usability testing" (Holzblatt & Beyer,1998; Laurel,2003; Sanders,2008: 14).

At The Institute of Design at Illinois Institute of Technology, graduate students working with Professor Vijay Kumar and Vincent LaConte have assembled a poster documenting ninety-three methods, indicating where they belong in the following five iterative design modes: definition (sense context); research (know context and know users); analysis (frame insights); synthesis (explore concepts and frame solutions); and realization (make plans) (Kumar, LaConte, & Students,2007). The Design Consultancy IDEO has published the *IDEO Methods Cards* documenting fifty-one techniques for researching human-centered issues (Moggridge,2007). While these methodologies are applied in clinical research, they belong in the design through research section because they are part of the general theoretical knowledge base about how to do design research. In addition research can also investigate and generate knowledge about fundamental design epistemologies, as discussed in the next section.

Basic: Research about Design

Findeli describes much of the research about or into design as the work that is "carried out under the heading of other disciplines (sociology, psychology, semiotics, economics, history, etc.... of design" (1995: 2). He appears to believe that this represents the most prevalent kind of design research available. According to Schneider, the research areas include history of design, aesthetics and design theory, as well as the analysis of design activity (2007).

Buchanan calls this area of research "design inquiry" and he sees it as searching for "an explanation in the experience of designers and those who use products" (2007: 58). He breaks this into two categories: "the discipline of designing" and "creativity of the designer". Cross also believes this area addresses "the nature of design activity, design behaviour, and design cognition" (Cross,2007a). He focuses much of his research on "designerly ways of knowing," which is discussed in considerable depth in the design research literature (Bonsiepe,2007; Dorst & Cross,2001). Findeli and Cross acknowledge the importance of understanding the unique forms of knowledge that contribute to designers' creative skills and awareness (Cross,2007b: 46; Findeli,1995: 3). Dorst and Cross break down designerly activities into a long list of meta-activities (such as creating ways to keep on learning from their design activities, creating a view about design quality, and constructing a design argument, among others). They also identify characteristically different approaches to design problems for designers with different ranges of experience and discuss how they work together (Cross,2007a: 12, 46, 51; Dorst,2008: 9 & 10).

Another fascinating area in which substantial research has been done is in defining the design problem[3], which falls into the category of designerly ways of knowing. In his PhD thesis, Henrik Gedenryd points out that while a designer is expected to solve a problem, in fact "producing the problem is the [significant] work that the designer must do" (1998: 69-70). Lawson, in reference to Rittel and Webber's "wicked problem" theory, says that, "it seems more likely that design is a process in which problem and solution emerge together" (2003: 47). Buchanan refers to the process of discovering the problem as "rhetorical inquiry", which is partly verbal and partly in "the sketches,

[3] It is fascinating because this is the fundamental understanding a designer needs to have to be able to do his or her work and this is often not explicitly acknowledged in our traditional industrial design curriculum.

models, and prototypes that are characteristic of design work" (2007: 64). Schön calls this activity "problem setting" in which, "we select what we will treat as the "things" of the situation, we set the boundaries of our attention to it, and we impose upon it a coherence which allows us to say what is wrong and in what directions the situation needs to be changed" (Schön,1983: 40). Dorst and Cross refer to this as "defining and framing the problem" (2001: 431-432). Cross, Dorst, Downton, and Gedenryd adopt Schön's view that the sketches, models, and other primarily visual representations designers develop while evolving their concepts are "reflective conversations with the situation" (Dorst & Cross,2001; Downton,2003; Gedenryd,1998).

In addition to these traditional explorations, designers may also raise questions that are not characteristic of other disciplines because often the answers are translated into form, colour, and the objects that surround us. This affords practitioners, students, and educators with the challenge to produce discipline specific knowledge that may be communicated by drawings, sketches, models, and other visual representations embodying non-verbal codes or messages as well (Cross,2007a; Dörner,1999; Downton,2003; Lawson,2003; Stappers,2007).

There are additional areas of investigation that have not been covered in this brief overview that are also part of the body of knowledge that is design research. The following section brings together the many approaches discussed in this paper.

The Relation between Design Research Categories

In his paper, *Creating design knowledge: from research into practice,* Ken Friedman asks, "How does new knowledge move from research into practice"(: 1). He goes on to answer:

> Concrete research results become visible to practitioners in a myriad of ways. Journal results, conferences, corridor talk among colleagues, knowledge transfer in shared projects, Internet discussion groups. The important issue is that a field must grow large enough and rich enough to shape results and circulate them. As this happens, the disciplinary basis of the larger field also grows richer. This leads to a virtuous cycle of basic results that flow up toward applied research and to clinical applications. At every stage, knowledge, experience and questions move in both directions…Practice tends to embody knowledge. Research tends to articulate knowledge (2000: 23).

Building on Friedman's thinking, the following map represents the relative positions of the categories and subcategories discussed so far in this paper. It illustrates the flow between research for design, research through design, and research about design as a circular process, each informing the other.

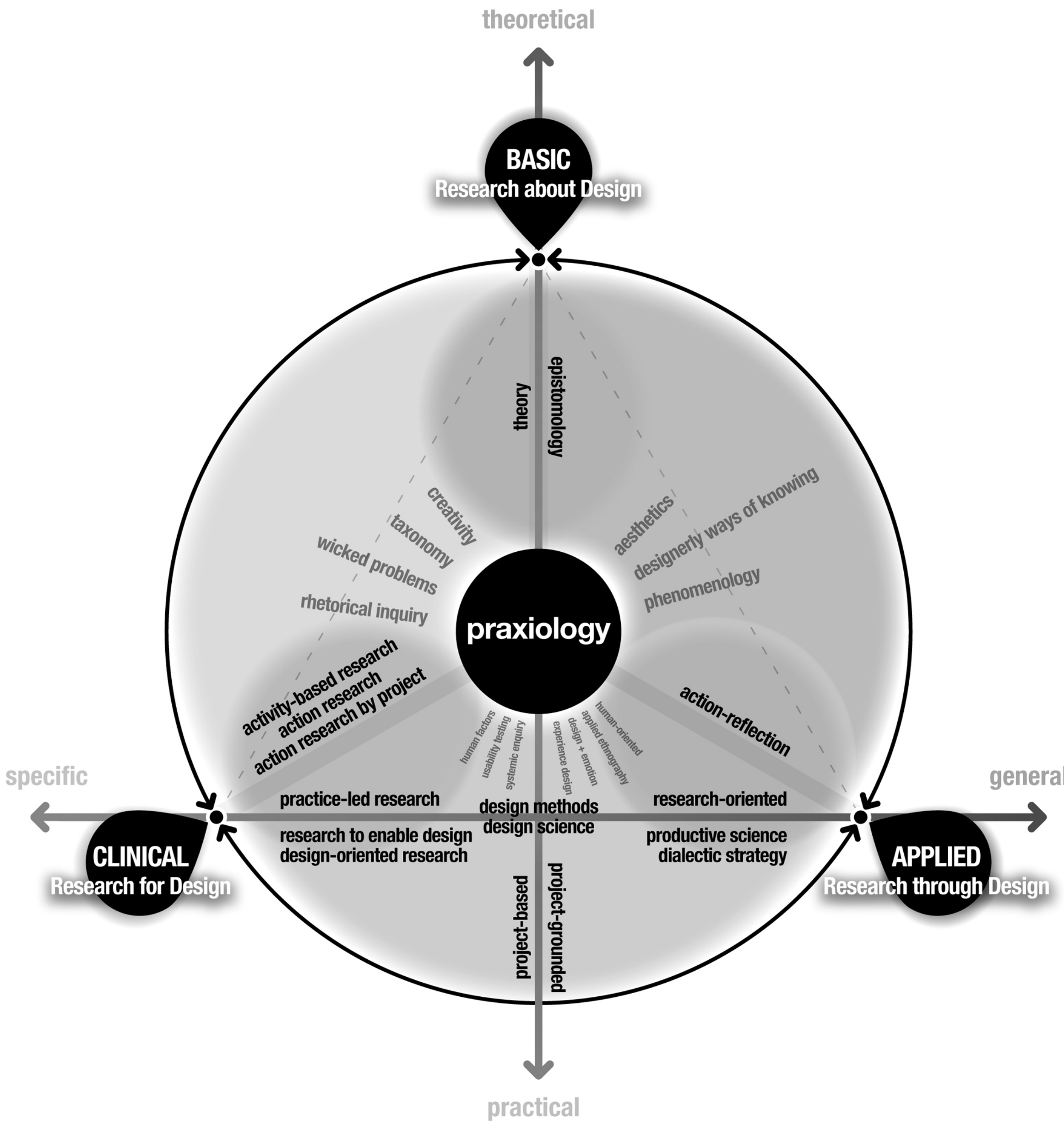

Fig 1. Map of Design Research Categories

While these categories of design research are interrelated, they also represent different levels of design knowledge. Downton writes about three kinds of knowledge: “how-to-knowledge” (a person demonstrating she knows how to draw) “knowing-that” knowledge (a person learning about how someone else draws), and “knowledge-of” (a person has peripheral knowledge that people can draw) (2000: 62). He goes on to say that, “Design theories are concerned with what design is, what it should be and what it could be” (2003: 79). From this perspective, one could expect to engage in design research at any of these levels and in a variety of combinations, depending on the initial question or hypothesis. With such a multifaceted range of options, is it any wonder that the discourse is as extensive as it is?

A visit to the PhD-DESIGN List serve[4] brings up many threads of discussion that run through this paper. It has become the central clearing house for current issues related to the academic relationship with design research–many of the key design researchers mentioned here share their explanations, perspectives, and evolving thinking. While that may validate the content of this literature search the list doesn't make sense in and of itself. The discussion threads often provide uncontextualized snippets of information. In response, this map illustrates the increasingly complex approaches to design research.

Conclusion

The multiple perspectives for describing design research in the literature are signs of healthy growth and of a field that is advancing to face the challenges of our times, rather than becoming overwhelmed by them. This paper develops a frame of reference that endeavors to organize the information found in the literature, primarily to develop insight into the complex field of research: for design, through design, and about design. It draws from the wide range of activity in the area of design research that is fueling the discourse and spreading design research knowledge. The initial historical overview provides a context for understanding the foundations of design research, which have been an ongoing part of the process since design emerged as a field on its own in the early twentieth century. In spite of the relatively short history of research and design, the foundation for thinking about contemporary design issues has been firmly established and promoted by many dedicated academics and practitioners, not all of whom share the same taxonomies. The complexity is not merely a matter of taxonomy; it is also a matter of breadth. The wide range of research approaches discussed in this paper are used to varying degrees in the pursuit of knowledge that is either specific to a design project, relevant to a class of design problems, or fundamental to the very nature of design.

The model presented here aims to provide a framework that will evolve along with the field of design research. By relating Frayling's terms –design for, about, and through research– to those of contemporary funding bodies–clinical, applied, and basic– and of current practice this paper attempts to provide continuity, while sorting out the different points of view.

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[4] This list can be subscribed to at "PHD-DESIGN@jiscmail.ac.uk"

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Caractérisation des activités collectives réunissant designers et chercheurs

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Abstract

En février 2008 s'est tenue au MoMA de New York l'exposition Design and the Elastic Mind. Par la présentation d'un peu plus de 200 projets, l'événement culturel voulait mettre en avant "un des rôles les plus fondamentaux du design : la traduction des révolutions scientifiques et technologiques au travers d'objets accessibles changeant la vie des gens".

Bien que les activités respectives du designer et du scientifique (chercheur et ingénieur) soient différentes, l'exposition montrait la plus grande proximité qu'entretiennent désormais les milieux du design et de la science. Que ce soit par la portée des propositions, des connaissances mobilisées ou des connaissances nouvelles que les projets en question ont apportées, le design investi par les dernières avancées scientifiques semble apporter des perspectives nouvelles aux deux disciplines concernées. Mais quand est-il des pratiques respectives, celles du designer et du chercheur ? Dans cet article, nous proposons d'explorer cette question par l'analyse d'une série d'entretiens semi directifs. Ces rencontres se sont étalées entre juillet et septembre 2009 et ont concerné 7 designers et 7 chercheurs ayant travaillé ensembles.

Keywords

design industriel; collaboration; designer; chercheur; interview; pratique du design; étude;

En février 2008 s'est tenue au MoMA de New York l'exposition Design and the Elastic Mind. Par la présentation de plus de 200 projets, l'événement voulait mettre en avant "un des rôles les plus fondamentaux du design : la traduction des révolutions scientifiques et technologiques au travers d'objets accessibles changeant la vie des gens"[1]. En cela, les projets se situaient dans une perspective proche du "design scientifique" de Nigel Cross [1] où l'objectif est de concevoir des objets basés sur les dernières avancées scientifiques. Comme l'affirme Raymond Willem, ici le design "rend la science visible" [2].

Bien que les activités respectives du designer et du scientifique soient différentes, l'exposition montrait la grande proximité qu'entretiennent désormais ces deux milieux. Que ce soit par la portée des propositions, des connaissances mobilisées ou des connaissances générées, le design investi par les dernières avancées scientifiques semble apporter des perspectives nouvelles aux deux disciplines. Mais qu'en est-il des pratiques respectives ? Dans cet article, nous proposons d'explorer cette question par l'analyse d'une série d'entretiens semi directifs. Ces rencontres se sont étalées entre juillet et septembre 2009 et ont concerné 7 designers et 7 chercheurs ayant travaillé ensembles.

Bien que partageant des valeurs identiques que sont l'innovation, la création de nouveauté et de connaissance, le design et la recherche supportent des pratiques différentes. Comme le rappelle Armand Hatchuel, professeur à l'Ecole de Mines de Paris, le designer se doit de "produire un objet inconnu qui séduisent et surprennent, tout en étant immédiatement reconnu". Tandis que le chercheur, de par les connaissances liées aux dernières avancées scientifiques qu'il mobilise, peut se permettre de surprendre par des objets inconnus qu'il aura loisir d'expliquer et de démontrer par la suite [3]. Il convient de rappeler que le fossé est d'autant plus important en France où la recherche en design n'est pas institutionnalisée : il n'y a pas de doctorat en design. En référence à la classification de Christopher Frayling, cette absence d'étude doctorale amène à constater que le profil du chercheur sur le design prévaut à celui du chercheur en design [4]. Aussi, la rencontre en

[1]. Glenn Lowry dans l'introduction du catalogue de l'exposition Design and the Elastic Mind.

France entre designer et chercheur est avant tout une rencontre de deux pratiques avant d'être celle de deux praticiens.

Des lectures aux entretiens

Les lectures qui ont précédés nos entretiens nous ont amené à nous intéresser à l'apport particulier que pourraient offrir les ressources de médiation. Que cela passe par les dessins, les croquis, les maquettes ou les représentations 3D, de nombreuses recherches ont déjà été menées pour qualifier leurs implications durant les activités de conception collaborative. Durant un travail d'analyse ethnographique de la conception d'un produit technique simple, Eric Blanco, chercheur en génie mécanique, a étudié le rôle particulier du croquis griffonné [5]. Le chercheur en est arrivé à argumenter que ces derniers ont la capacité de décrire à la fois le processus et sa temporalité. Ils sont à la fois traducteurs et médiateurs de l'activité. Le chercheur insiste aussi sur une des limites des brouillons : leurs faibles niveaux de codification les dédient à la conception et ils ne peuvent transmettre la mémoire du sens donnée au projet. Ils sont aussi à distinguer des objets dits "fermés", fortement codifiés et qui fonctionnent selon un régime descriptif. Ils sont pour cela dédiés à la fabrication. Dans un contexte proche, le sociologue Dominique Vinck a étudié le rôle des représentations graphiques dans la coopération entre métiers [6]. Renforçant l'analyse d'Eric Blanco il complète en avançant que les rapports de prescription entre acteurs sont entretenus par les modalités de production et de mise en circulation des représentations graphiques. En tout état de cause, il nous a été peu évident d'étudier les nombreux éléments identifiés dans la revue de la littérature, notamment ce qui concerne les traces de l'activité supportées par les ressources de médiation. La plupart des écrits retranscrivent des études de terrain s'avérant riches en informations propres à une analyse ethnographique. Aussi, elles sont difficilement identifiables dans le contexte de l'entretien semi directif. Pourtant, nous avons su déceler que les activités collectives réunissant chercheurs et designers s'inscrivaient dans un cas particulier au niveau des rôles réciproques joués par les ressources de médiation entre les acteurs.

Pour commencer, un designer industriel ayant une forte expérience de travail avec les chercheurs, nous a expliqué le rapport particulier qu'il entretient habituellement avec un chercheur : "le chercheur n'est pas un client […] il n'est pas à séduire. Donc lui montrer un produit fini n'aurait aucun sens." Le designer opère ainsi d'une autre manière vis-à-vis des chercheurs en "leur "montr[ant] des réalisations antérieures. Pour qu'ils puissent voir où tout ça peut emmener, dans quel degré de finalisation, de sophistication [le projet] peut aller." Poursuivant sur le rôle particulier des croquis et des brouillons, les recherches du designer, il explicite alors sa stratégie. Pour lui, il s'agit de "montrer que le projet est encore extrêmement fragile et ouvert. […] comme indéterminé, en transformation pour que la personne qui est en face de [lui] trouve sa place et puisse s'approprier le croquis ou la pré-maquette". Ainsi, le designer a compris que le fait de présenter au chercheur un "objet fermé" ne peut engager la coopération car cela implique tacitement un rapport de prescription du designer sur le chercheur [5]. Au contraire, présenter un objet "fragile et ouvert" offre ce que Dominique Vinck appelle des "prises" [6]. Comme en alpinisme, une prise relève à la fois des particularités de l'objet et de l'action qui est engagée avec lui. En cela, comme le designer le rappelle, il ne se présente pas selon le régime habituel de la séduction. Il n'est donc pas dans la monstration mais davantage dans la démonstration. Ainsi face à un chercheur, le designer présente ses recherches formelles et d'usage selon une posture qui le rapproche davantage du chercheur où le fait de convaincre prime sur la séduction.

Les entretiens nous ont aussi amené à observer le mouvement inverse : le chercheur prend conscience que le rôle des ressources de médiation est partagé. Un chercheur sur les agromatériaux rapportait lors d'un projet de collaboration qu'il avait été amené à manipuler, dans le sens expérimental du terme, ses agromatériaux avec les designers. L'objectif était didactique : le designer avait la volonté de comprendre le processus de conception de ces nouveaux matériaux. Par la suite, il a fait un rapprochement intéressant. Selon lui le travail de croquis du designer apparaissait comme le pendant des "manipulations" du chercheur. Il pointa alors l'aspect fortement itératif qui vise à aboutir à un résultat présentable, non pas pour séduire mais pour prouver et démontrer. Ce chercheur a insisté sur le fait que le designer, dans le cadre des activités collectives auxquelles il a participé, doit lui aussi vérifier la faisabilité de ses idées. En insistant sur le travail de réflexion, "le designer va mettre [son idée] sur papier, nous [les chercheurs] on va la mettre dans nos éprouvettes ou dans nos extrudeurs et faire un test".

Ces rapprochements dans les fonctions induits par les ressources de médiations ne vont pas uniquement dans le sens du designer vers le chercheur. Un autre chercheur, docteur en science de l'informatique, nous rapportait son expérience avec les designers. Durant une période de recherche dans un laboratoire transversal où se côtoyaient des chercheurs en informatique des architectes et des designers, il prit conscience que sa production de chercheur devait "inspirer, informer, soutenir la démarche du designer et pas du tout s'y suppléer et se substituer à son travail." De là, il s'est "rendu compte qu'il fallait mieux utiliser les mêmes outils que les designers pour pouvoir bien communiquer avec eux." Finalement, l'objectif pour lui était de réutiliser les ressources de médiation des designers afin d'apporter un maximum de "prises" au sens de Vinck, avec des modalités pertinentes et accessibles pour les designers. Enfin, il a souligné un paradoxe dans l'utilisation des ressources de médiation propres aux designers : "plus le rapport évolue, plus [il a] l'impression de rentrer et d'être considéré par certaines personnes comme un designer." Le fait d'utiliser certains outils, certaines manières de fonctionner qui sont proches du design amènent des personnes à penser qu'il est designer.

Un rapprochement par les ressources de médiation

Aussi, si un rapprochement peut se faire selon les pratiques de manière générale, il s'observe surtout dans notre étude par les ressources de médiation. Leurs rôles réciproques semblent de ce fait se confondre entre designers et chercheurs : chacun semblant adopter les modes de communication de l'autre. L'aspect séduisant des ressources de médiation du designer semble laisser le pas à une forme davantage démonstrative. De son côté, les ressources de médiation des chercheurs sont adaptées aux designers en empruntant leurs manières de faire. En cela, le dernier chercheur évoqué précisait qu'il utilisait entre autres le scénario pour travailler avec les designers. Dans son contexte de chercheur, il nommait ces ressources de médiation par le terme de "représentation intermédiaire". Un terme que l'on retrouve dans nos lectures. En effet, Eric Blanco parle "d'objet intermédiaire" pour qualifier les objets qui médiatisent les interactions entre acteurs en représentant "à la fois les intentions et compétences de leurs auteurs et le produit à venir" [5].

Au-delà du rapprochement, l'apport

Le fait que les pratiques des designers et des chercheurs soient d'une manière générale relativement proches n'est pas une nouveauté en soi. C'est en partie pour cette raison que nous avons choisi jusqu'à présent de nous intéresser aux ressources de médiation et non aux pratiques. Annie Gentès, chercheuse à Telecom PartisTech, explique que les processus de conception des designers et des ingénieurs/chercheurs sont en réalité proches du fait que les deux utilisent un processus de "médiation créative" [7]. Concrètement, ce processus correspond à la production d'un objet pour rendre compte médiatiquement d'une invention technique dans un contexte social, voir économique. Basant son analyse dans le cadre des technologies de l'information, Annie Gentès avance que les designers cadrent la technologie dans une narration précise en la plaçant dans un contexte et un environnement particulier selon un apport sémiotique. De leur côté, les ingénieurs/chercheurs ont recours au récit descriptif des fonctions de la technologie en détachant l'objet des facteurs externes. Les deux modes de représentation bien que partiellement similaires, se complètent : les designers tentent de placer les technologies de manière pertinente dans un contexte choisi quand les ingénieurs/chercheurs illustrent leurs limites. Dans le cas de notre travail de recherche, la complémentarité entre chercheurs et designers dans les modes de représentation va de pair avec les apports réciproques aux pratiques de chacun. Les apports ont en effet été plus facilement identifiables lors des entretiens.

Dans cette optique, un designer nous expliquait qu'il ne souhaitait pas apporter des réponses "fantaisistes ou juste prospectives ou vaguement manifestes" dans son travail. De ce fait, il avouait sans peine qu'il était "très vite en limite de compétence", ce qui le motivait à faire appel à un scientifique. Il identifiait là les limites dans sa pratique : "Je n'ai ni envie, ni intérêt à continuer tout seul. Parce que sinon ça veut dire que je deviens moi-même une sorte de scientifique […] ou à singer une attitude de scientifique. Je suis beaucoup plus intéressé par créer des collaborations [...] plutôt que de m'imaginer omnipotent, apte à être le designer, le scientifique et le chercheur à la fois." Ce constat est également partagé par de nombreux chercheurs qui identifient clairement leur apport de cette manière. A titre d'exemple, le chercheur sur les agromatériaux dont nous avons déjà parlé identifiait son apport comme une "caution scientifique".

Le chercheur n'est pas en reste. Là aussi l'apport attendu par l'aide du designer favorise les conclusions d'Annie Gentès. De ce fait, la mise en contexte du designer devient un moyen de tester les limites d'une technologie issue d'un laboratoire. Un chercheur en traitement du signal nous rapportait le cas d'un *workshop* entre son laboratoire et une école de design. L'intérêt pour lui était de "voir en fait quels sont les vrais problèmes, […] les vrais obstacles pour l'utilisation de [ses] outils." En ce sens, le chercheur cherchait à contextualiser ses travaux : "parce que nous [les chercheurs] on développe des outils informatiques mais on ne sait pas finalement comment ça va être utilisé. C'est naturel qu'à travers ce genre d'interaction on ait un *feedback* pour améliorer nos outils."

Si les apports respectifs semblent obéir à des connaissances rencontrées dans nos lectures, nos entretiens ont néanmoins décelé que le rapport pouvait parfois s'inverser. Nous l'avons davantage constaté du côté du chercheur qui à son tour se révèle être en "limite de compétence". Dans ces cas précis, le designer ne va pas aider à repousser les limiter d'une technologie mais une mise en contexte particulière va offrir au chercheur des problématiques jusqu'à alors inédites. Un designer témoignait son expérience lors d'un projet pour créer des bottes de protection contre les mines antipersonnel. Son hypothèse initiale était de ne pas chercher à résister à l'explosion mais de concevoir une forme qui en dévierait le souffle. Aussi, il a fait appel à des chercheurs d'un laboratoire en balistique "pour qu'ils nous fassent part de leurs connaissances", pour qu'il puisse "valider [ses] hypothèses". Nous sommes dans un rapport classique entre designer et chercheur. Mais il s'est avéré "qu'il y avait très peu de connaissances dans ce domaine, c'est-à-dire on ne caractérisait pas finalement ce que produisait l'explosion d'une mine." La question amenée par le designer a finalement intéressé le laboratoire qui "a fini par financer une partie des essais", ce qui a produit des connaissances scientifiques publiées par la suite.

Conclusion

Pour conclure, notre étude a permis de caractériser deux cas typiques dans les activités collectives réunissant designers et chercheurs. Il y a en premier lieu celles où les apports réciproques sont ceux identifiés par Annie Gentès : le chercheur apporte des connaissances et des nouvelles technologies quand le designer teste leur validité par contextualisation. Ces activités collectives sont ponctuelles, de courte durée et organisées par la rencontre des institutions correspondantes : laboratoire de recherche, université, école de design, cabinet de design, centre d'art, etc. En second lieu, nous avons les activités collectives où une influence des pratiques est à l'œuvre : l'apport du designer vient nourrir le travail du chercheur, et ce dernier envisage différemment ces recherches par l'apport du designer. Ces seconds cas sont la plupart du temps initialement issus d'une activité collective traditionnelle. En revanche ces activités collectives particulières s'actualisent par la suite et deviennent pérennes sous de nouvelles formes d'organisations. Différents projets comme Variable Environment[2] réunissant l'Ecole Polytechnique Fédérale de Lausanne (EPFL) et l'Ecole Cantonale d'Art de Lausanne (ECAL) ont été les initiatives à l'origine du laboratoire commun EPFL+ECAL Lab[3], "nouvelle unité de l'EPFL en collaboration avec l'ECAL" marquée par "une stratégie pour stimuler des travaux à l'interface entre des disciplines essentielles de l'innovation." Cela démontre que les organisations pour favoriser les activités collectives sont véritablement à créer. Si les designers semblent avoir moins de contrainte dans leur activités professionnelles, cela ne semble pas le cas pour les chercheurs. Un jeune chercheur qui a eu l'occasion de travailler plusieurs fois avec des designers nous expliquait qu'il ne pourrait pas poursuivre ce genre d'expérience dans le monde de la recherche et qu'il allait "devoir arrêter d'être un chercheur."

2. http://sketchblog.ecal.ch/variable_environment/

3. http://www.epfl-ecal-lab.ch/

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Converting the participants' verbal expressions into design factors

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Abstract

Investigating and extracting users' desires and aspirations often conduct design researchers to a great deep challenge. Therefore, the designers usually examine several ways to get closer to these unrevealed feelings. These ways include applying various qualitative and quantitative techniques. Amalgamation of these techniques might be the most desired technique among designers in revealing deep inside feelings. But once a qualitative technique is applied, the design researchers deal with the difficulties of making the outcome data, including verbal and visual expressions, comprehensible enough in order to be used in the subsequent steps of design or to be conveyed to product developers. So, their usage of such qualitative techniques would be subject to misconception and misunderstanding, and here, the expertise of designer will have a crucial effect. Consequently, designers often find qualitative data formats as imperfect reports as they might not be applied convincingly throughout the design process.

This paper presents some encountered complexities of a pilot survey titled "Designing and Implementing an Artificial Design Tool Based on Improved Kansei Engineering" which, due to its concept, involves applying intermingled quantitative and qualitative methods. In addition, this paper is an effort to describe the borderline between quantitative and qualitative methods and their transformation point, and also to describe some practical solutions suggested by the authors.

Within any mixture of quantitative and qualitative techniques, there are two participants: human in one side (both as designer and also the focused and target group) and machine (computer) on the other side. In other words, within any combination of these two techniques, we encounter the qualitative data expressed by the target group and self perception of designers on one hand, and the quantitative data produced or required by the machine on the other hand. And then, the problem will be how to take advantage of these two sources for the analysis and concept generation phases. Surely the future methods of design together with the future design-assistant machines will raise this fundamental question: how can we overcome the rigid borderline between qualitative and quantitative methods and make a seamless concept of co-qual-quant model which will bolster the real human-machine connection. It is one of the design complexities of the time and one of the requisites of the future. We have come up with a solution through a conducted case study, in which we have made a bridge between the human and computer. So, we have used some qualitative methods on the human side (for example PPP and Mood Board) and some quantitative techniques (such as AHP) on the other side and we have tried to infer some co-qual-quant model-based parameters to inject to the design machine as a pure quantitative instrument.

Keywords

User-centric design, qualitative techniques in design, design problem solving, Kansei engineering, AHP in Kansei Engineering, co-qual-quant model in KE

Emotional bonds between users and products are an essential element that can determine the commercial success of a product. Eliciting user desires and emotions often presents a challenge to design researchers. Users can offer a valuable design resource to support the designing process. However, such involvement can be perceived as problematic. This is partly because users find it difficult to conceptualize and express their ideals and wishes, and therefore, they need to be supported. Product functionality as such is closely interwoven with social and cultural values. Users are not always conscious of their needs or may not regard particular pieces of information as useful. Likewise, users are not always able to verbalize their emotions and reflections. Coates distinguishes between the idea of the stereotype (what a typical product is currently like) and the ideal (the imagination of how an object should be like). New designs aim to come reasonably close to the ideal, whilst not leaving the perception of the stereotype (standard) too far behind. Coates criticizes the use of focus groups in market research based on its preoccupation with stereotypes instead of ideals, because the stereotype is what participants know best about and agree most upon. Ideals are "fuzzy" as they vary across people and are not necessarily conscious. *Blue-sky* and *what-if* possibilities are therefore more difficult to reflect upon and verbalize.

So, it is important to give users many different channels through which they can express their requirements and ideals. Several qualitative techniques like Mood Board and Product Personality Profiling have been proposed and employed recently to retrieve peoples' ideals rather than their stereotypes to overcome these shortcomings. A methodological "trick" to trigger novel ideas was employed by encouraging people to consider the "future". By assisting users in *suspending reality*, new ideas and wishes may emerge. People begin to think more creatively and disclose their wishes and ideals more freely.

These techniques broadly use Images and enable communication of intangible emotions such as happiness, sadness and calm, beyond linguistic restrictions. Images are a powerful resource to convey meanings, particularly emotional values and experiences. Especially, abstract imagery which is applied in Mood Boards is often more successful in this than figurative images which can have strong literal interpretations. As they tend to be purely visual, they transcend linguistic restrictions. Their application can serve as an important tool to communicate values that cannot be expressed easily through words.

As the subject of design becomes more novel and complex, it would be more difficult for the users to think and imagine the hidden aspects of the subject, and also their unrevealed desires. Here, Qualitative techniques play an important role. They are more powerful tools in helping people visualize the current and future context of design and their imaginary and ideal products. Therefore, applying them seems crucial, but also interpreting their result might be a bit of minefield. So, in some occasions converting these qualitative data to quantitative data will bring about confusion and should be solved using combination of appropriate techniques. This is the main approach which will be discussed in this paper.

Framework of the paper:

As a descriptor for the applied technique, we propose a framework which governs all parts of the model. Here, the framework and its basis will be described.

The technique mainly combines AHP, Mood Board and PPP to provide the optimization algorithm with the necessary input parameters (attributes) and also importance weights (final weights resulted from AHP) of those parameters. The novelty of the design subject also made usage of Mood Board inevitable, because we had to reduce the representative objects in the questionnaires (sample products) into more sensible ones for the users. We used Mood Board for simplifying and reducing the representative objects from a complex, concrete and real world object (for example image of some green cars) to some simple and abstract images. Also it helps us to communicate with the unawareness of the users. In addition, we have further used our findings from both Mood Board and PPP in defining AHP criteria. Then, the final extracted weights of importance from AHP were inputted as the coefficients of the fitness function in Genetic Algorithm optimization, the project's synthesis phase.

We will split the whole framework into some modules and will describe them separately. These segments include "attribute gathering", "attribute reduction" (includes two sub-segments), "verification", "importance weight extraction and final quantification", and "result convergence".

Case study:

This section is assigned to parts of a conducted project titled "Designing and Implementing an Artificial Design Tool Based on Improved Kansei Engineering" in which we examined application of Mood Boards and Product Personality Profiling as two qualitative techniques in some phases of Kansei engineering parallel to routine exploited quantitative tools. Further, we assessed the results by repeating the procedure with the conventional quantitative approach. The detailed procedure of case study in the first approach is illustrated in the following flowchart. Each block will be discussed separately in the following statements.

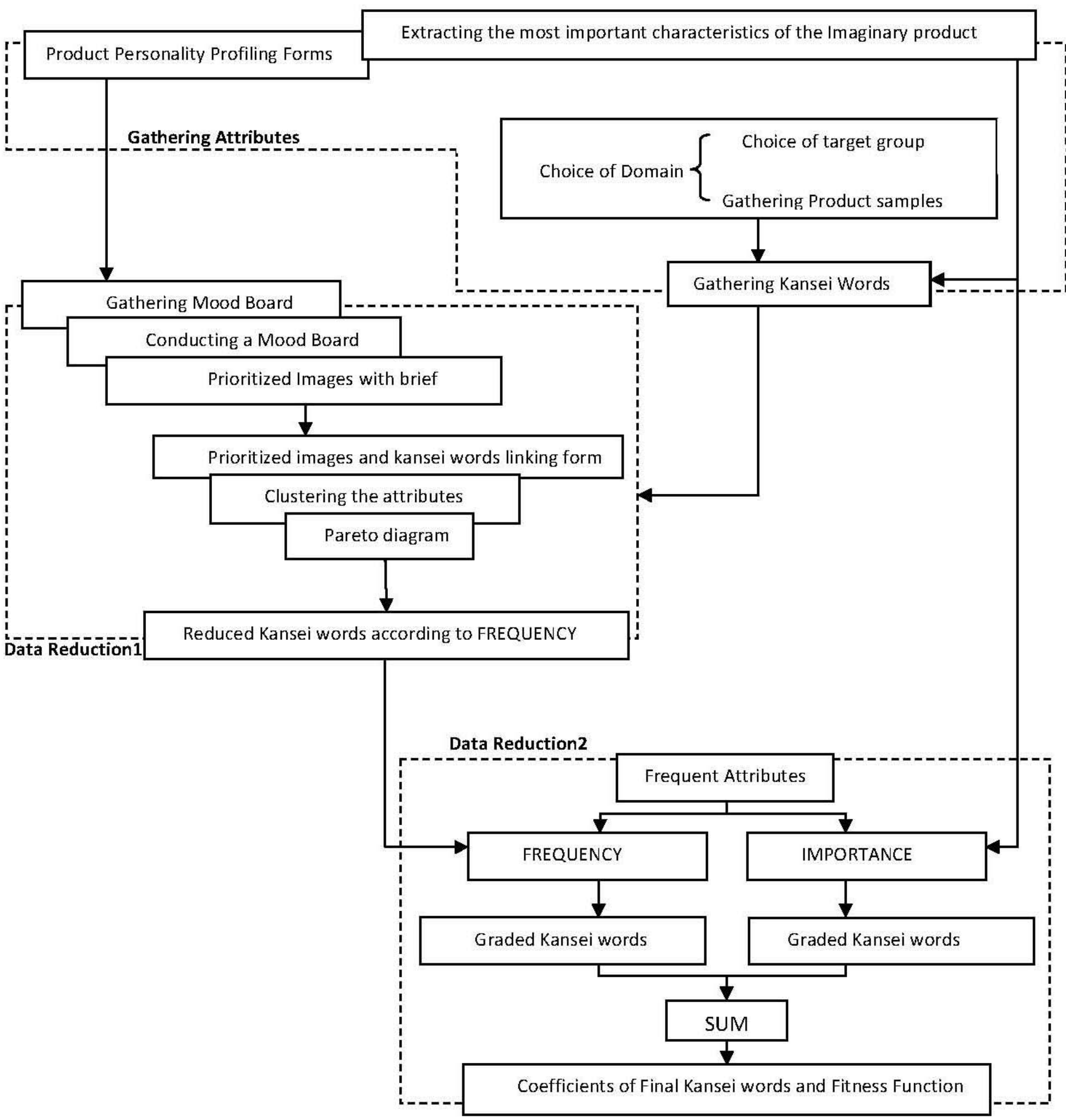

Figure 1. An overview of the whole process

Gathering attributes (Kansei words)

Commonly, the procedure of KE initiates with choice of domain in which the target group and sample products are chosen. The target group included 20-40 Iranian women and sample products ranged from electric and hybrid urban vehicles of renowned manufacturers to some new concepts. In the phase of gathering the Kansei words which is portrayed in the first dashed box in figure1, first all of the related sources such as internet, magazines, pertinent literature, experts, experienced users, relating Kansei studies, ideas, and visions were investigated, also a discussion group was held consist of 20 industrial design girl students in which they were asked to talk about the product samples and choose 3 most preferred ones in accordance with the project. All chosen samples were graded respecting their frequency and 3 of them were applied in the later PPP analysis. Then, we conducted a PPP session which included 20 participants who were shown PPP forms. This form included 3 columns for 3 selected products and also one more column for describing the imaginary product. One sample of this form is presented in figure 2.

Imaginary product	Product C	Product B	Product A	participant	
					sex
					age
					occupation
					lifestyle
					car
					personality
					Family environment
					clothes
					newspaper
					pet
					Favorite TV program
					Music
					Food
					Name
					Role in the family
					Favorite Cartoon Character
					Perfume
					Do you like to buy this product?
					Color

Figure 2. A sample of PPP form

Through PPP analysis we extracted a series of the most important attributes for imaginary products which were useful to be included with other gathered Kansei words. This analysis was also helpful for “data reduction phase”, the next step in KE.

Reduction of attributes, Phase 1:

The outline of this phase is shown in the second dashed box in figure1. Instead of regular application of marketing tools in this phase, Mood Boards was applied. At this point, previous PPP analysis was supportive in helping the design team to have much better visualization while gathering abstract images for Mood Boards. Afterward, one Mood board session consist of the same former 20 participants was held. A variety of images numbered as 778 from various categories were chosen. These images reduced to 271 images in the second classification. Then, all the participants were asked to set a layout of their 7 preferred images and also to prioritize them in accordance to their importance and relevancy to the Mood board question. They were also asked to express a short brief for each of their choices. Some of the advantages of using Mood Board were noticed as high enthusiasm among participants in fulfilling the task, and quicker understanding of the subject. One of these layouts is shown in figure 3.

Figure 3. A sample of a mood board layout used in the case study

The next task was to convert these qualitative responses to some fathomable values for the synthesis phase while reducing the number of Kansei words to the most important ones. Therefore, firstly all the gathered attributes were clustered and then linking forms were planned. This form included a list of all the new attributes and was presented to the participants to be marked for each of their 7 selected images. The list of attributes printed in the form is shown in the table 1.

Lightness	Particularity	Power	Slowness	Fun	Excitation	Complexity	Sensible
Heaviness	Ordinary	Softness	Rapidity	Seriousness	Calmness	Simplicity	Ornamental
Delicate	Sturdy	Sport	Spacious	Kind	Stylish	Compact	Happy
Sad	Mature	Childish	Feminine	Masculine	Smartness	Silliness	Unfriendly

Table 1. List of attributes

In the next step, these data were processed and the most frequent attributes were determined using Pareto diagram. The most frequent attributes in the first three priorities is illustrated in figure 4. These frequency values built the **Frequency** criterion for the second data reduction step.

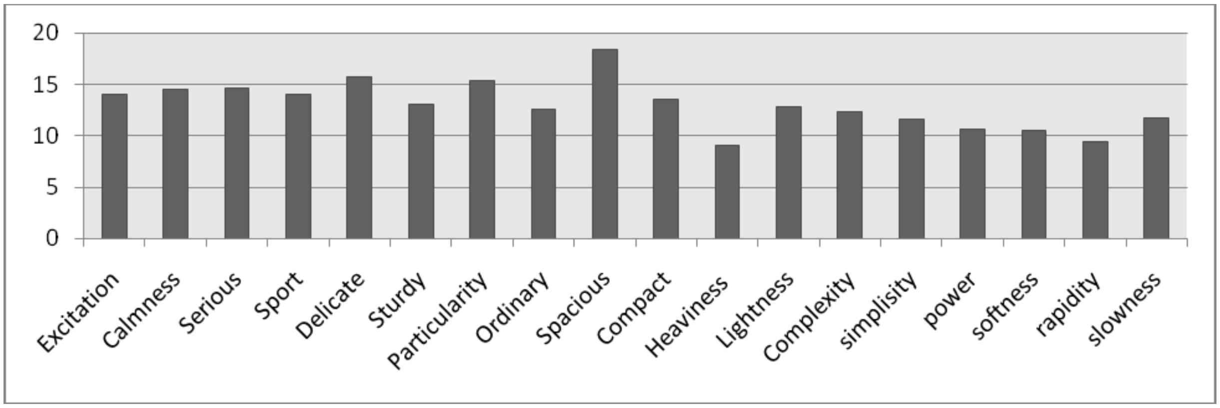

Figure 4. Comparative chart for frequency of attributes

Reduction of attribute, Phase 2:

In order to assign inclusive values to the attributes based on ideas of both participants and design team (the human side of design procedure), another reduction was conducted applying AHP. This phase is shown in the third dashed box of the figure1.As it was discussed in previous section, the output of the first reduction phase was used in defining the frequency criterion in the second step. Also, most of these attributes were in contrast with one another in the meaning; therefore, the attributes were rearranged to polar Kansei words like Spacious-Compact, Excitation-Calmness before being processed.

On the other hand, the **Importance** criterion was defined in accordance to the results gained from PPP analysis based on the designer's viewpoint and interpretation. Within this free point of manipulation, designers will be able to incline the results with respect to the main objectives of the project. For example if designers wish to orient towards a highly delicate final concept, they can assign a greater importance degree to the delicate attribute while processing it in AHP.

Furthermore, the partial scores for each attribute in both criteria were added together and the final scores were determined. Table 2 presents the first 5 attributes with higher final scores. These values were further used as coefficients of fitness function in the synthesis phase based on Genetic algorithm optimization.

FINAL SCORE	ATTRIBUTE
0.17	Spacious-Compact
0.114777	Sturdy-Delicate
0.088467	Particularity-Ordinary
0.083879	Serious-Sport
0.082718	Excitation-Calmness

Table 2. Final score of attributes based on co-qual-quant model

Verification:

In order to evaluate the quantification procedure of qualitative input data, a parallel process was conducted. Within this process all the attributes were graded using seven grade scales, and then the ten highest scored attributes were used in the first step of fuzzy survey. Figure5 shows a frame of the interface of this survey in which all the samples were scored with respect to attributes.

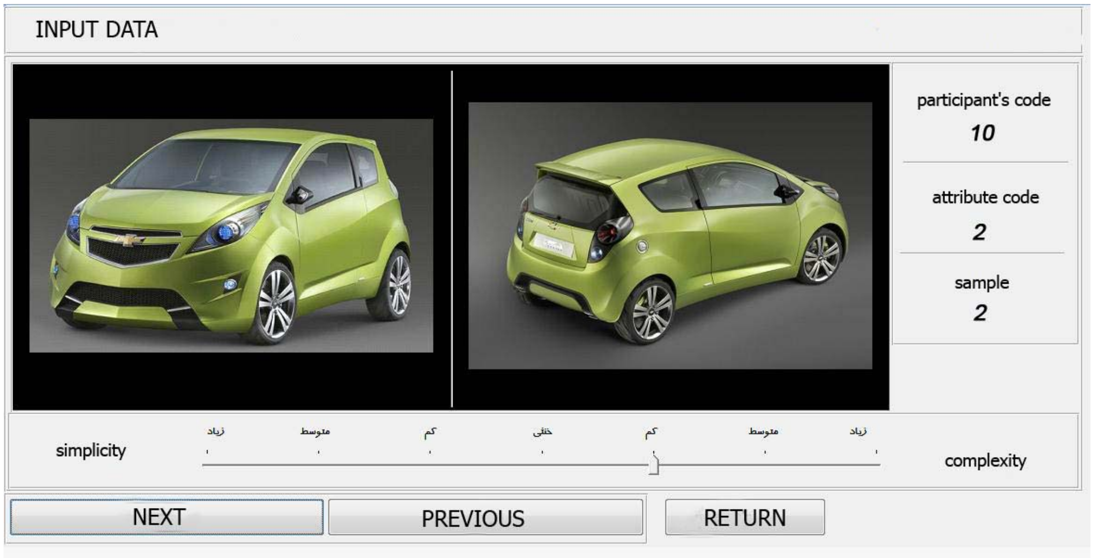

Figure 5. Fuzzy survey interface sample (Phase 1)

The output matrix of the first fuzzy step was categorized and reduced using Factor Analysis. By applying factor analysis the dependant variables or attributes were recognized and merged into one unique group, and then new name was given to this group of attributes. Interestingly, it was possible to categorize and name the main extracted attributes within similar five attributes obtained in the previous procedure like Spacious-Compact, Sturdy-Delicate, Particularity-Ordinary, Serious-Sport, and Excitation-Calmness.

In the second step of fuzzy survey, the data base obtained from the first step was used in order to give the participants a chance for comparing (and making a convergence between the mental concepts of Kansei terms), and also enhancing the accuracy of their choices. A frame of the survey interface is shown in figure 6. All participants were asked to firstly score the vehicle in the left side of the screen and then click the Enter button to see the car with the closer score to her choice. She was then free to change in her assigned scores according to her preference and was able to see the changes in data base accordingly. She was able to continue the procedure as long as she would feel pleased by her scores.

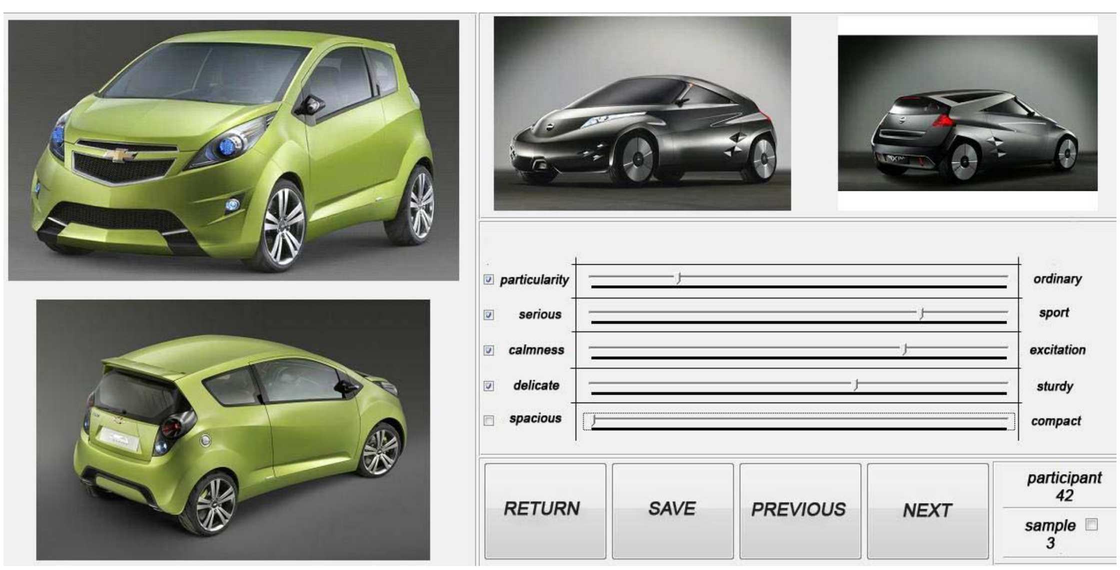

Figure 6. Fuzzy survey interface sample (Phase 2)

Importance weight extraction and final quantification

Due to the overall positive meaning of all of these attributes, in the next task they were all graded based on variance, which means that attributes with lower range of variance are of the most importance and have balanced mixture of both polar attributes, and vice versa. So, the attributes were again prioritized and scored applying AHP based on variance. Table 3 presents the new degrees of these attributes after AHP.

FINAL SCORE	ATTRIBUTE
0.177954	Spacious-Compact
0.088992	Sturdy-Delicate
0.077788	Particularity-Ordinary
0.09352	Serious-Sport
0.06641	Excitation-Calmness

Table 3. Final score of attributes based on pure quantitative procedure

Results Convergence:

After comparing the result of both methods (the pure quantitative method and the new co-qual-quan-titative method), it seemed that there was a meaningful correlation between the two sets of results. It was also expected that there would be such correlation and similarity between the results, because we have had selected a concrete and previously well defined object as the object of the design: a car. But it should be clearly mentioned that for different design objects or methods (for example for pure conceptual or state-of-the-art objects of design or for methodologies which use pure conceptual medium objects) there will be no guarantee for the convergence of the two results, indeed there will be a degree of divergence from a little difference between outputs of two methods up to total different sets of results.

Conclusion:

The new methods of design require the designer to use the numeric and quantitative tools. On one hand the daily developing use of CAD tools and computers and on other hand the need for satisfying the public interest, both force the designer to use computational and quantitative methods. This surely will save a lot of time and expenses in the manufacturing and designing industries, and accordingly will guarantee predicted success for the product.

But on the other hand, this may rise up some new problems in the design area: the designer role will be diminished and the users may show a faulty or unaware response to the quantitative design tool. This requires the methodology designers to revise the methods for overcoming this method.

On of the solutions is to inject some sort of “unconscious” awareness to the tool, and on the other hand there should be always enough role be left for the radical or intended presence of the designer.

As the result of such intention, we have re-designed some parts of a classic “Kansei Engineering” methodology to fulfill these needs. We have added some qualitative methods (as mentioned above, including PPP, MoodBoard and AHP) to the methodology and tried to expose the participants to some fully conceptual aspects and meanings of the object of design. Also we have tested the results in a real-world implementation, a project entitled “Designing and Implementing an Artificial Design Tool Based on Improved Kansei Engineering”.

As the final verification method, and as long as the subject of our project permitted us, we have rechecked the whole results with a pure quantitative and tested method and the result was to a compelling degree consistent. Despite what was mentioned above, in different design solutions or objects, the results might not be convergent like the mentioned project. However, as it seems that the philosophy of the modified methodology is enough reasonable and obvious, we suggest the usage of co-qual-quant techniques in such kind of complexities; for instance, a conceptual and ambiguous object or a culturally unfamiliar one. Not to mention the fact that surely there would be other combinations of such approaches, mixture of qualitative and quantitative approaches, which would yield the appropriate results.

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Synergizing Positivistic and Aesthetic Approaches to Improve the Development of Interactive, Visual Systems Design

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Abstract

An extensive literature review undertaken at the outset of this endeavor revealed that the current status of interactive visual systems development, implementation and sustenance has evolved from theory and research that is neither especially pluralistic nor synergistic.

There exist two distinct systems design approaches: 1. the largely positivistic and functionally guided approaches derived from the realm of information technology (IT), and 2. the incorporation of the more qualitatively based, aesthetically and experientially guided approaches derived from the realm of dynamic interaction design.

The authors hypothesized that this paradigmatic schism required a new approach that could bridge fundamental gaps in knowledge and understanding between visual interaction designers and IT professionals. They further hypothesized that achieving this goal would enhance the usability and usefulness of many types of interactive visual systems.

The authors created a theoretical, pluralistic process model comprised of aesthetic and positivist design characteristics of interactive visual systems.The model consisted of a process framework and a typology of design characteristics that depicted how aesthetic and positivist design characteristics affect each other. They then tested the hypothesis that diverse individuals perceive design characteristics in interface construction across paradigms by conducting a small-scale visual experiment on 105 participants. This hypothesis was formed by combining an aesthetic visual design approach with a functional, systems-based approach.

This experiment strongly confirmed the hypothesis; it affirmed the efficacy of using this type of pluralistic research typology and framework to better inform designers and IT researchers and practitioners who are challenged to design dynamic, interactive visual systems.

Keywords

aesthetics, IT systems development, interactive visual systems design, pluralistic research framework, positivism, user experience

Both the completed and ongoing research upon which this paper is based have been and are predicated on the same premise. It contends that the decision-making processes that inform the development of interactive visual systems would yield more efficacious results if they were guided by an inclusive, pluralistic research paradigm that could account for both functionalistic and aesthetic concerns. The primary objective of the authors' endeavors is to demonstrate how thinking derived from the discipline of visual communication design might be better integrated with thinking derived from the discipline of functional information systems design. To this end, the authors propose the application of a pluralistic framework to positively catalyze the operation of interactive visual systems that synergizes the systems-based, utilitarian approaches distilled from the information technology disciplines with the aesthetically based, user experience-driven appoaches distilled from the realms of design. (Again, information technology is broadly classified here to include information systems, human computer interaction and computer science.)

Justifications for altering existent research methods that affect the development and operation of interactive visual systems and that have become more inclusive and less reliant on narrowly structured archetypes have recently been authored by researchers working in the disciplines of IS, IT and interaction design. Goles and Hirscheim (2000) advocate a pluralistic approach to IS research as a means to overcome the limitations imposed by a single research perspective. They conclude that myopically informed research in this area limits, distorts, or even obscures relationships between information systems, people, organizations and society: "…paradigmatic pluralism should not simply be tolerated, but [is] a goal the IS community should strive for. Paradigmatic pluralism's strength is its recognition of the intrinsic diversity of problem formulations faced by the community of IS researchers (p.263)." Fallman (2008) calls for interaction design research to accommodate the interpretative attitude of many of the humanities disciplines, but he also calls for it to synthesize many positivistically framed scientific ideals without suppressing the role of aesthetics in favor of functionalism. Fallman asserts that "…when it comes to interaction design research, issues of aesthetics concern not only how something looks and feels, but also the aesthetics of the whole interaction, including how something works, how elegantly something is done, how interaction flows, and how well the content fits in (p.8)." Appeals for more inclusive approaches regarding the application of research methodologies applied to interactive visual systems design have also come from researchers working in the realm of human computer interaction. Bertelson and Pold (2004) have called for the re-orientation of HCI as a discipline that must address aesthetics as a crucial factor that informs interaction design research, arguing that "…predominantly positivist approaches are narrow, inflexible and cannot properly assess how aesthetic considerations affect user perceptions or actions (p.26)."

The objectives of this paper, and of the research that has been undertaken to inform its premise, are threefold. The first is to improve the iterative development processes that guide the creation and implementation of interactive visual systems. The second is to broaden the disciplines of communication design and information technology by facilitating a cross-pollination of theory and practice. To achieve these first two objectives, the authors created a model that is a pluralistic research typology and a framework of interactive visual systems design constructs, dimensions, and variables that bridge the paradigmatic planes occupied by these disciplines. As of this writing, this model is presented as an initial prototype that has been and still is in the process of being tested and evaluated—the authors' research will yield data and new knowledge that will cause it to undergo more iterative development over the course of the next two to three years. The authors believe that utilizing this type of model judiciously and effectively will help them at least begin to achieve their third, more "user-focused" objective. This involves improving the efficacy of the development and implementation processes that affect both the systemic functionality and the aesthetically affected perception and interpretation of interactive visual systems.

These objectives are articulated in the form of the following research questions.

How might the paradigmatically synergic framework that we have proposed to bridge gaps between positivistically informed approaches and aesthetically and experientially informed approaches to creating interactive visual systems efficaciously affect the decision-making processes that will guide their future development?

How should this unique approach to visual systems development, implementation and sustenance begin to fill current voids in the research and development infrastructures in the realms of information technology and dynamic, interactive design?

How will the pluralistic research typology we propose benefit user-centered IT applications in a manner that better accommodates the diverse perceptions regarding operability, adaptability and essential functionality among diverse groups of users?

A Rationale for Constructing This Type of Approach

The authors believe that practioners and researchers from IT and visual systems design can improve the effectiveness of interactive information systems by integrating theory, processes and methods from both paradigms. Representing these two paradigms, the research team was comprised of individuals from communication design (aesthetic paradigm), and from IT systems design and management science engineering (positivist paradigm). Each contributor had to accept the possibility that knowledge that originated outside his discipline might have to be included or acknowledged as an integral part of their collective endeavors. For the communication designer, it meant accepting that at least some of the theory that guides research regarding the design of interactive systems is viably grounded in the positivistic tradition that originated in the hard sciences. For the IT systems designer and management science engineer, it meant addressing how the aesthetic configuration of components that exist in space and that are operated in real time affect the perceptions of users and their behaviors, and that ultimately shape how these people construe meaning.

This work is motivated by what is possible rather than what has already been established, and by what the team members have deemed “the ‘what if?’ factor,” which may involve permeating and dissolving the existent paradigmatic boundaries of their respective disciplines. Viewed from the limited technical and vocational perspective of communication design, the outcomes of their endeavors offer a means “…to begin initiating, facilitating and managing new concepts as intelligent authors, researchers and developers of content (Storkerson, 2008, p. 4).” Viewed from the positivistic, functionally dominated research perspectives of information technology, the approach advocated by the research team expands the literature in these disciplines that addresses aesthetics as a vital factor affecting the operation of interactive visual systems. This work challenges the mindsets of IT and Information Systems (IS) that are “…at best, suspicious about beauty. ‘If it is pretty, it won’t work,’ summarizes one of the common prejudices among HCI and IT researchers and practitioners, and sometimes a pretty product is accused of hiding ‘harm behind its beauty’ (Russo and De Moraes, 2003, p.143).”

In order for an interactive visual system like a website to be “useful, useable and desirable (Cagan and Vogel, 2002)” to its users, its operation must be facilitated by the practical application of knowledge derived from both IT and communication design. In the absence of aesthetic knowledge, developers of functional systems rely on their users’ experiential sensibilities to make the systems usable. In the absence of functional IT systems knowledge, developers of aesthetic systems rely on their users’ aesthetic sensibilities to make the systems usable. Despite these interdependencies, the domains occupied by these two sets of researchers and practitioners tend to remain conceptually separated. Visual aesthetic design rests on an artistic framework of aesthetic, right-brain-oriented, subjective, qualitative criteria. Alternatively, IT website development rests on a functional framework of positivistic, left-brain-oriented, objective, quantitative criteria. Not surprisingly, no published research typology listing the characteristics of these now interdependent disciplines exists in either the scholarly literature of IT or communication design. Hassenzahl (2004) called for a pluralistic research typology when he wrote, “Future research must aim at unifying approaches to user experience. Its major objectives will be the selection of key constructs and a better understanding of their interplay (p. 345).” Tractinsky (2006) echoed, “To improve our understanding of the role of aesthetics in IT, we should identify relevant constructs and dimensions (p. 342).”

The authors agree with this call to action, and believe that a pluralistic typology is necessary to establish a research framework for interface development, website design, and all other endeavors that require interactive visual systems design. They propose that interactive visual systems design requires the integration of a fundamental understanding of visual communication design and IT. Those working in IT would benefit from a much deeper understanding of how meaning emanates from the aesthetic forms and configurations that allow users to operate their systems. Those working in visual communication design would benefit from understanding how and why the functions their design work actuates are planned, organized and sustained.

Constructing the Pluralistic Typological Framework for Interactive Visual Systems Design That Informed This Study

The authors utilized the aforementioned concepts to construct a typological framework that integrates aesthetics and positivism into a model of interactive visual systems design. They hypothesized that this framework could contribute to an increase in cross-disciplinary understanding between interactive systems designers informed by knowledge of visual communications and interactive systems designers informed by knowledge from IT. The framework was constructed in three steps. They began by categorically grouping characteristics that affect decision-making that are rooted in aesthetic concerns into the first of two “paradigmatic planes (Figure 1).” They then categorically grouped characteristics that affect decision-making that are rooted in positivistic, primarily functional concerns into a second paradigmatic plane (Figure 2). The third step involved configuring these two paradigmatic planes so that they intersected each other in a (virtually) three-dimensional problem space (Figure 3). The intersection of these two planes, represented by the darker area bisected by the dashed, vertical line, depicts an area of concern that is shared by interactive visual systems designers who hail both from visual communications and IT.

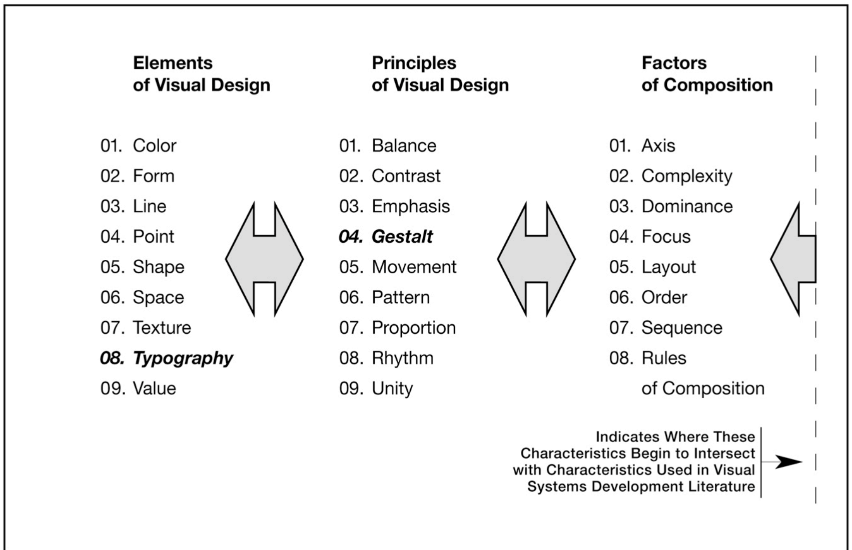


Figure 1. Aesthetic Characteristics Derived from Traditional Visual Design

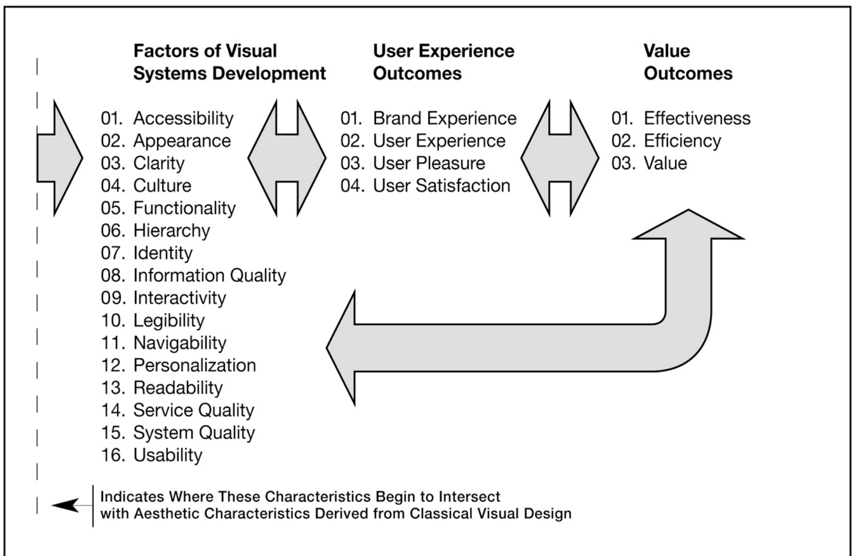


Figure 2. Functional Characteristics Derived From Visual Systems Development Literature

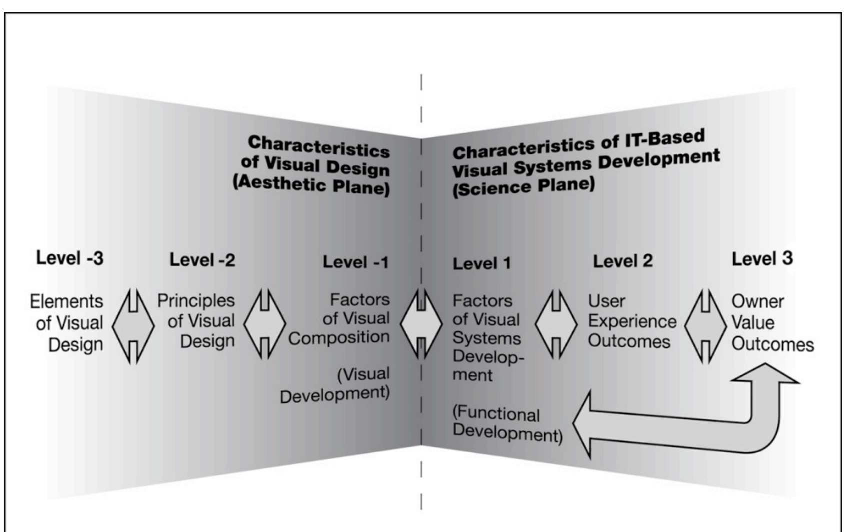


Figure 3. Framework for Visual Systems Design

The terms listed under the headings Elements of Visual Design, Principles of Visual Design, and Factors of Composition in Figure 1 and in other parts of this paper are derived from visual arts and visual communication design (these are articulated in detail in Tables 2, 3 and 4); similarly, the terms that are listed under the headings Factors of Visual Systems Development, User Experience Outcomes and Value Outcomes in Figure 2 and in other parts of this paper are derived from researchers and practitioners who develop their theories and test their hypotheses according to the scientific method (these are articulated in detail in Table 5, 6 and 7). While the authors acknowledge that these two sets of terms evolved separately and for different reasons, they believe that they can be carefully joined. This led them to the realization that all of the terms under the aforementioned headings in Figures 1 and 2 could function in this study as “variables,” and that these groupings of headings and their respective variables could be called “dimensions,” which are descibed in more detail in the next two paragraphs. These dimensions can then be formed into the “constructs” that are depicted as the two intersecting paradigmatic planes in Figure 3. The designations constructs, dimensions, and variables are positivistic research terminology.

Table 2. The Elements of Visual Design; Dimension Level -3 in the Typological Framework for Visual Systems Design

Element/Variable	Definition
Color	The perception of particular wavelengths of light as specific hues by the color receptors of the human eye
Form	3-dimensional, the visual appearance of an object in space
Line	1-dimensional, a continuous series of points; defines the edge of a shape or the boundary along which two shapes meet
Point	0-dimensional, a dot on a surfacee-Service Journal
Shape	2-dimensional, the boundary of an object; a self-contained area of either geometric or organic form
Space	The portion of an area that appears to be empty, the portion of a surface that is unfilled; the portion of a page left unmarked, existing between graphics, margins, gutters, columns, and text elements
Texture	The visual sensation of touch; the surface quality of a shape or form
Typography	Describes how the visual design of elements such as letterforms and the configuration of systems of these elements are organized on a printed or pixel-rendered page to facilitate the visual communication of language
Value	The lightness or darkness of a color

Table 3. The Principles of Visual Design; Dimension Level -2 in the Typological Framework for Visual Systems Design (These Involve Combining One or More Elements of Design)

Principle/Variable	Definition
Balance	The symmetrical or asymmetrical arrangement of objects or spaces within a composition so that they are perceived as having specific visual weight within it
Contrast	Visual dissimilarity between adjacent or juxtaposed objects, textures spatial arrangments or configurations of these within a given visual structure
Emphasis	Relates to the creation of the perception of varying degrees of dominance between the elements that comprise a given composition
Gestalt	A psychological theory suggesting that the mind's perceptions are holistic, continuously attempting to organize unassociated items into a coherent whole; In visual design, the combination of two or more compositional elements with distinct meanings as a means to create a unique, singular perception of new meaning
Movement	Occurs when the arrangement of elements and the spaces between them create the perception of motion (overlaps with rhythm) 2-dimensional, the boundary of an object; a self-contained area of either geometric or organic form
Pattern	An underlying model or structure that organizes surfaces or structures in a consistent, regular manner
Proportion	Scale-based relationships between one element and another, or between an entire entity and its component parts
Rhythm	Visually-timed or organized movement through space achieved by repeating or alternating elements and the intervals between them
Unity	Describes the relationships between the individual parts of a composition and the whole entity necessary to create the perception of wholeness

Table 4. Factors That Affect Compositional Structure in Visual Design; Dimension Level -1 in the Typological Framework for Visual Systems Design; Intersects with the "Science" Plane

Principle/Variable	Definition
Axis	Establishing a straight or curved line along which particular elements may be aligned to achieve balance and order within a composition
Complexity	The relative number of related parts in a composition; the degree of organization resulting from manipulating elements and principles of visual design
Dominance	The most prominent object(s) or characteristic(s) of a composition; establishing a perceptible hierarchy of emphasis, from most-important element(s) to least, in a given composition
Focus	A single, particular area of emphasis in a composition
Layout	The planned arrangement of objects and the spaces between them on a surface or page
Order	An organizational hierarchy of object characteristics arranged by importance; establishing varying degrees of emphasis in a composition through the successful manipulation of the elements and principles of visual design
Sequence	An underlying model or structure that organizes surfaces, spaces, or structures in a predictable, regular manner
Rules of Composition	Rule of thirds, rule of odds, rule of space, rule of the golden mean, etc.

Table 5. Factors That Affect the Development of IT Systems; Dimension Level 1 in the Typological Framework for Visual Systems Design; Intersects with the "Aesthetic" Plane

The factors presented in this list appear in alphabetical order in Figure 2.

Factor/Variable	Definition
Operational Factor *(Accessibility)*	The capacity to serve all users: "How well does the system comply with best practices and laws that address the needs of specially abled users?"
Operational Factor *(Functionality)*	How effectively does a given interactive visual system meet and fulfill the essential purpose(s) for which it was constructed?
Operational Factor *(Interactivity)*	How easy is it for specific users to cognize the manner in which the components that comprise a given interactive visual system are supposed to be operated to facilitate that system's functionality? Having done this, how easy it for them to actually operate them?
Operational Factor (Personalization)	How effectively can a given interactive visual system be adapted by a specific user to suit his or her personal preferences?
Operational Factor (Usability)	How effective, efficient, and satisfying is the experience of using a given interactive visual system to a specific user as he or she accomplishes necessary or desired tasks?
Actualization Factor *(Hierarchy)*	The cumulative ranking, order, complexity, and depth of the parts that consitute a given interactive visual system; also a factor crucial to visual design (as expressed in *Factors of Composition* such as *Dominance, Focus, Order* and *Sequence*)
Actualization Factor *(Navigability)*	How effectively can a user perceive and traverse a given system's hierachy of information? (Also a factor crucial to visual design, as expressed in *Factors of Composition* such as *Dominance, Focus, Order* and *Sequence*)
Visual Perception Factor (*Appearance*)	Accounts for "look and feel:" How does the initial impression of the system affect the visual perceptions of given groups of users?
Visual Comprehension Factor (*Clarity*)	How effectively are essential messages perceived, interpreted and acted upon by specific users?
Visual Comprehension Factor *(Legibility)*	How easy is it for someone who is not visually impaired to discern the inherent empirical differences in the typographic elements that appear throughout a given interactive visual system well enough to be able to read them?
Visual Comprehension Factor *(Readability)*	How psychologically "unintimidating" and "easy-to-read" do the typographic elements that appear within a given interactive visual system appear to a specific user?
Empathetic Factor *(Culture)*	How effectively has the inherent functionality of the system been tailored to accommodate the shared beliefs, customs, attitudes, and preferences of particular groups of users?
Empathetic Factor *(Identity)*	How effectively does the system accommodate and reflect a given user's/user groups' unique sense of social, cultural, economic or political belonging? (This factor is often referenced in relation "persona-based marketing" and "tribal marketing.")
Qualitative Factor *(Information Quality)*	How effectively does the information presented within a given interactive visual system meet the real and perceived needs of a given user?
Qualitative Factor *(Service Quality)*	How effectively do the transactional, logistical, and information delivery services providided by a given interactive visual system meet a specific user's real and perceived needs?
Qualitative Factor *(System Quality)*	How effectively does the overall functionality facilitated by a given interactive visual system meet a specific user's needs?

Table 6. User Experience Outcomes; Dimension Level 2 in the Typological Framework for Visual Systems Design; Intersects with the "Aesthetic" Plane

Outcome/Variable	Definition
Brand Experience	The quality, extent, and intensity of a specific user's understanding of and experience with a given brand's essential promises, touch points, marketing axioms, etc. as facilitated by the manner in which these are communicated throughout a given interactive visual system; it is this outcome that informs how a given product or service is perceived differently from others that are very similar to it
User Experience	Describes the overall quality of a specific user's experience with a given interactive visual system; this outcome is affected by how the system is perceived, learned and actually used
User Pleasure	Describes the level of enjoyment or delight that a specific user experienced as a result of his or her interactions with a given interactive visual system
User Satisfaction	The level of contentment or approval a specific user experiences as a result of his or her interactions with a given interactive visual system; the degree to which the user actually "likes" interacting with the system

Table 7. Owner Value Outcomes; Dimension Level 3 in the Typological Framework for Visual Systems Design; (these measure the overall success of the system on behalf of its owner)

Factor/Variable	Definition
Effectiveness	The extent to which a given interactive visual system accomplishes the purpose or purposes for which it was developed
Efficiency	The extent to which the benefits generated by a given interactive visual system outweigh what it costs to operate it
Owner Value	Subjectively, the extent to which a given interactive visual system contributes to the satisfaction of some predetermined criteria, including customer satisfaction, compliance, loyalty, revenue generated, etc.

The "Aesthetic Plane" (fully articulated in Figure 1) in this framework is comprised of a hierarchical arrangement of characteristics that have been appropriated from several sources of current, empirically based visual theory (Leborg, 2006; Arnheim, 2004; White, 2002; Wong, 1993; Dondis, 1974; Wong, 1972) and from the author with a background in communication design education and research. These characteristics are organized into The Elements of Visual Design, The Principles of Visual Design and The Factors of Composition, and are depicted in Figure 1. They are also depicted as hierarchical dimensions numbered -3, -2 and -1 respectively in the "intersectional diagram" illustrated in Figure 3. Tables 2, 3 and 4 articulate the meanings of the terms that constitute each of these hierarchical dimensions. Variables from Tables 2, 3 and 4 (contrast, emphasis, balance, focus, readability and appearance) that are used in this study were presented to 105 participants in the study, described later in this paper. This occurred prior to their engagement in any of exercises that involved their operations and assessments of the samples of interactive visual systems during the study.

The "Science Plane" (articulated in Figure 2) in this framework is comprised of a hierarchical arrangement of characteristics aggregated from a review of scholarly literature that informs IT web development, HCI, IS, CS and e-commerce ventures (Table 1), and from the two authors who have extensive experience in IT and HCI research and teaching. These characteristics are organized into Factors of Visual Systems Development, User Experience Outcomes and Value Outcomes and are depicted in Figure 2. They are also depicted as hierarchical dimensions numbered 1, 2 and 3 respectively in the "intersectional diagram" that forms Figure 3. Tables 5, 6 and 7 articulate the meanings of the terms that constitute each of these hierarchical dimensions.

It is important to note that the authors have configured the intersecting Aesthetic and Science Planes in Figure 3 so that the three dimensions (described as Levels) that comprise them can exist such that a bi-directional "flow of influence" affects the variables under each dimensional heading. In this way, an Element of Visual Design/Level -3, such as value can affect a Factor of Visual Systems Development/Level 1, such as readability or system quality. Knowledgeable visual communication designers learn this during the earliest stages of study as an undergraduate, but often have great difficulty articulating how the variables under the Aesthetic Plane affect those that exist under the dimensions that form the Science Plane, especially to those unfamiliar with design programs (Frascara, 2007). IT theory and practice inadequately addresses aesthetics and the variables in the Aesthetic Plane. Instead, IT theory and practice confines itself almost exclusively to the Scientific plane. Conversely, the opposite is also true for Communication Design theory and practice. It inadequately addresses how the variables in the Scientific Plane affect the variables in the Aesthetic Plane, and confines itself almost exclusively to the aesthetic plane.

The authors contend that the dissimilar treatment of the aesthetic and positivistic approaches to systems design has resulted in dysfunctional processes in the aesthetic realm and unaesthestic systems in the positivistic realm. The authors' research has led them to the realization that the common knowledge of the IT world is not the common knowledge of visual interaction designers and vice-versa. This paradoxical problem "…works both as a trigger to creative imagination and as a context for the evaluation of the design. For a solution to be a solution, it needs to be recognized as such by all of the relevant discourses. In practice, it should be acceptable to all of the relevant stakeholders (Doorst, 2006, p.15)". The research in this paper is a first step in a process of "bridging a gap in understanding" between researchers whose work is fundamentally informed by two different paradoxical perspectives, and it represents an initial movement toward achieving greater appreciation and comprehension between the two.

Assessing the Affects of Specific Dimensional Variables from the "Science Plane" on Those from the "Aesthetic Plane"

A Contextualization of the Authors' Approach

Research that affects the design and development of interactive visual systems has to account for issues that are framed by epistemological, praxiological and phenomenological concerns (Cross, 1999). It is in response to this diversity of fundamental concerns that the essential contentions of this paper are made. Just as there once was a time in IT systems design when functional websites were developed without database design (and now they are), current IT systems websites are developed without enough knowledge of the affects of visual design (and they still are not). Similarly, there was once a time when interaction designers failed to approach the design of visual interfaces differently than for print (and now they do), current interaction designers develop websites without enough knowledge of the effects of IT (and they still do not).

Interactive visual systems must effectively facilitate web applications, social networking and the semantic interpretation of data. The way they are used, and the way those who use them interpret meaning and act on those interpretations is based on how both the aesthetic configuration and the functionality of all of the elements of a given interactive visual system are perceived by particular people. The perceptions and subsequent actions taken by any group of users within such a system are directly and indirectly affected by several factors. Among them are:

- the user's ability to synthesize data derived from sensory cues (cognition);
- their socio-cultural perceptions of visual gestalts (semiotics);
- their emotional responses to specific representations of information presented visually (psychology);
- their abilities to conform their activities to the system based on how the design of that system has been configured to facilitate its functionality (information design).

The first and third items from this list form rubrics for the factors that were of greatest concern to the authors during the study, but this does not imply that the authors believe they are most important among this group. Rather, in the context of the test instrument utilized in this early phase of their research, they were the most straightforward in examining constraints imposed by time, the ability to secure viable responses from a large enough group of participants, and the accessibility of necessary physical facilities.

A Description of the Study and of the Methodology That Guided It

The demonstration study described in this section was designed to test a given group of users' abilities to perceive the way that the manipulation of particular sensory cues influenced their visual perception of a specific interactive visual system. This system was a simple, commercial website interface for a small interior design firm. This interface was selected due to its uncomplicated visual organization and low level of functional complexity, and these characteristics were held constant throughout the study.

The authors' primary objective was to test their hypothesis that a dependent variable located in the positivistically informed, paradigmatic "Science Plane" (see Figures 2 and 3) could be directly influenced by the manipulation of one or more variables from the leftmost edge of the paradigmatic "Aesthetic Plane" (see Figures 1 and 3). They chose the factors appearance and readability from dimension Level 1 as representative variables from the Science Plane, which exist under the dimension Level 1 heading Factors of Visual Systems Development and are described in Table 5 as sub-dimensions of Visual Perception and Visual Comprehension. From the Aesthetic Plane, the factors color and value were chosen from under the dimension Level -3 heading Elements of Visual Design. The variables contrast, emphasis and balance were chosen from under the dimension Level -2 heading Principles of Visual Design, and the variable focus was chosen from under the dimension Level -1 heading Factors of Visual Composition. The authors chose not to examine how variables under the dimensions of the Science Plane influenced the variables in the Aesthetic Plane because a). that research is ongoing and not yet complete, and b). even if it had been completed in time to include in this paper, it would constitute the content of either a separate paper or a lengthy addition to this one.

The authors used the original version of the website interface as the control element of their test instrument (Figure 4). They created altered versions of it wherein the factors color and value from the dimension Level -3 heading Elements of Visual Design were manipulated so that the visual perception of these altered versions would be perceived as significantly different from the original version. The authors then performed three stages of instrument development: alpha, beta, and pilot testing. The alpha testing stage involved soliciting contributions from a panel of five communication design, information technology, and survey design experts from within the sphere of the authors' University, who developed, tested, and obtained approval for the initial instrument from their University's institutional review board. The beta testing stage involved the review and testing of the instrument by a panel of 10 doctoral students from all of the University's College of Business' (CoB's) five departments. The beta testing stage revealed that several more minor revisions needed to be made to the test instrument (depicted in Figure 5) before it could be utilized with undergraduate participants from both CoB and the University's College of Visual Arts and Design's (CVAD's) Department of Design. Once the authors completed these revisions, the test instrument was made available for online operation to 38 fourth-year, undergraduate, communication design majors (although only 18 responded) and 67 third-year, undergraduate information technology and decision sciences and marketing and logistics majors.

Facilitating the Study with the Test Instrument

The test instrument contained six groups of six identical questions and required an average of less than ten minutes to complete. The authors assured students that their anonymity would be preserved, and that their participation was entirely voluntary. Students had a choice between completing the questionnaire for extra credit, completing an equivalent extra credit activity, or not participating in the study at all, which resulted in receiving no credit.

The participants in the study from communication design were all enrolled in a fundamental, web-based, interactive systems design course and had just completed week six in their course schedule when they participated in the study. The students enrolled in CoB majors participated in the study at various times during the 15-week semester during which the test instrument was made available to them online. To account for the disparity between the two groups regarding the understanding of how aesthetic considerations affect and effect interactive visual systems, the authors crafted the study so that it only challenged participants to identify to what degree they perceived change between between the control website interface and a series of six variations to this interface (see Figure 5).The authors did not call for participants to render any type of judgment about whether or not the changes in any of the six variations improved or worsened the interface design in any of the Levels on either of the two paradigmatic planes depicted in Figure 3. This would have required the entire group of participants to possess relatively well-developed aesthetic skills and sensibilities, which was not the case, since students in the CoB typically do not receive instruction in visual design. The authors determined that student participants were appropriate for this study because all of them were regular computer users and had a great deal of familiarity with operating interactive visual systems, especially the types necessary to use websites and navigate the Internet.

The test instrument manipulates, in sequence, two independent variables in the design of the control interface: value and color (Elements of Design, Level -3 in the Aesthetic Plane, Figure 1). The authors manipulated these to change the way that the components of the control interface (Figure 4) might be perceived by the student participants of the six different color/value variations. An example of a how the student participants were presented with a configuration of the control interface and a variation of it appear together in Figure 5. Each of the six variations was accompanied by an image of the control interface for comparison purposes. The study participants only needed to acquire a basic understanding of contrast, emphasis, and balance (Principles of Visual Design, Level -2, see Figure 1), focus and readability (Factors of Composition, Level -1, see Figure 1), and appearance (Factor of Visual Systems Development, Level 1, see Figure 2), since these were the characteristics about which they would be queried throughout the test instrument. The communication design students in the study were already familiar with these terms, as their coursework requires them to develop a working knowledge of them. The authors provided definitions for each of the terms prior to the commencement of the study. The participants received access to explanations and definitions of the terminology in three ways: 1. verbally, 2. in the explanation section of the online instrument and, 3. by mousing over them whenever they appeared in the online test instrument. The compositional configuration of the interface was held constant throughout the study; the Factors of Visual Composition, Level -1 (Figure 1)—order, complexity, layout, rules of composition—were not manipulated in any of the six variations to the control interface during the study. The authors believed that introducing more variables would be beyond the scope of this study.

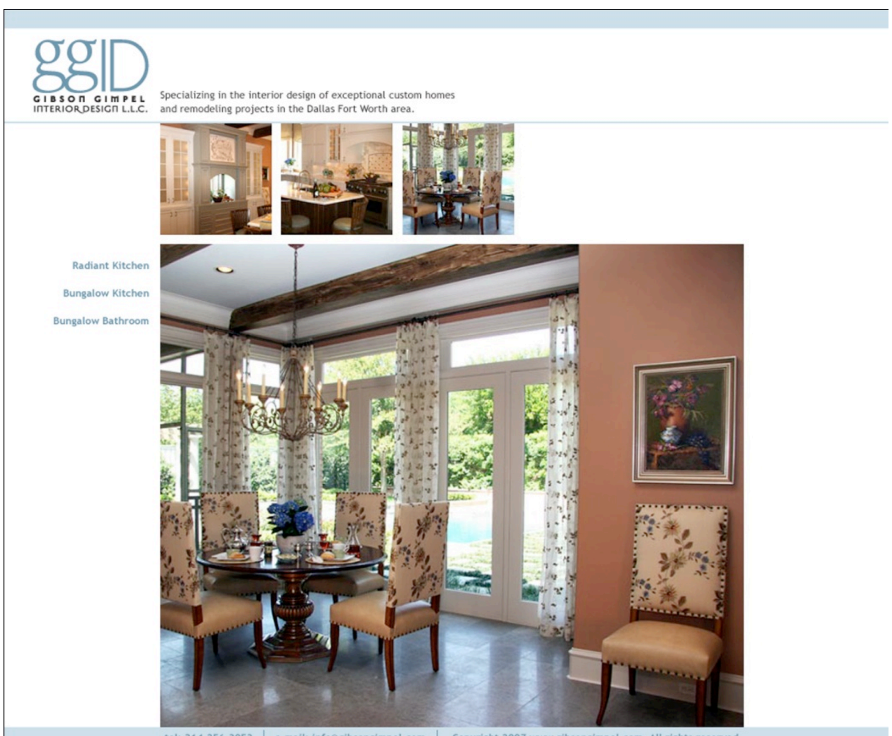
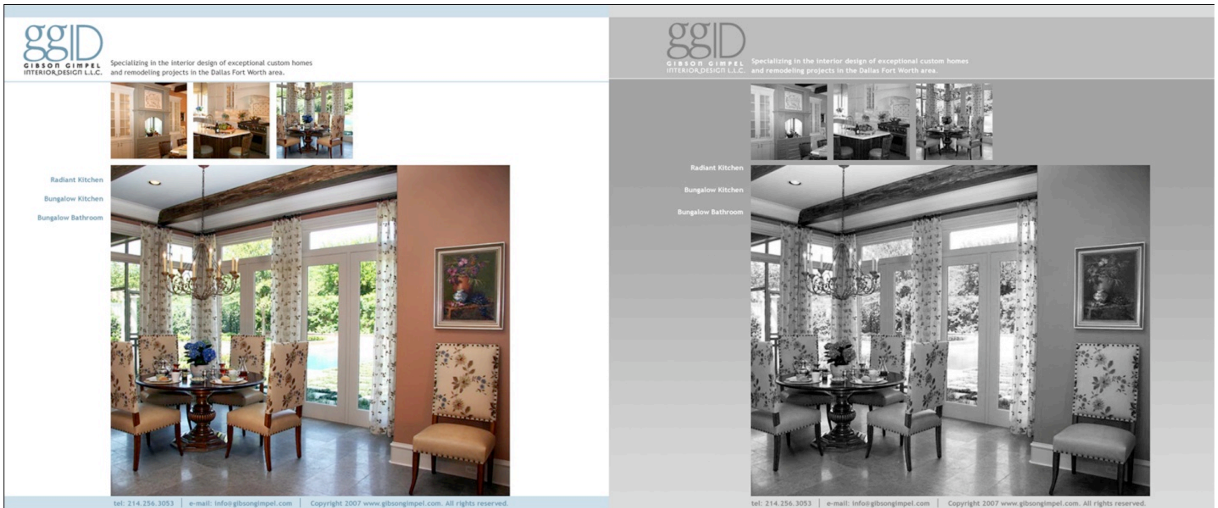


Figure 4. The original ("control") web interface used in the Study

Change in each of the six variations to the control was achieved by manipulating either the colors or the values of the components that appeared within it. The authors presented six questions directly beneath this configuration; each question solicited responses by using a seven-step Likert scale from “Strongly Disagree” to “Strongly Agree” (Figure 5).



1. You perceive a change in the ***contrast*** between the original interface design and the variable. — 1 2 3 4 5 6 7
2. You perceive a change in the ***emphasis*** between the original interface design and the variable. — 1 2 3 4 5 6 7
3. You perceive a change in the ***focus*** between the original interface design and the variable. — 1 2 3 4 5 6 7
4. You perceive a difference between the ***readability of the type*** in the original interface design and the variable. — 1 2 3 4 5 6 7
5. You perceive a change in the ***visual balance*** between the original interface design and the variable. — 1 2 3 4 5 6 7
6. You perceive a difference between the ***overall visual appearance*** in the original interface design and the variable. — 1 2 3 4 5 6 7

On this scale:
1 = strongly disagree;
4 = neutral;
7 = strongly agree

Please indicate your strength of agreement by choosing only one of the seven roundels per line in the scale at left.

Figure 5. A sample page from the Pilot Survey, depicting the control interface and a manipulated interface as the participants in the Study encountered them. Each time a participant encountered one of these comparisons (six were used), he/she was asked to respond to the six statements that appeared immediately below the two interfaces by checking one of the radial buttons in the seven-step Likert-scale response table. Each participant could view a brief definition of the italicized terms by mousing over them at any point during the Pilot Survey.

The Results of the Study

A total of 105 responses were collected from the combination of communication design and CoB students. The communication design group of participants was used as an expert calibration group. These participants had all completed at least three years of undergraduate study in the communication design curriculum at the authors’ university. Approximately 83 percent of their responses were above neutral Likert item 4 (see Figure 6). This established a baseline for 83 percent of the items they perceived, indicating that visual change had occurred. For 72 percent of the items above Likert item 5, they either agreed or strongly agreed that change had occurred.

The three business groups, having 87 total respondents, reflect the same perception patterns, with frequencies of 77, 78, and 75 percent above neutral, and a 66, 60, and 61 percent in agreement or strong agreement that change had occurred. The authors suggest that these results indicate that the communication design students had a deeper understanding of the extent to which color and value affected change in each variation.

Figure 7 depicts the arithmetic means for the independent variables in all groups. In the expert communication design group, the variables that exhibit the strongest agreement are the visual variables of appearance, contrast, and readability. The three business groups also exhibit the strongest agreement for these three variables. Similarly, these three variables account for 57 percent of the measured change for the expert group, and 54, 52, and 54 percent for the business groups. The variables balance and emphasis received the lowest scores in all groups. Although the business respondents' results do not demonstrate the crispness and clarity of perception possessed by the communication design group, the results support the contention that the business groups perceive almost the same intensity of change and the same direction of change as the more expert group. The scores and means of the respondents for all groups confirmed that all of them perceived that a visual change had occurred, and all groups agree that changes occurred, and all groups agree regarding the intensity of that change. Generalizing this finding, we confirm the substantial research across a multitude of disciplines asserts that the effects of aesthetic design can be perceived by most normally-sighted individuals.

The authors also believe that these results support the idea that aesthetic training enhances the visual perceptions of individuals who use or develop visual interfaces. Although this may seem obvious to designers who regularly operate in the Aesthetic Plane, the authors believe it is not known or understood to IT systems developers who regularly operate in the Science Plane. This pluralistic testing of aesthetic phenomena in interactive visual systems design is based on a positivistic inquiry, using the scientific method. Thus, the authors believe that this supports their premise that the two paradigmatic planes are compatible for interactive visual systems design.

Conclusions

The authors' implemented their proposition that the intersection of the Aesthetic Plane and the Science Plane can be compatible. The instrument used to test this assertion manipulated a limited array of visual design variables: color and value (which were independent), contrast, balance, emphasis, focus, readability and appearance (which were dependent), and order, complexity and layout (which were held constant). All of the participants in the study, regardless of their educational backgrounds or training, perceived aesthetic changes similarly when measured by a scientific instrument.

The results suggest that interactive visual systems researchers and developers from both paradigms can perceive visual changes to the systems similarly, even if their perceptions are informed by different philosophical approaches. It also suggests the value inherent in challenging researchers and practitioners working in communication design and IT to significantly expand their inquiries into each others' spheres of understanding. It is not enough for those working in IT to have "read a bit of Moggridge, Winograd, Mullet and Sano" to improve their knowledge of the effects of aesthetics on various user groups' abilities to operate interactive visual systems, just as it is conversely not enough for communication designers to have "read a bit of De Angeli, Sutcliffe, Hartmann and Kristof" to improve their knowledge of the design and implementation of functionally focused interactive visual systems.

That being said, the authors also concluded that the variables that form the two intersecting paradigmatic planes utilized here reveal a set of limitations that further study must overcome. The necessity of further empirical study and more broadly informed reasoning from both communication design and IT must be brought to bear if the relationships between the sets of variables that occupy the Levels and the Planes are to reveal more useful, useable knowledge.

Further examination of the "cross-Level" effects of the variables of each of the Planes presented a vast and complex network of interdependent, cause-and-effect relationships between elements, factors, variables, sub-variables, dimensions and constructs. Accounting for how the complex web of relationships throughout the entire amalgam of the variables from beyond Levels 1 and -1 affected each other was a complex task, and this complexity limited the authors ability to some degree throughout the study. This complexity also inhibited their attention on the area of the two intersecting planes that form the main bridge between visual design and IT, in which they had originally anticipated a broader accounting of variables from all the Levels.

Next Steps

This experimental study leads the authors to conclude that their hypothesis is confirmed. It affirmed the efficacy of using this type of pluralistic research typology and framework to better inform designers and IT researchers and practitioners. In addition, these results justify integrating the knowledge that exists in the realms of visual design and functionally motivated information systems, and information technology design.

The authors' research findings reveal that the greater contribution to both the IT and the interactive visual systems design communities will be made by concentrating their efforts on integrating the tenets of traditional (functional) systems design and visual design. This concentration will steer them away from attempting to study aesthetics with a positivist approach, which is a less viable approach for achieving their research objectives. The ultimate goals are still to 1. address deficiencies in IT researchers' and professionals' understandings about how aesthetic decisions affect users' perceptions of and actions within functional systems, and 2. to address deficiencies regarding visual systems designers' understandings of how functional IT systems are planned, implemented and effectively sustained.

For the next step in this research, the authors will focus on how selected factors of visual development should be integrated with the factors of functional information systems design. This research will proceed in stages, incorporating the knowledge that the authors have gained from the model presented in this paper, but will be limited by examining the effects of only a few of the variables at a time from the current model's Level -1 and 1, which a few others have recently demonstrated to be more easily supported by empirical findings (Hassenzahl, 2003). The next study that the authors plan will focus on groups of communication design students and CoB students and practicing business professionals in the near future.

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Authors' Biographies

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Design Fiction: A Method Toolbox for Design Research in a Complex World

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Abstract

Current debates on design research, and its relation to other research fields and scientific disciplines, refer back to a fundamental distinction introduced by Herb Simon (Simon, 1996 (1981)): Design and design research do not primarily focus on explaining the world as it is; they share with engineering a fundamental interest in focusing on the world as it could be. In parallel, we observe a growing interest in the science studies to interpret scientific research as a constructive and creative practice (Knorr Cetina, 1999; 2002), organized as experimental systems (Rheinberger, 2001). Design fiction is a new approach, which integrates these two perspectives, in order to develop a method toolbox for design research for a complex world (Bleecker, 2009; Wiedmer & Caviezel, 2009; Grand 2010).

Keywords

epistemology; science studies; design fiction; experiment

Introduction

Research Context & Basic Hypothesis

Design research looks back to several decades of debates concerning the practice, theory, methodology and epistemology of design research (Cross, 2007; Bayazit, 2004). Thereby, we can identify different approaches to defining and structuring the field: some scholars focus on mapping and structuring the multiple existing, *self-declared research projects, identifying dominant clusters* and research fields (Sanders, 2006; Laurel, 2003; Gray 2004), assuming that what identifies as design research actually qualifies as design research; some scholars argue for *particular epistemologies and theories* as a promising starting point to define possible approaches in design research (Cross, 2007; Fallman, 2003; Findeli & Bousbaci, 2005), suggesting that design implies particular ways of knowing and thus also particular epistemologies; some scholars characterize design research in relation to other scientific disciplines or a general pre-understanding of science, arguing for *particular qualities of design as a scientific research discipline* (Cross, 2006) or *emphasizing the oxymoron* inherent in any attempt to link design to scientific research (Frayling, 1993; Krippendorff, 2006).

One interesting observation thereby is, that implicitly or explicitly, these various attempts continue to refer to a fundamental perspective introduced decades ago as a root distinction in design research (Simon, 1996 (1981)): Design and design research do not primarily focus on the world as it is, like most scientific disciplines, trying to develop descriptions, interpretations, and explanations of existing objects, processes, and activities; design and design research share with engineering a fundamental interest in *focusing on the world as it could be, on the imagination and realization of possible futures*, as well as on the disclosure of new worlds. This implies a reflection of the contingencies of our world today, and of the practices for creating, imagining, and materializing new worlds. Another interesting observation is, that the controversies in the science studies concerning scientific research in general increasingly emphasize the *inherently constructivist and imaginative nature of scientific practice* (Galison, 1997; Knorr Cetina, 1999; 2002), the importance of improvisation (Knorr Cetina, 2002) and experimentation (Rheinberger, 2001) for the research process in general, or the primary role of artifacts (Knorr Cetina, 1999), images (Jones & Galison, 1998), or materiality (Galison, 1997) and their design in research practice.

Instead of arguing for design research as a particular approach to scientific research, or for design research as being systematically different from scientific research, it is much more appropriate to understand in more detail the close relation between design as the imagination and creation of possible future realities (Jonas, 2007; Bonsiepe, 2007) on the one hand, and the construction of reality and objectivity in scientific research (Daston & Galison, 2007) on the other hand. In this perspective, we argue for an approach, which understands *research as design* (Grand, 2010), and thus as a systematic extension of the current discussions in design research. Such an approach has two fundamental implications: First, it implies that the conceptualization of design and design research as a practice and research field, which particularly focuses on the world as it could be, should be taken as the actual core for defining and practicing design research: This is what we call *design fiction* (Wiedmer & Caviezel, 2009; Bleecker, 2009). Second, it implies that design is a productive approach to conceptualize scientific research itself as a design practices: This is what we call *research as design* (Grand, 2010; Jonas, 2010).

Current Relevance & Open Issues

This characterization of design and design research, as well as of scientific research in the perspective of design, is particularly important and relevant today: As we learn from the recent science and technology studies (among others: Nowotny, 2008; Nowotny, Scott & Gibbons, 2001; Rheinberger, 2001; Bijker & Law, 2000; Biagioli, 1999; Latour, 1999; Felt, Nowotny & Taschwer, 1995; Bjiker, Hughes & Pinch, 1989), our societies are involved and engaged in fundamental debates and reflections concerning not only the world as it is, but concerning possible futures, in many areas. Thereby, those debates and reflections are characterized by a high complexity, due to the multiple perspectives, interests, concerns, issues, and approaches, which are represented by the multiple parties involved. From the perspective of the development of our contemporary societies, we can argue that these societies become increasingly knowledge intensive (Stehr, 1994), reflexive (Beck, Giddens & Lash, 1994), and experimental (Latour, 2004), implying that knowledge creation, scientific research and technological innovation are central to our societies. From the perspective of scientific research, we can argue that the sciences are social (Nowotny, Scott & Gibbons, 2001), technological (Bijker & Law, 2000), and commercial (Stehr, 1994).

Our world is increasingly involved and engaged in complex, collective political and economic debates and experiments (the current financial crisis is just one of the most recent examples), in which different actors including governments, companies, NGOs, social movements, virtual communities, … are engaged, and in which the differentiation between scientific research, institutions and laboratories on the one hand, and societal and political processes on the other hand, are blurring (Novotny, 2008). As the same time, this opens new opportunities for research as design, if design is understood as the creation, realization and materialization of possible future realities. In most cases today, the reactions and actions in those collective debates and experiments are not particularly imaginative and creative. We thus suggest that design and design research are pre-disposed to play a very active and important role in those controversies and collective experiments, and that design and design research should make its particular practices, tools and methods relevant to those debates, while at the same time developing new tools and methods, which are important for collectively dealing with possible futures in a complex world.

Research Question & Argumentative Structure

In our paper, we develop a strategy for design and design research to contribute to those controversies and activities, which we call “Design Fiction”, asking the research question:

How can design research contribute to the collective controversies and experiments, in which our societies deal with fundamental current and future challenges and transformations of our complex world?

In order to answer this research question, we proceed in three steps: in Part 1, we discuss recent contributions on the epistemology of design research, which indicate productive building blocks and relevant insights into a re-conceptualization of design and design research as design fiction (Bleecker, 2009; Brown, 2008; Bonsiepe, 2007; Krippendorff,, 2007); in Part 2, we discuss some recent contributions in the science studies, which explore, describe and analyze the inherently constructive, creative, controversial, critical, material and imaginative nature of scientific research in general, thus allowing to re-conceptualize the research process as a design process (Latour, 1986; 2005; Galison, 1997; Knorr Cetina, 1999; 2002; Rheinberger, 2001; Nowotny, 2008); in Part 3, we identify current approaches in design and design research (as well as scientific research), which provide particular methods and tools to conduct research in this design perspective (Dunne, 2005; Dunne & Raby, 2001).

Part 1: From Design Research to Design Fiction

The ongoing discussion regarding methodology in design research is characterized by a strong dualism between the assertion of what scientific research means and of what designers do (Chow & Jonas, 2009). In order to explore the current state of the art in this debate, as well as to introduce “design fiction” as a new possible perspective, we discuss some promising epistemological approaches in design research today.

In general, the debate is strongly connected to stereotypes of what artists, designers and scientists do. According to Frayling (1993), the stereotypes of an artist or a designer are typically anti-rational and inward looking; the designer practices hands-on experimentation, not based on systematic hypotheses or orderly procedures. The scientist, to the contrary, has “… conjectures on hypotheses and sets about proving or disproving them according to a set of orderly procedures. His subject exists outside himself […]” (Frayling, 1993, p. 3). Frayling dissolves these stereotypes through investigating the blurred zone between art, design and science.

The identification of the intersection between research and design is thereby a significant thread in many relevant perspectives. Frayling stresses the process of discovering as an important intersection between experimental scientific research and artistic creation. He is going even one step further and references the recent research into the philosophy and sociology of science: “Doing science is much more like doing design” (Frayling, 1993, p. 4) .

He is joined by other approaches, which emphasize for example the intersection of analytic and synthetic processes (Owen, 2007), of design-led and research-led practices (Sanders, 2006), of research-oriented design (focusing on the real) and design-oriented research (focusing on the true) (Fallmann, 2007), as essential for both, design practice and research practice.

Implied in this focus on discovery processes is an explicit focus on processes. “Tinkering” is one of the key factors for innovation in design and sciences according to Bonsiepe (2004). Science as a cognitive and design as a non-cognitive process shows a structural similarity and are both intentional (Joas, 1991). As consequence, Bonsiepe argues in favor of a particular school of reflexivity and thinking (“Schule des Denkens”) in the area of design and design research, nourished and inspired by the particularities of design experience. As a consequence, design research must involve designers, if we understand designers not as a disciplinary category, but as those people able to create and realize possible futures through their thinking and acting, generating new knowledge for design practice.

„Engineering, medicine, business, architecture and painting are concerned not with the necessary but with the contingent - not with how things are but with how they might be - in short, with design“ (Simon, 1969, p. xii). Design research and design can thus be seen as a discipline (amongst others) which deals with practices and processes in order to create preferable, future situations. Designers are aimed at discovering situations which are changeable and designed (Bonsiepe, 2004). They are motivated by challenges, opportunities and possibilities, not seen by others, to change something (Krippendorff, 2007).

When designers envision possible futures, they can rely on multiple ways, methods and strategies how to communicate and materialize possible futures. These „diegetic prototypes“ (Bleecker, 2009, p.7) or sketches in the figurative sense, are more than fully functional engineered prototypes or already finished designs. Design artifacts are an entrance point for critical thinking about the self evident, not only as the world could be, but rather to find a new, distant perspective on reality as it is. In critical design, artifacts thus „… should draw attention to how product limit our experiences and expose to criticism and discussion their hidden social and psychological mechanisms …“ (Dunne, 2005, p. 24).

In line with these prominent approaches in design practice and design research, “design fiction” can be interpreted as a new strategy for design research, trying to benefit from the qualities of a “designerly way of knowing” (Cross, 2007) and the current discussion of design research frameworks, by systematically questioning and deconstructing the self-evident, transcending it towards new, possible futures; concretely materializing, visualizing and embodying relevant controversies and perspectives in the form of artifacts, interfaces, installations and performances; asking “how the world could be” instead of discussing how the world is; thus taking the inherent contingency of the world seriously and thereby exploring insights from different disciplines. Thereby, it is important for any initiative and intervention in design research to find the right focus “in between” the simply utopian, which is too far away from our current concerns and issues to have an impact on the current controversies and approaches, and the too realistic, which is so close to what we already know and experience that no real provocation, relevant challenge, new perspective can emerge.

Part 2: From Scientific Research to Research as Design

Controversies concerning Images of Knowledge

In the science studies, we observe a growing interest to interpret scientific research as a constructive and creative practice (Knorr Cetina, 1999; 2002). It is argued that scientific research itself is a particular way of enacting and shaping reality. If we take this seriously, we can identify two major implications: on the one hand, it must be concluded that what we accept as scientific knowledge at a particular point in time is, emerging from ongoing controversies among multiple parties (Latour, 1999); what we discussed as “designerly” ways of knowing are not inherently scientific or non-scientific, but they must be seen as particular perspectives on scientific research, which over time either become part of a collectively shared understanding of scientific research (Foucault, 1971), or they remain dissident (Krippendorff, 2007).

On the other hand, we learn from the science studies that scientific knowledge itself must be differentiated into three dimensions (Elkana, 1986): the corpus of knowledge is identifying the content of scientific knowledge; the images of knowledge are focusing on the types of knowledge which qualify as scientific (this is the dimension, which is most important in our context); and social values, indicating the inherently political and ideological dimension of scientific practice in general. Our attempt to argue in favor of “design fiction” as a way of approaching design research as scientifically relevant is thus an attempt to enter a controversy and establishing this forward-looking, creative way of knowing as relevant to scientific research in general. Thereby, the science studies themselves increasingly emphasize the inherently constructivist and imaginative nature of scientific practice (Galison, 1997; Knorr Cetina, 1999; 2002), the importance of improvisation (Knorr Cetina, 2002) and experimentation (Rheinberger, 2001) for the research process in general, or the primary role of artifacts (Knorr Cetina, 1999), images (Jones & Galison, 1998), or materiality (Galison, 1997) and their design in research practice.

Scientific Research and Experimental Systems

More specifically, we observe a preoccupation with research on the important role of experimentation in the recent science studies (Knorr Cetina, 1999). It is argued that experimentation has increasingly become the predominant way of scientific research to enact and shape reality in ways, which allow for the exploration of particular research questions and the realization of specific research agendas. Thereby, experimentation is embedded in the creation and construction of specific systems, as specific assemblages of technologies, artifacts, representation tools, methods, research questions, disciplinary perspectives …, which together form an experimental system (Rheinberger, 2001). This implies that contrary to multiple perspectives, which see experimentation in design and design research as a clear indication of the inherently scientific nature of design practice, we argue that it is only through the creation and construction of an experimental system, which allows to explore important open research questions and to investigate a particular research agenda, that design practice and design research have the potential to develop knowledge which potentially qualifies as scientific (Grand, 2010).

Furthermore, we learn from the detailed study of experimental systems, that they are equipped with a series of tools and artifacts, methods and practices, which are closely related to design: first of all, experimental systems are ways of exploring unanswered questions, a feature which we find in various design practices (see below); second, experimental systems require tools and machines, which allow to document and represent the various experiments as they take place, this implying the development and usage of particular representation tools and documentation strategies; third, it is systematically emphasized how important the materialization of an experimental system is, including the selection of particular materials for building experimental assemblages (Galison, 1997), the development of multiple interfaces to conduct those experiments (Knorr Cetina, 2002), the physical, chemical and biological processes, which typically take place in these experiments.

Blurred Boundaries and Collective Experiments

As we learn from some unconventional perspectives in the science studies, the traditional view on experimental systems as taking place in well-defined laboratories with clear boundaries, it is argued more recently that actually those experimental systems have blurred boundaries and involve multiple parties (Nowotny, 2008; Nowotny, Scott & Gibbons, 2001; Rheinberger, 2001; Latour, 1999; Felt, Nowotny & Taschwer, 1995; Bjiker, Hughes & Pinch, 1989): today, most important societal issues and unanswered questions are somewhat related to what could be called collective experiments (Latour, 1999). Our societies can be characterized by fundamental debates and reflections concerning their possible futures, implying a high complexity, due to the multiple perspectives, interests, concerns, issues, and approaches, which are represented by the multiple parties involved. As we discussed above, these societies become increasingly knowledge intensive (Stehr, 1994), reflexive (Beck, Giddens & Lash, 1994), and experimental (Latour, 2004), which implies that (scientific) knowledge creation shifts to the center of society itself; the sciences are thus social (Nowotny, Scott & Gibbons, 2001), technological (Bijker & Law, 2000), and commercial (Stehr, 1994).

Our world is thus itself engaged in multiple complex, collective political and economic debates and experiments, our discussion of experimental system thus grows beyond the traditional scientific laboratories and become increasingly relevant for our understanding of the (knowledge) society in general (Stehr, 1994; Latour, 1999). The opportunities of re-thinking the role of design in scientific research, as well as of re-defining scientific research in the perspective of design, are thus not only appropriate within the boundaries of traditional laboratory settings, but might actually become a way of understanding, describing, structuring and creating the experimental systems, which our societies need to deal with their most controversial, essential and complex questions and challenges. This is what we call research as design, arguing that a designerly way of knowing is fundamental for any attempt to build experimental systems, playing a very active role in those controversies and collective experiments. In this perspective, design and design research should make their particular practices, tools and methods of imagination, materialization, visualization, representation and interaction relevant to those debates, while at the same time developing new tools and methods, which are important for collectively dealing with possible futures in a complex world.

Part 3: Toward a Method Toolbox for Design Research

We argue that our way of conceptualizing design fiction (Part 1) is a particularly promising way of conceptualizing design research and design practice in the perspective of re-interpreting scientific research itself as design (Part 2). In the remaining sections of this paper, we identify some major dimensions for a method toolbox for such design research practices, as well as identify a series of design methods relevant for such a toolbox (Part 3).

Basic Criteria

Based on our discussion of design research and design fiction, as well as of research as design, we see the following dimensions as particularly important for evaluating the scientific relevance of design practices, design methods and design tools for design research: (1)

design fiction requires methods, practices and tools which allow for the *creation and construction of possible future worlds*, in relation to the actual world; (2) furthermore, these methods, practices and tools must allow for *materializing those possible future worlds*, in terms of images, artifacts and interactions realized in diverse media; (3) in addition, it is important to develop a method toolbox which is characterized by a plurality of different perspectives and approaches, which get beyond ideological premises and allow to map and assemble the *pluralities and the multitude of potentially relevant perspectives*; (4) furthermore, these methods and tools must be able to represent, visualize and document the *experimentation processes*; (5) then, we emphasized the importance of understanding experimentation as being generated through an *experimental system*, which implies a focus on asking a series of questions, allowing for a series of experiments, or the exploration of a series of related hypotheses. Finally, (6) it is important to understand that these multiple methods and tools, visualizations and representations, experiments and questions, will *change the design research practices* themselves over time.

Looking at those six criteria, we see that our approach is somewhat parallel to the four fundamental processes, which characterize translation in Actor-Network Theory (Latour, 1999): The creation and construction of possible future worlds inherently implies what Actor-Network Theory identifies as *problematization*: Any suggestion of a future possibility is at the same time a way of questioning the world as it is, it is emphasizing the contingency of our taken-for-granted reality and identifying alternative possibilities as a general option. Furthermore, our emphasis on materializing through the involvement of multiple artifacts, images, media, and on the engagement of multiple perspectives goes in parallel with *mobilization* in Actor-Network Theory. In addition, we emphasize the importance of collectivizing the experimentation processes, engaging multiple actions, artifacts, actors, activities into the process, thus referring to what Actor-Network Theory identifies as *interessement* and *enrolement*. At the same time, our approach is distinct from Actor-Network Theory in two respects: through its emphasis of creating and constructing new possible futures, which can be identified as the distinct contribution of a design perspective on experimentation; and through its emphasis on the systemic nature of experimentation, which is not at the core of the conceptualization of translation in Actor-Network Theory, but important more general.

Possible Research Strategies in the Method Toolbox

In order to systematize our design research method toolbox, we allocate individual research strategies to particular dimensions of the method toolbox. At the same time, it is important to note that each research strategy obviously fulfills multiple criteria and could thus be related to multiple dimensions of the "Design Fiction" method toolbox.

1. Creation and construction of possible future worlds: As discussed, creating possible future worlds at the same time implies to refer to the world as it is: In this perspective, *critical design* (Dunne & Raby, 2001; Dunne, 2005) for example is a promising approach, which is building artifacts, which materialize and visualize the often invisible dimensions of new technologies (including for example electromagnetic fields, …), thereby at the same time criticizing these existing technologies and their ways of hiding important features, while exploring alternatives. Furthermore, multiple design practices are characterized by their focus on exploring research questions: a particularly promising approach in our context is to *ask unanswerable questions*, as it is done by MVRDV in their five minutes city project (as well as in many other research projects), where an unanswerable question triggers the development of unconventional and creative approaches for dealing with urbanistic themes (Maas, 2003). *Reinterpreting the past* is another way of opening new future possibilities, by transforming and translating what is into what could be. Fashion design for example is characterized by the continuous re-interpretation of existing collections for the creation of new collections.

2. Materializing those possible future worlds: Throughout our paper, we have been emphasizing that "design fiction" is an approach, which combines the invention, creation and construction of possible futures, which are explored, tested, evaluated and improved through a constant attempt to materialize their central features. *Sketching* is the central approach in design, which advances at the interfaces between the future and the present, the possible and the actual, the imaginative and the realist (Gänshirt, 2007). Thereby, we learn from an interdisciplinary view on the multiple design practices, that sketching takes multiple forms: *drawing* on paper is the prototypical approach, but *building simple models* in architectural design and industrial design in going in a very similar direction, or *the development of a mood board* in fashion design, or *simulating interactions* in the new media. Furthermore, we can argue that the *ethnographic observation of design in use* is another way of exploring potentially inspiring new ways of materializing, visualizing and embodying the future (Kelley, 2001); in this perspective, the future is actually seen as always already taking place in the everyday activities of people *using and mis-using design* for their purposes and embedded in their mundane practices.

3. Plurality of different perspectives and approaches: This interpretation of design practice and design research as combining the invention of possible futures, combined with sketching and materializing those possible futures, is at the core of design practice in general, as well as of multiple modernist design ideologies. As a consequence, it is essential to complement this perspective with an emphasis on the plurality of possible futures, as well as on the multitude of possible approaches and strategies in inventing, sketching, materializing and

visualizing those possible futures. In this respect, we share the basic intuition of Actor-Network Theory (Latour, 1999), which emphasizes the importance of continuously challenging the taken-for-granted, un-questioned, self-evident “nature” of the world as it is, while at the same time emphasizing and mapping the multitude of possible alternative worldviews. Interestingly, it is in this context that convincing design research strategies are missing, or that the development of tools and methods for mapping those multiple perspectives and related controversies is gaining its relevance (Latour & Weibel, 2005). The recent interest in artistic and design practice and research for mapping technologies is indicating a growing awareness of the importance to advance our competencies and methods in this respect.

4. Representing, visualizing, documenting the experimentation processes: Interestingly, this is at the same time a pre-condition for advancing with respect to another fundamental issues for design research: in order to advance in our understanding, description and explanation of how design practices are inventing and materializing, imagining and visualizing, creating and embodying new possible futures, we need tools and methods, which are able to document and represent, map and visualize those design processes themselves. It is interesting to observe that in many design fields, this emphasis on the design and research process is coming to the forefront of discussion: in urbanistic and architectural contexts, *publicly arguing based on models and computer simulations*; in fashion design, exhibiting the *materiality, processuality, multiplicity of design as a practice*, instead of overemphasizing the resulting outcomes and artifacts (Maison Martin Margiela, 2008); in iconic research, emphasizing the importance of integrating the *sketches, drawings, models, simulations* as important for our understanding of the resulting picture or installation (Boehm, 2007). Furthermore, the growing interest in exploring the potential of *programming design processes*, as an important way of better understating the processuality of design, is interesting to observe (Maeda, 2000).

5. Experimentation as being generated through an experimental system: With this new focus on programming, the inherently systemic nature of creation and experimentation is also more explicitly considered. As discussed above, design research can only benefit from the recent insights in the science studies, if the *processual and systemic nature of experimentation* and the importance of creating and establishing experimental systems is really understood (Knorr Cetina, 2002; Rheinberger, 2001). In parallel, it becomes obvious that those design practices are particularly important for advancing and conceptualizing design research, which already considering experimental systems as their way of organizing practice and research: the current interest in *programming design processes* is obviously one way of advancing this research field (Maeda, 2000); in parallel, *artistic processes exploring seriality* are very important, as they allow to better understand the close interplay between shifting research

questions, and their relation to shifting experimental arrangements (Calle, 2003). Furthermore, we see a growing interest in understanding archives as laboratories, as already realized and materializes series of artistic and designerly practice (Bismark et. al., 2002). Overall, we observe a growing interest in exploring design practice and design research as taking place in *laboratories*, which are characterized by a specific materialization, allowing for processuality and ensuring the systematic representation of what is going on (Obrist & Vanderlinden, 1999).

Changing the design research practices themselves: As discussed above, design research is closely related to design practice (6.), so in the long run it will be interesting to observe how the method toolbox for design research, as it is sketched in this paper, will impact on design as a field of practices.

Conclusion

In this paper, we argue that the distinct contribution of design as a field of practice and research lies in focusing on the world as it is; design shares with engineering the fundamental interest in focusing on the world as it could be. However, while this perspective is important in many classical approaches to design research, as well as in multiple approaches to design practice, it has not been systematically explored as the actual starting point for conducting design research. We argue that “design fiction” as a way of approaching design research allows to advancing in this direction, by explicitly identifying and discussing a method toolbox for design research in this perspective.

In parallel, we argue that “design fiction” can benefit from the science studies. In this perspective, design research and scientific research in general can be interpreted as a constructive and creative practice (Knorr Cetina, 1999; 2002), organized as experimental systems (Rheinberger, 2001). By emphasizing the processual and systemic nature of experimentation, as well as the importance of developing tools, methods, techniques and media for mapping, representing, visualizing those experimental processes, “design fiction” allows to open a new research field of design research, which at the same time leverages the unique qualities of design as a practice, and incorporates the quality criteria for productive and creative experimentation in scientific research.

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Visual Means for Collaboration Across Disciplines

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Abstract

The complexity of today's design problems—the global economy, rate of change in new technologies, the challenges of sustainability development—requires diverse design teams, comprised of multiple disciplines as well as multiple cultures, to look at broader and different perspectives and larger scopes of investigation. Due to the multilayered and multifaceted interactions between team members, effective communication and collaboration among people in multidisciplinary design teams becomes critical to ensure a project's success, in particular, and for innovation, in general. Research shows that one of the most important aspects of collaboration is effective information sharing—shared knowledge and shared understanding among all team members (Citera, et. al., 1995). Design teams traditionally share information verbally as well as visually through representations such as drawings and sketches, three-dimensional models, project walls, or conceptual maps. Consequently, an important aspect of communication is the role that visual thinking and visual communication practices play in the success of the design team. The exploration and finding of a current frame of reference for creating and utilizing visual tools for communication, capable of serving as a common means of expression for multidisciplinary teams, is the purpose of this research paper. To that end, individual field focused interviews were performed with distinct groups of stakeholders from the business, design and engineering professions. The interview included visual participatory research methods that prompted visual responses and reflected the interviewee's own use of visual methods for communication. In every case, visual means proved to be valuable thinking and communication assets. Two specific dimensions of communication that allowed team members to define, generate, and communicate innovation opportunities—storytelling and representation—were identified. The research findings and interpretations also generated conclusions and future opportunities for the design manager, for the instructors of design, and for the design, engineering and business professionals.

Keywords

Collective innovation; multidisciplinary collaboration; visual thinking;
design management; design thinking

Design problems are unstructured and ill-defined by nature, and, in today's dynamic and changing world, most of them are also "wicked problems." Reed (2002) defined an ill-defined problem as one that addresses complex issues and thus cannot easily be described in a concise, complete manner. Wicked problems in design include issues such as sustainability challenges in products with differing regulations as they are assembled and manufactured in different countries, optimizing the features of an existing car to a new model, a new banking business model, or the visual labeling of universal health-related drugs. The task of designing the outcome at the same time as the context is embedded in wicked design problems. “We have also come to realize that no problem ever exists in complete isolation. Every problem interacts with other problems and is therefore part of a set of interrelated problems…” explained Ackoff (1974, p. 21). Because of this interconnectedness of problems, the design problem-solving process has to be a multidisciplinary endeavor—functional disciplines working in close collaboration across functions, instead of looking in narrow silos like ergonomics, finance, human factors, product design, or marketing, to name a few. (Martin, 2006; Olson et. al., 2001). However, discipline and cultural differences between design team members can create high levels of skepticism that may even extend to the desirability or utility of pursuing collaboration among them (Horn and Weber, 2007). Design problems are hard to solve because, basically, they are inherently complex and this complexity increases the difficulty in understanding them and finding reasonable ways to resolve them. Research shows that for team members to reach a shared understanding of problems and a successful agreement to potential solutions, critical thinking is needed along with innovative problem-solving methods across disciplines (e.g. Citera, et.al. 1995; Diestler, 2004; Feldman, 2002; Sternberg, 1998). In the words of Horn and Weber (2007), to get to the root of ill-defined problems, collaborative reasoning and resolution are needed.

For multidisciplinary teams to collaborate and to obtain insight collectively and successfully, they need to process and develop a shared understanding of all the relevant information involved in the design project (user, concept, context, constraints, team member perspectives, etc..). “All [this] information must be processed by the team so that all team members have a shared understanding… Whether it is a case of dealing with inter- or intra-team communication, visualizing early and often is essential to develop that shared understanding,” described Cagan and Vogel (2002, p.207). Visualizing ideas and displaying them in a clear way that everybody can see, or visualizing concepts in two and three dimensions, are some ways to develop that shared understanding. Typically, design team members communicate face-to-face through verbal explanations but also through the use of visual and physical representations or, in recent studies, a full integration of words, images, and shapes into a single, unified communication unit, which Robert Horn defined as *Visual Language* (Horn, 1999). This is especially important during the initial stages of the design process. Currently, the starting point of the design process for many design disciplines in the professional practice is the making of the design brief. The design brief is, basically, an early definition of the design problem and the possible descriptions of the strategy to solve it. The design brief corresponds to what some authors have defined as the “fuzzy front end” (e.g. Koen et. al., 2002; Sanders and Stappers, 2008) and others as the formulation phase (e.g. Buijs, 2003; Gill and Lilly, 2008). According to Koen et. al. (2002), the innovation process may be divided into three areas: the fuzzy front end (FFE), the new product development (NPD) process, and commercialization. Koen et. al. described the FFE as “experimental, ambiguous, and often chaotic, with a great deal of uncertainty. In contrast, an efficient NPD part of the innovation process is disciplined and goal-oriented, following a clearly defined process” (2002, p.13). They indicated that is at the FFE of the process where the greatest opportunities for innovation may emerge.

In sum, the need to develop tools and methods that enable clear, effective communication among team members has become essential for the understanding and resolution of complex design problems. The exploration and finding of a current frame of reference for creating and utilizing visual means for communication and collaboration, capable of serving as a common means of expression for multidisciplinary teams, is the purpose of this research paper. This study will mainly use visual means as a general term to describe the visual products of all the possible interactions between design team members working together in a design project.

Methods and Analysis

Overview

This paper is a qualitative research study looking at the communication flow and the visual means of communication and idea generation utilized during eighteen different design situations or scenarios by multidisciplinary design teams. This study defined communication flow as the different communication activities and interactions that design team members go through during the process from design problem setting to initial problem-solving proposal.

The intention in this work is to research how multidisciplinary design teams comprised of design, engineering and/or business professionals use visual means for communication and collaboration, identify which ones are used, and when they are used in the process. A pilot-questionnaire was created to identify the scope of the problem, and, from its results, focused one-on-one interviews were developed with open-ended questions and participatory design research methods. The focused interview techniques were chosen because they are helpful in finding out in-depth information about a specific situation—important considerations, consequences and feelings (Zeisel, 2006; Merton, et. al., 1956). The participatory design methods were chosen because their intuitive use of images has the potential to trigger emotions and to understand a specific situation that can aid verbal descriptions (Sanders, 2005). The focused interviews were conducted on 18 design project scenarios from different design, engineering and business professional practices that were representatives of the consumer and service industry, and governmental agencies. The location of the interviewees was in the Columbus and Dayton, Ohio areas.

The data collected were analyzed through abstracted diagrams (visual perspectives) in order to look for patterns and relationships. Three general communication activities among stakeholders emerged to be common to all 18 design project scenarios. Visual means for communication and collaboration utilized by discipline and communication activity were also identified, which resulted in two dimensions of communication as focus areas for this study: storytelling and representation.

Finally, the research findings and interpretations were used to build a current frame of reference for using and generating visual means for effective sharing of information within multidisciplinary teams. The research findings and interpretations also generated conclusions and future opportunities for the design manager, for the instructors of design, and for the design, engineering and business professionals.

Interviews: responses and analysis

The interviewees were eighteen professionals: general managers, marketing managers and creative directors with backgrounds in industrial design, interior design, graphic design, marketing strategy, public relations and communications, mechanical engineering and industrial engineering. The 18 interviewees were asked to describe the different communication activities and interactions that design team members went through during the initial stages of a relevant design project of their choice that included design, engineering and/or business professionals. The interview combined brief questions concerning the interviewee's discipline, area of specialization, and number of team members by discipline together with open-ended questions, such as reflections on working with other disciplines or how they personally learn about a problem. Primarily, interviewees were asked to explain the communication process from the very first moment they were assigned to work on a design problem until the moment when the design team was ready to provide the initial solutions or recommendations to the client.

The methodology used for the interviews was to voice record their descriptions and to give them the option of generating a visual narrative of their experience (see Figure 1). At the end of their narratives, interviewees were given a list to check of the possible visual means of communication that they might have used during the communication process (see Figure 2). While checking from the list, interviewees were asked to identify in which part of the communication process the visual means selected were used.

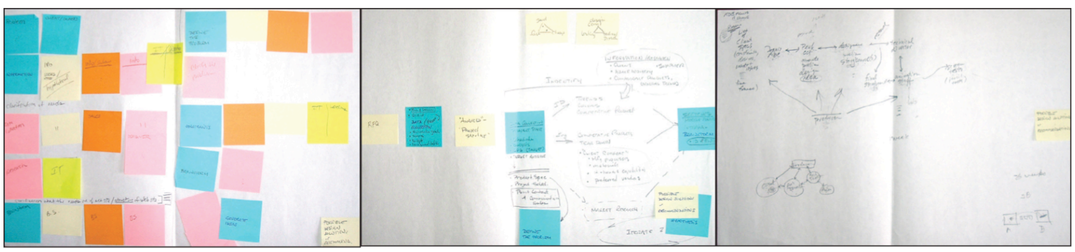

Figure 1
Example of visual narratives generated by the interviewees. From left to right: from a creative director, an industrial engineer, and a production manager.

❑ Mind maps	❑ 3D objects/models	❑ Task analysis
❑ Word lists	❑ 2D objects/models	❑ Collages
❑ Drawings and sketches	❑ Computer models	❑ Visual presentations
❑ Flow charts	❑ Story board	❑ Interactive collaboration
❑ Diagrams/graphs	❑ Scenarios	❑ Others
❑ Matrix	❑ Personas	

Figure 2
List of possible visual means used in the communication process given to the interviewees at the end of the interview. The interviewees identified which visual means they used and in which stage of the process.

At the completion of all the interviews, the data collected included the audio recordings of the eighteen design project scenarios plus answers to the open-ended questions of the interview, the visual narratives supporting the interviewee's verbal descriptions, the completed lists of visual means of communication used in the design experiences described, and a lot of notes from the interviewer. To start analyzing the results, a tally was done of the visual means utilized by the interviewees. That gave some initial insight into the way the different disciplines were using visual means for communication and collaboration. Then, the audio recordings were reviewed with special attention paid to each individual communication process depicted. Afterwards, the communication processes of all the eighteen design experiences were analyzed through abstracted diagrams to provide a visual perspective that allowed for the emergence of relationships. As Albarn and Smith (1977) put it, “The diagram can present at a glance what a verbal description can only present in a sequence of statements. It is the ideal mode for describing relations between things.” (1977 p.69). The communication process between design team members is a highly interactive process that arises from the relationships and interactions across the parts, not from individual parts in isolation. How the parts of a system and levels of analysis are defined is a matter of perspective and purpose (Beinhocker, 2007). The interviews only offered the individual perspective of each interviewee, but her/his description of the communication process included the interactions between members as well as the purpose of those interactions to the process.

Tally of visual means utilized in the communication process

A first tally of all the different visual means employed during the scenarios described by the interviewees revealed that professionals from different backgrounds utilized visual means in very different ways, as shown in Figure 3.

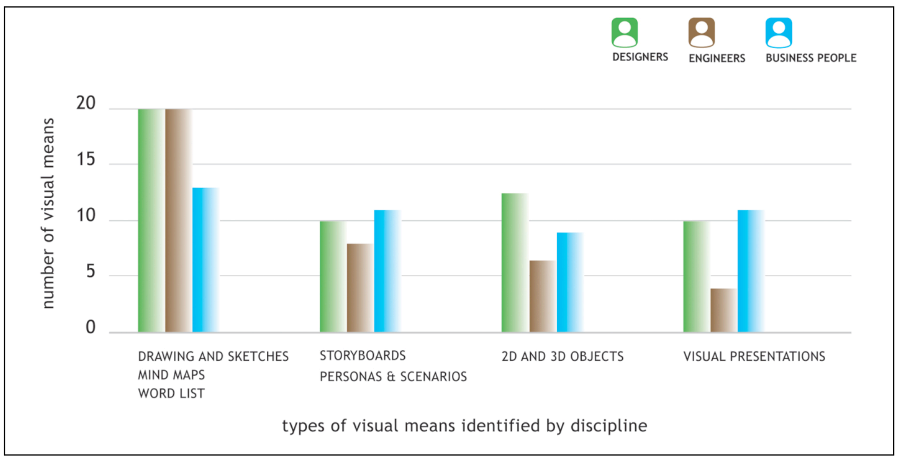

Figure 3
Number and types of visual means identified and utilized by discipline.

While all interviewees were involved in utilizing and generating visual tools, there were differences in how many visual means were used for communication between members and at what point during the process they were used. The pattern that emerged at looking at the results of the tally of visual means utilized is that designers and engineers were heavily involved in producing visual means as aids for analysis and idea generation (individually and collectively), while business people preferred to utilize the representations generated by the team for dialogue and feedback.

For instance, in the scenario described by a mechanical engineer, a team of four engineers and one industrial designer situated in two different locations discussed a design project using sketches and CAD drawings. One of the engineers made a paper model of the new design that was used by a business manager for presentation to the client. The business manager had to meet with the client several times because the changes requested by the client were not feasible, and he wasn't able to discuss the changes without going back to the office and consulting with the engineers. A last meeting with the client and business manager had to include one of the engineers to analyze the viability of the changes. Another example is the scenario described by a marketing director using the designer's boards to test and sell a new idea. Usually, designers mount sketches and layouts of possible ideas on cardboards or simply boards for ease of viewing and sharing. The marketing director identified a new business opportunity and used several boards crafted by a visual communication designer to explain the purpose and content of the prospective idea to her different company's departments. The marketing director used the boards to generate dialogue outside the design team, and didn't participate in the making of the boards other than by giving verbal feedback to the designer's sketches. In both scenarios, the way that the three disciplines, design, marketing, and engineering used visual means was an indication of the lack of integration within the team. This demonstrates the traditional approach where disciplines work independently from each other: "Marketing traditionally has defined the product, while engineering and design have iterated between themselves based on their respective, and usually differing, interpretation of the marketing criteria," explained Cagan and Vogel (2002, p.139).

In order to identify patterns and relationships in the types and uses of visual means through the communication interactions between team members, each scenario was analyzed through abstracted diagrams. Again, the diagrams were produced based on the interviewees' own visual narratives developed during the interviews, the audio recordings, the list of visual means, and the interviewer's notes. The methodology employed to create the diagrams was to first identify the participants and their interactions throughout the communication process and then match which visual means they used during those communication interactions. The measure of success of the communication flow was mainly determined by what the interviewee expressed. For example, a marketing director expressed the success of the design project described by saying "we were able to present new innovative concepts to management in just three days"; while a very unsuccessful design project scenario was expressed by a creative director saying, "it was a nightmare of process and outcome". It resulted ten successful and eight unsuccessful communication flows. Figure 4 shows an example of an abstracted diagram of communication flow and visual means utilized in the design project scenario described by an industrial designer.

Communication activities identified

A general communication process emerged after a first draft of the abstracted diagrams of the eighteen design project scenarios. In all of the scenarios described, the communication process started with an expressed need from a client (individual or team) who searched for recommendations and/or solutions to a design problem. The client was usually from outside the design company, but sometimes it was management from other departments of the same company. During this study the design company is referred to as the team of professional designers, business and/or engineers that participated in the design project that the interviewee described, regardless of the "real" type of association. The initial flow of information occurred between the client and the representative(s) of the design company, usually the design manager or project manager. During preliminary meetings the client and the design manager defined the perceived needs or design problem. Then, the design company initiated its own process of generating ideas and/or

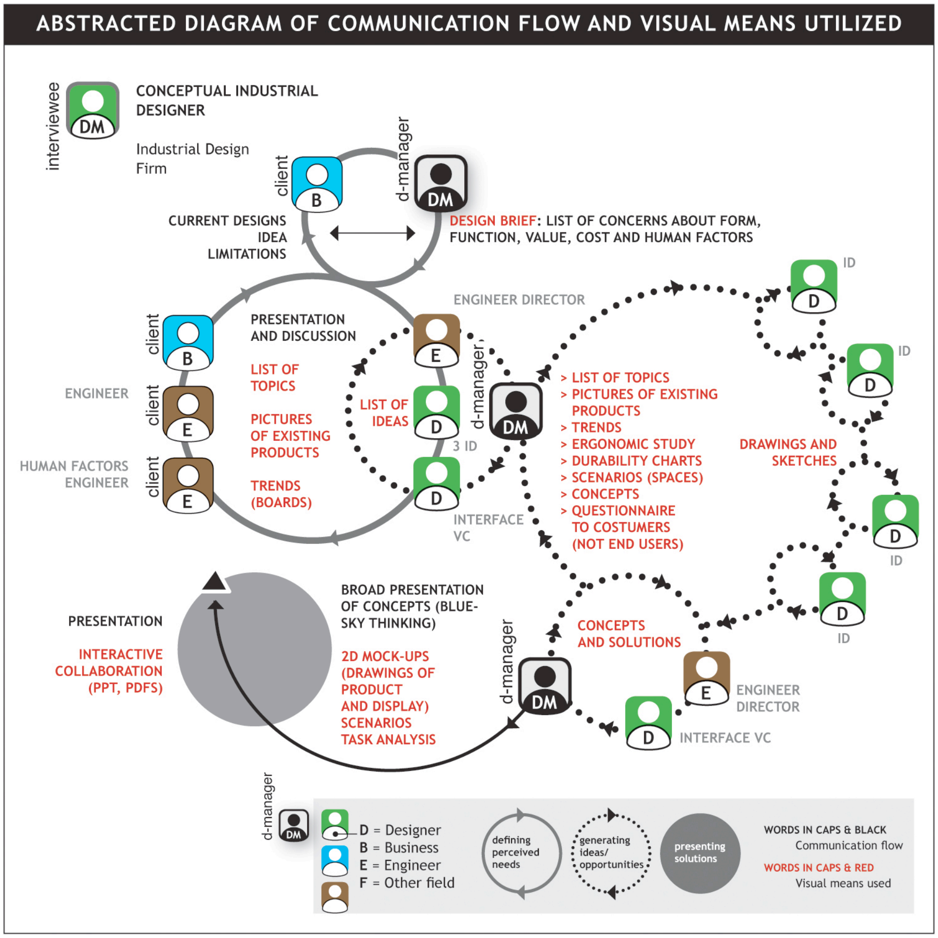

Figure 4
Example of an abstracted diagram of communication flow and visual means utilized in the design project scenario described by an industrial designer.

design opportunities in a more or less collaborative and inclusive way in order to present recommendations or possible solutions to the client. So, in general, the communication process in all design scenarios could be broken down into the following three communication activities (see Figure 5):

1. The communication interactions between the client and the design company for the purpose of *defining the problem or perceived needs*.
2. The communication interactions between the team members of the design company for the purpose of *generating ideas and opportunities*.
3. The communication interactions between the design company and the client for the purpose of *presenting solutions and/or recommendations*

During those three communication activities, team members reviewed existing data, researched new data, developed design briefs, defined constraints, brainstormed new ideas and opportunities, discussed with each other, drew and sketched, shared information, made quick prototypes, and presented new ideas.

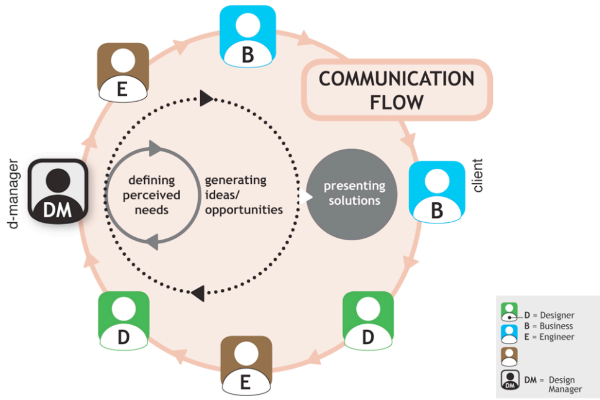

Figure 5
The three general communication activities identified in the communication process of the eighteen design scenarios described by the interviewees.

Synthesis and Interpretation

Visual means by discipline and communication activity

To understand how the different disciplines utilized visual means and for what purpose, new sets of diagrams were generated with a summary of visual means by discipline and communication activity to identify patterns and insights. The diagrams show the most representative visual means compared by discipline (averaged) and identified by more than three interviewees during each of the communication activities: defining perceived needs, generating ideas/opportunities and presenting solutions.

Visual means utilized during defining perceived needs

Overall, interviewees defined the perceived needs of the design project through word lists, drawings and sketches, background research and associative thinking.
(See Figure 6).

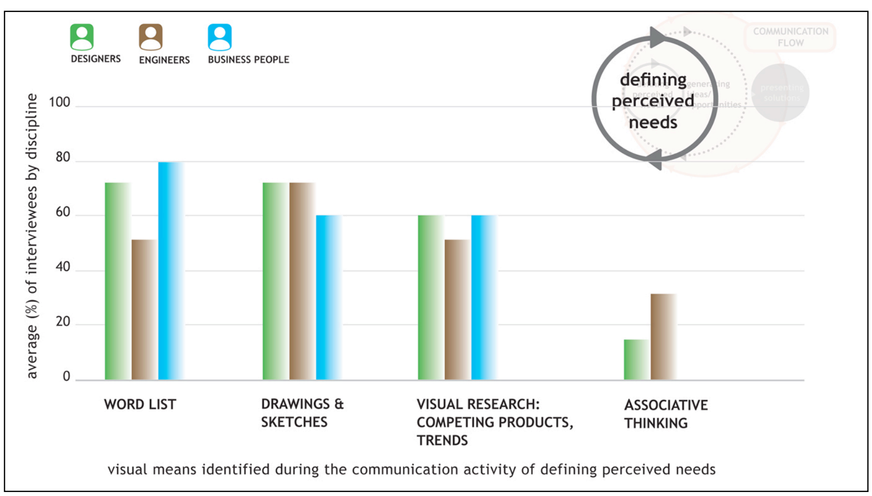

Figure 6
Visual means comparison by discipline during the communication activity of defining perceived needs.

It is interesting to note the extensive use of word lists (list of needs, list of specifications, list of topics, list of concerns, list of goals, etc…). Twelve out of the eighteen interviewees expressed the use of word lists to define the needs of the design project. The down side of using word list to define a design problem is the difficulty to find relationships. Especially at the beginning stages of the design process, it is essential to look at the connections between the functional disciplines, and consider a broader set of interrelated perspectives (that a word list cannot provide) to define the perceived needs of the design problem. Mind maps, for example, are an alternative to linear thinking, because of the radial, graphic, and non-linear presentation of concepts. Mind maps can help look at the whole dimension of the problem by depicting thoughts and associations that are not obvious when the information is organized by lists of categories or priorities (Buzan and Buzan, 1993). Business professionals and design managers could benefit from using mind maps or a similar visual tool to become more effective team leaders.

> … successful leaders consistently reject an approach that leaves things off the table, or distorts the view by parsing pieces of the problem out to various other people. Successful leaders take the whole piece and work on it as a whole; so they keep a holistic view of all the things that they think are salient. Like a painter they put some things in the background and some in the foreground, but everything is always in view. (Stuart quoting Roger Martin, 1999, p.6)

Drawings and sketches were the most utilized visual means during the communication activity of "defining perceived needs" (thirteen out of eighteen design project scenarios), followed by word lists and visual research (the visual part of competition analysis and trends). Visual associations could be also considered visual research during this communication activity. Looking at the visual means exclusive to a single discipline, two designers mentioned taking pictures, two engineers mentioned the use of functional demonstrations, and one businessperson mentioned the use of whiteboards to aid the collective definition of the design problem.

Visual means utilized during generating ideas and opportunities

Overall, interviewees collectively generated ideas and opportunities through drawings and sketches, scenarios, 3D objects, task analysis, 3D models, flow charts and storyboards. (See Figure 7).

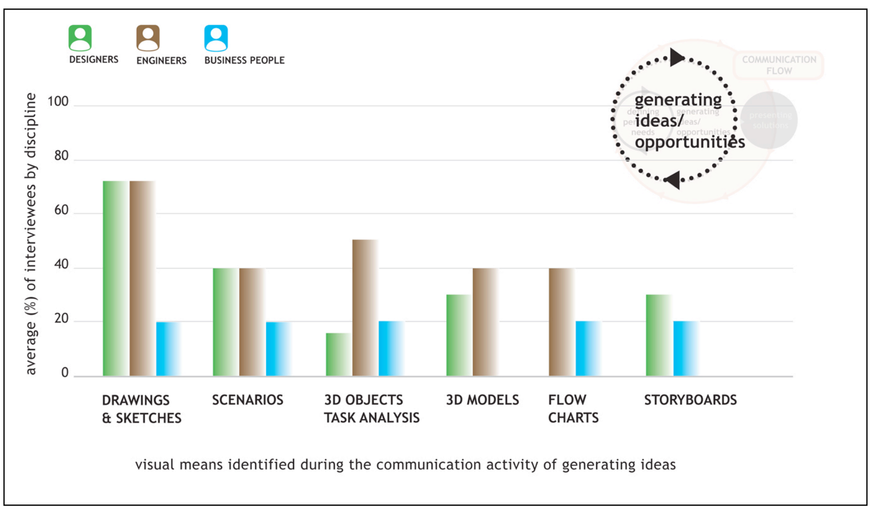

Figure 7
Visual means comparison by discipline during the communication activity of generating ideas and opportunities.

Designers and engineers were more heavily involved in using visual means for idea generation than business professionals, especially drawings, sketches, and scenarios. Scenarios could be descriptions of a-day-in-the-life activities of the user, or descriptions of the context of use for a product or service. A creative director referred to “scenarios” as the different web-page simulations that her team performed. Another pattern of the diagram illustrated in figure 6 is the favouring use of 3D objects and task analysis by engineers. This is not surprising due to their functional decomposition techniques for idea generation: engineers decompose artifacts by pieces associated with functions. Looking at the visual means exclusive to a single discipline, two designers mentioned user testing, one designer visual associations, another blue-sky thinking and another designer and ergonomic study; while one business person mentioned the use of a project wall and another the generation of image banks.

Visual means utilized during presenting solutions

In sum, interviewees presented solutions mainly through power point presentations (PPT) or PDF files, 2D and 3D mock-ups, interactive collaboration and storyboards. (See Figure 8).

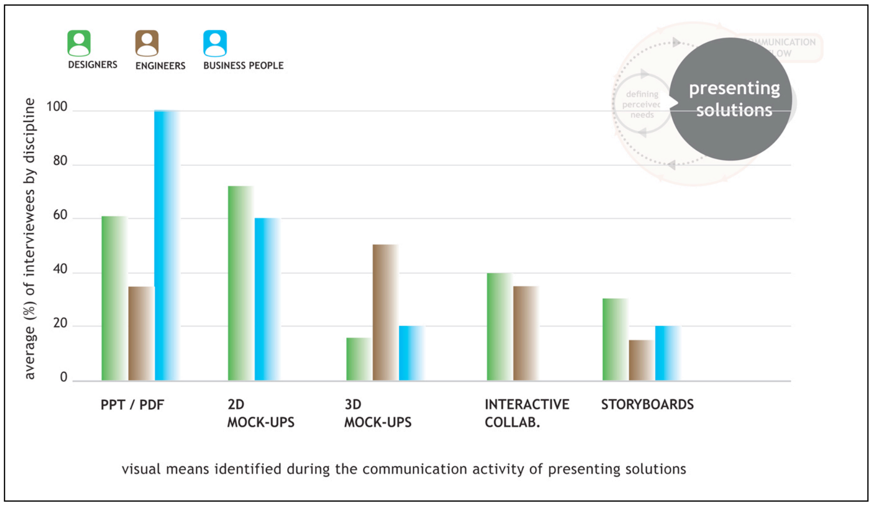

Figure 8
Visual means comparison by discipline during the communication activity of presenting solutions.

Deciding which elements of the design proposal are going to be presented, how to organize them, and in which medium and format, are all crucial decisions in developing effective visual presentations. By interactive collaboration interviewees did refer to the interactive communication made possible through computer screens (e.g. presenting a rendering in a PDF format and receiving feedback through a modified PDF file with virtual sticky notes on it). Currently, the use of PDF files to show drafts or proposals for feedback is common practice, especially in visual communication and interface design. However, the various ways that a design team can present a proposal through interactive collaboration—including face-to-face, in a group, in a conference setting, synchronized in a network, or asynchronized (send it or leave it without explanations)—calls for a further research into the technologies that can support each one. Especially if the design team presenting solutions is not co-located, i.e. in virtual settings.

Summary: *making* visual means and *telling* through visual means

A summary of all the visual means identified by discipline and communication activity was put together in a chart (see Figure 9). The chart illustrates the number of interviewees by discipline that expressed utilizing the visual means listed on the left column during one of the three communication activities showed at the top of the chart.

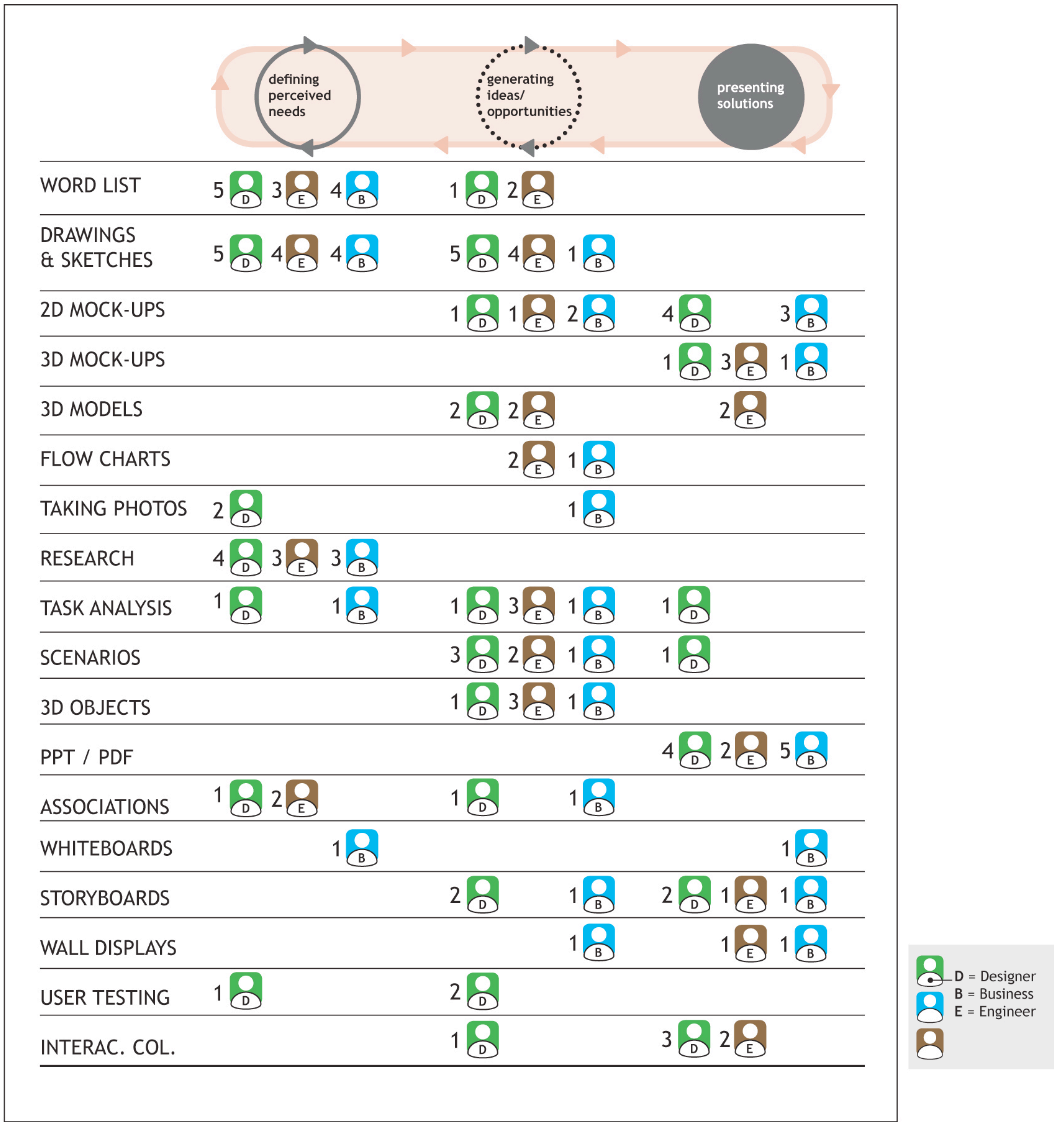

Figure 9
Summary of all the visual means identified by all the interviewees and organized by number of interviewed disciplines and communication activity.

Interviewees utilized more visual means for generating ideas and opportunities than for the other two communication activities. Having all the information arranged in the same visual (chart) triggered the emergence of two basic dimensions in the use of visual means: visual means that were used to generate visual representations (*making*) and visual means used to generate discussion and feedback (*telling*). (See Figure 10). For example, visual means to generate visual representations are drawings, sketches, and 3D mock-ups made out of paper, clay, foam, or cardboard; while visual means to promote discussion and feedback are storyboards, wall displays, and slide presentations. Even though the actual tools may have been the same (sketches, drawings, 2D mock-ups, etc) the communication process they supported was different depending on who the “user” was. For instance, designers and engineers made sketches and models. They used them to support the idea generation process. The visual representations generated from this process, assisted team members in communicating with themselves, and with each other. Business managers, on the other hand, utilized the products of the previous process to support their verbal communication exchange and generate discussion, feedback and additional dialogue.

Comparing the number of interviewees that identified visual means for *making* and the number of interviewees that identified visual means for *telling*, the result is 64 versus 62, which are very similar results. Consequently, it may be suggested that visual means to generate visual representations (***making***) are as important as visual representations used to generate discussion and feedback (***telling***). *Making* and *Telling* are two dimensions of communication embedded in the same visual means, depending on the eye of the beholder and/or the activity that they support. For instance, a logo proposal mounted on a cardboard is “made” by a designer and it serves to “tell” an idea to the client, usually by a marketing professional. The logo proposal is the same visual means and can be “written” (*making*) and “read” (*telling*) in different ways and by different people. Another example is a sketch, which not only supports the mind-hand interaction but also serves to communicate an idea for feedback and to spark the idea generation process. Furthermore, the idea represented in the sketch will change with each “teller” and with each “telling”.

Also, there are visual means primarily used for *telling* (such as a visual presentation) and visual means specifically suited for *making* (such as a 3D prototype). However, somebody had to *make* the visual presentation (organize the information, create visuals to display, know the software, manipulate digital images, etc.) before it could be used to *tell* a story. Same situation with the making of the 3D prototype—there was a need to *tell* through the prototype a concept, function, or idea that was behind the *making* of it. Continuing with this example, if product designers are the ones making the prototype and a project manager is the responsible to explain the prototype to the client, the product designer might enhance the *making* from understanding the way the project manager is going to tell the concept, and the project manager might do a better *telling* from understanding the process of making a prototype. Understanding how the different disciplines make visual representations and how they interpret them for telling purposes, becomes, then, an integrated skill relevant to all parties.

Finally, it is interesting to notice that it is easier to divide visual representations for telling and for making when more specialized skills are needed to produce them (e.g. a CAD model), and the division blurs when more collective creativity and integration is put into the visual means (e.g. information walls), probably because, in the latter case, making and telling are ad-hoc and in-situ (not discipline-dependent or sequence in the process-dependent). Furthermore, making and telling converge in the new domains of co-design (Sanders, 2008, personal communication). Sanders and Stappers (2008) defined co-design in a broader sense to refer to the creativity of designers and people not trained in design working together in the design development process—“...the evolution in design research from a user-centered approach to co-designing is changing the landscape of design practice, creating new domains of collective creativity.”

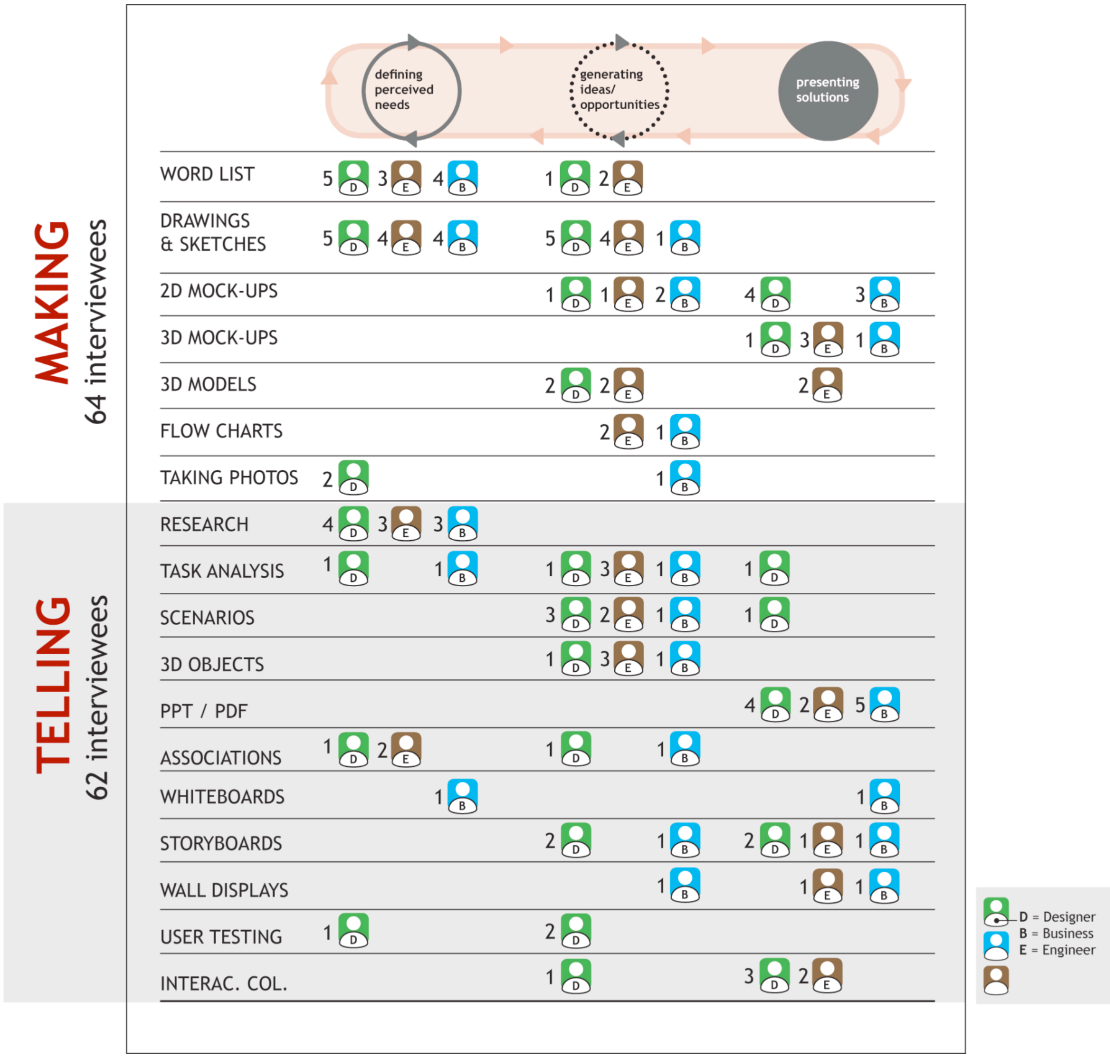

Figure 10
Emergence of two dimensions in the use of visual means: visual means that were used to generate visual representations (*making*) and visual means used to generate discussion and feedback (*telling*).

Conclusions and future work

By understanding how the different disciplines use visual means and at what stages in the communication process, and by identifying the visual means that assist the communication flow within multidisciplinary teams towards effective collaboration, design managers can ensure that information between all the team members reaches across discipline boundaries, and all perspectives are taken into consideration; educators can design interdisciplinary curricula to strengthen visual means for communication and collaboration across disciplines; and professionals in the practice of design, business and engineering can build awareness and understanding of the different disciplinary roles and visual skills involved in the design process.

This study suggests the need for better training in the use of visual means by all disciplines. Some professionals can benefit from learning how to use visual means to generate representations. This can be a powerful tool when the team member is interested in participating in the generation of ideas. Others can benefit from learning how to better communicate by using visual means as communication vehicles to generate feedback, discussions and to sell ideas to the client (Graell and Gill, 2008.)

This study also emphasized that the very essence of design team visual collaboration and communication resided in the ability to reflect on ideas and give them shape through drawings and sketches, and through new forms of integrating words, visuals and symbols. Understanding the function of rough sketches away from their aesthetic value and leveling differences in the knowledge of graphic languages among design team members may result in a more effective collaborative and communicative design space.

This study has also explored emerging visual means to facilitate collaborative sharing of information, and should continue in the future. As the fuzzy front end of the design process is increasing, design professionals and practitioners have to be prepared to work more effectively in multidisciplinary environments. More visual means to define the design problem and generate ideas collectively are needed. Currently, some new visual tools have been developed to collectively solve more complex problems (e.g. mess mapping), but further research is needed to address the different needs of the design industry—new visual tools that speak to different design backgrounds and levels of expertise.

In sum, visuals that facilitate communication and collaboration among multidisciplinary design teams are intuitive and messy, with new forms being developed as new visual languages (visual information murals, visual generative techniques, visual scenarios) are being brought to play to understand the scope and complexity of the design problem as well as the people to design for. In order to find valid design solutions a wide array of relevant variables are to be taken in consideration. Limiting design considerations to aspects that can be thoroughly quantified or that can follow particular processes, is what Roger (2006) calls the obsession to reliability.

Finally, there are opportunities to expand the context of this research study beyond design, engineering and business. The exploration and formulation of new visual languages capable of serving as a common means of expression for [multidisciplinary] teams, is expanding to areas of study beyond the professional practices. For instance, this researcher is currently exploring visual tools for qualitative research in areas such as literacy studies, macrocognitive processes and co-creation.

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Experiential, Embedded, Electronic

Integrating Academic Skills Into The Art And Design Curriculum

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Abstract

The objective of this paper is to reflect on the possibilities experiential learning offers to the fuller integration of study skills into the undergraduate design curriculum.

Undergraduate design courses are experiential at their core. Students are actively engaged in their own learning, constructing it for themselves (often literally). However, this practice needs to be complemented by the ability to critically reflect on these experiences, a knowledge and understanding of its context in the field, as well as the aptitude to communicate these insights. This is where contextual studies and study skills come in.

By taking the natural approach of practical design teaching, could a model be developed that allows students to experience the building up of academic study skills in a similar way to how they engage with practical design skills?

Two main hypotheses were made: firstly that the learning needed to be experiential and secondly that the study skills teaching needed to be embedded as much as possible into the rest of the curriculum. These were complemented by the aim to test whether at least some of this could be achieved by the integration of electronic means.

During a case study at Staffordshire University a module has been developed that takes the students step-by-step through some basic processes of researching, culminating in an essay that conforms to academic conventions. Links to the different awards the students are studying are made at every opportunity, embedding the academic research into, and thereby developing, their reflective practice. In order to allow further student interaction a private wiki has been set up, where students can not only practice and test their skills, but also share their research.

The testing of this model is very much a work in progress and while feedback has been positive, it also has identified a number of issues that need to be developed further.

Keywords
experiential learning; critical reflection; study skills; contextual studies; academic writing; reflective practice

The provision of study skills can feel like an 'odd one out' part of the undergraduate design curriculum[1]. While necessary to provide first year students with the abilities to negotiate their academic studies, if study skills are taught in dedicated modules they might include content (and employ learning strategies) that are markedly different from studio teaching. Taking the study skills modules delivered during the first semester of art and design awards at Staffordshire University as a case study, this paper investigates whether it is possible to utilise teaching strategies that are modelled on the experiential learning that takes place

[1] This paper focuses on awards that predominantly teach practical, rather than theoretical skills. While courses that specialise in History of Design or Design Management, for example, certainly also have opportunities for including experiential teaching into their curriculum, these were disregarded for the purposes of this research.

during studio practice when teaching transferable skills and whether that could lead to a fuller integration of study skills into the undergraduate design curriculum.

After a brief survey of the contextual studies[2] and study skills provision in art and design at Staffordshire University, one of the main differences to studio teaching will be identified as the format in which the teaching is delivered. While studio teaching is largely experiential, both study skills and contextual studies often rely on the more traditional strategy of formal classroom delivery. In order to fully explore this difference, an overview of theories of experiential learning will be given and links to practice (and particularly reflective practice) will be made. Using this as a background, the usefulness of contextual studies in developing skills of critical reflection will be discussed.

This paper then goes on to describe a new model for study skills teaching developed using the main hypothesis that learning should be experiential, but also that it should be embedded as much as possible into the rest of the curriculum and that at least some of this could be achieved by the integration of electronic means. Findings after teaching this module for the first time suggest that, while further research is needed, initial results are positive, but also that a certain distance between studio practice and academic modules in the first year might actually be desirable to train students in their abilities to critically reflect.

Study Skills at Staffordshire University

While some university courses in art and design achieve a seamless integration of theory and practice, a real concern for others is that often a gap between them is perceived, particularly if theoretical teaching is divided from studio practice through being delivered by different staff and in separate modules.

The starting point for this research was a project with the objective to audit the balance of research and practice in art and design awards at Staffordshire University[3] to determine the extent to which theory and practice were integrated by the alignment of the contextual studies curriculum with studio practice teaching. As part of this, a review of the study skills provision was also undertaken.

Study skills at Staffordshire University are taught as a separate module in the first semester of the first year of undergraduate art and design courses. The content includes a breakdown of skills that students will need while negotiating an undergraduate university course, such as note taking, critical reading, giving presentations, finding secondary sources and academic writing. Ultimately, however, all these skills are transferable not only onto other modules of the individual courses, but also onto future life as a professional. In the positioning in the award schemes, the study skills module is the first of the contextual studies modules, which aim to give students an insight into the larger historical and theoretical context of their specialism and thereby allow the students to develop a critical perspective on their own work.

Outcomes sought from this research were recommendations for the enhancement of research skills that help art and design students to integrate theory and practice, as well as the development of a study skills module that would ensure that all students are familiar with research methods, processes and principles.

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[2] 'Contextual Studies' at Staffordshire University is geared towards giving students the tools and skills to research, critically analyse and understand the various contexts in which their disciplines can operate. Lectures and seminars that provide historical, theoretical and professional practice background information are integrated with research projects that allow students to develop an informed design vocabulary that is grounded in a comprehensive contextual awareness.

[3] Awards being surveyed for this project included 3D Design, Advertising and Brand Management, Animation, Fine Art, Graphic Design, Media Production, Photography, Product Design, Surface Pattern Design and Visual Effects Design

The initial investigation taking place in the academic year 2008/09 explored both the teaching of study skills and contextual studies. Through informal interviews with award staff, reports from external examiners and module feedback from students, it was established that contextual studies and study skills were delivered in a traditional classroom format. The balance between theory and practice was different from award to award, ranging from 10% to 50% on the theory side, but the respective ratios were deemed appropriate for what the individual awards were trying to achieve. However, in some awards the linkages between the 'theory' and the 'practice' modules and the critical engagement that ideally would stem from that failed to make it through to students' work - in both practical and essay form. Particularly students seemed to be too focused on their own speciality, with little or no larger outlook on art and design.

There were 13 study skills modules at Staffordshire University in different art and design awards. For delivery, these were bundled together into four groups which resulted in a ‘one-size-doesn't-really-fit-anyone’ module. Teaching was delivered through lectures that alternated with workshops designed to give the students the chance to apply the previously covered skills to their own research. There were also two sessions in the library giving students electronic research skills and one session introducing them to the Design Collection, the in-house museum. During the theoretical lectures, links to the students' practice were limited to examples of work from the field. However, there was room in the timetable for award staff to deliver additional sessions, an opportunity only some of the awards took advantage of. These modules were assessed through a 1,000 word illustrated essay. Feedback from the students indicated that the essay writing was seen as 'overcomplicated' and ‘very difficult’. While a lot of the students seemed to be aware of the importance of being able to write academically for their degree, there did not seem to be much understanding of possible links to their practice. The theory-practice gap appeared to be firmly in place.

When reflecting on the differences between the two types of modules - studio practice on the one hand, and contextual studies and study skills on the other - one rather obvious distinction was the type of delivery. Study skills and contextual studies modules took place in lecture theatres and seminar rooms, not in the studio spaces familiar to the students. The ‘informal’ was squeezed into a ‘formal’ environment. The hypothesis was formed that the type of learning strategies employed in the studio might also be utilised on the theoretical part of the curriculum.

Experiential Learning

The traditional classroom teaching format can be quite distinct from studio teaching. In its most extreme Freire (1982) criticised this model as basically passive, where no new knowledge is created.

> Education thus becomes an act of depositing, in which the students are the depositories and the teacher is the depositor. Instead of communicating, the teacher issues communiqués and makes deposits, which the students patiently receive, memorize and repeat. This is the 'banking' concept of education, in which the scope of action allowed to the students extends only as far as receiving, filing, and storing the deposits. (Freire, 1982: 45f; in: Beard and Wilson, 2006: 30)

In the context of studio practice, on the other hand, one main learning strategy that is employed is experiential learning (Gray and Malins, 2004). No matter what skills students learn in the studio, they need to learn them by doing, through active exploration.

Largely based on the work of Kolb (1984), and Dewey (1925) before him, experiential learning theory draws a strong link between learning and experience. Indeed, Kolb defines learning as "the process whereby knowledge is created through the transformation of experience" (1984: 38). Beard and Wilson (2006) go even further when they state that "Experiential learning is, in essence, the underpinning process to all forms of learning since it represents the transformation of most new and significant experiences and incorporates them within a broader conceptual framework" (2006: 19). Boud, Cohen and Walker (1993) make a similar point when they argue that

> Learning builds on and flows from experience: no matter what external prompts to learning there might be - teachers, materials, interesting opportunities - learning can only occur if the experience of the learner is engaged, at least at some level. These external influences can act only by transforming the experience of the learner. (8)

However, while all learning may stem from experiences, not all experiences necessarily result in learning, which is one of the main criticisms made of this particular pedagogic model. In order for the experience to become a meaningful basis for learning, it needs to be reflected on (Beard and Wilson, 2006).

The importance of reflection in the context of one's practice has long been a recognised concept in art and design. Donald Schön (1983) and his work on 'reflective practice' promotes the idea of the professional (or practitioner) using two different types of reflection: concurrent (reflection-in-action) and retrospective (reflection-on-action). Reflection-in-action is almost instantaneous learning, it stems from the immediate interaction with external stimuli.[4]

Reflection-on-action is learning through looking back at an experience and analysing it, making sense of it retrospectively. This is a step removed from the experience itself and as such more abstract. It goes through the steps of undertaking an action, evaluating it, learning from it and planning the next action, a variation of which is Kolb's experiential learning cycle.

A third type of reflection has been suggested by John Cowan as 'reflection-for-action' (1998 in: Gray and Malins, 2004: 57) or a 'prospective' analysis of experience by Beard and Wilson (2006: 247f). This is concerned not just with learning from the experience for similar experiences in the future, but also with the question whether this action should be continued with or whether its type needs to be significantly changed. Rather than being instantaneous, it is an evaluation of the practice through not just the experience itself, but putting it into a larger future context. This type of reflection is critical reflection.[5]

Critical Reflection in Practice and in Contextual Studies

Developing a critical perspective on our experiences (and learning) is particularly important because experiences are by their nature subjective. As Beard and Wilson point out, this subjectivity of experiential learning is one of the main criticisms being made of this approach to learning (2006: 38ff) and had already been addressed by Dewey in 1925:

> When the notion of experiences is introduced, who is not familiar with the query, uttered with a crushingly triumphant tone, '*Whose* experience?' The implication is that experience is not only always somebody's, but that the peculiar nature of 'somebody' infects experience so pervasively that experience is merely somebody's and hence of nobody and nothing else. (Dewey, 1925: 1, as quoted in Beard and Wilson, 2006: 40)

This issue is linked to the process of developing research methodologies for art and design and the question whether art and design practice can be part of academic research. As Schön points out:

> ... when we reject the traditional view of professional knowledge, recognising that practitioners may become reflective researchers in situations of uncertainty, instability, uniqueness, and conflict, we have recast the relationship between research

[4] 'Action learning' is another concept that is close to reflective practice and experiential learning, though Beard and Wilson (2006) define it as being located specifically in the workplace and being concerned with project work in groups.

[5] For the purpose of this paper the term 'critical reflection' will be used in an individual or organisational context and not in the sociological definition introduced by the thinkers of the Frankfurt School.

> and practice. For on this perspective, research is an activity of practitioners. It is triggered by features of the practice situation, undertaken on the spot, and immediately linked to action ... the exchange between research and practice is immediate, and reflection-in-action is its own implementation. (Schön, 1983, 308f)

Gray and Malins, whose book *Visualizing Research* (2004) is about developing research methodologies for post-graduate studies in art and design, also discuss this particular problem. Referring to Robson's *Real World Research* (1993), they state that the problem of subjectivity (or 'insider' problems as Robson terms it), is a challenge for all researchers. However, they argue that this

> can be addressed to some extent by always exposing ideas and practices to other professionals for feedback, support and advice. In seeking the views of others, which will inevitably be subjective, we can develop inter-subjective views, which are less likely to be one-sided. Of course, keeping a critical view of your research at all times is essential. (Gray and Malins, 2004: 23)

Through a survey (and their own experience) of previous and ongoing research degrees in art and design Gray and Malins (2004: 20f) suggest the legitimising of the practitioner as researcher, the 'practitioner-researcher', which acknowledges and embraces subjectivity and the ‘insider’ role. They go on to say that

> the interaction of the researcher with the research material is recognized. Knowledge is negotiated - inter-subjective, context bound, and is a result of personal construction. Research material may not necessarily be replicated, but can be made accessible, communicated and understood. This requires the methodology to be explicit and transparent (documentation is essential) and transferable in principle (if not specifics). (Gray and Malins, 2004: 21)

They conclude that there is not one specific methodology that fits art and design research, but rather that because the practitioner-researcher needs to be taken into account, research projects need to be approached pluralistically, combining a number of methods to triangulate results. (Gray and Malins, 2004: 21)

In order to introduce undergraduate design students to this way of working and prepare them for using reflection to develop their practice not just in-action but also on- and for-action, they need to acquire the skills to work rigorously and make their reflection (and thus their practice) transparent. This is done in undergraduate studio practice through the critique or 'crit', where students informally discuss the progress of their work with tutors and peers. This is also where the area of contextual studies, which trains students to develop a knowledge and understanding of the context of their practice in the field, comes in. Training students in their studio practice as well as contextual studies is a first introduction to different methods of reflection, something that ultimately can build up to the pluralist approach to art and design methodology that Gray and Malins (2004) argue for. What provides contextual studies with a different perspective on work is particularly that here the main strategy for assessing student learning is not through practical work, but rather the critical essay.

The process of writing, while sometimes unfamiliar or uncomfortable to design students (Gröppel-Wegener, 2004; also see work of Writing-PAD project), has an important role in critical reflection, even for practitioners. Gray and Malins (2004: 57f) report on the work of McAleese (1999), who proposes the keeping of reflection journals as an 'off-loading' device - one main tool "to enable and externalize reflection-on-action" (Gray and Malins, 2004: 58). They go on to say that while they recognise a possible fear that exists in practitioners that speaking or writing about their work has an adverse affect on working creatively, there are compelling reasons for articulating and exposing practice. They cite four main reasons to communicate reflection: developing various models of practice; developing interdisciplinarity and collaboration through better communication; extending professionalism through self-evaluation; and having better conversations with 'ourselves'. (Gray and Malins, 2004: 58f)

This issue plays into the different kinds of knowledge experiential learning offers. As argued by Biggs (2004) there is a marked distinction between experiential feeling and experiential content. While experiential feelings are subjective and maybe cannot be expressed through words, it is the content that can be communicated that should be at the heart of the research. Biggs argues that experiential feelings are an individual representation of the experiential content, which for the researcher should trigger cognitive reflection in order to uncover the content.

The trick for the researcher is to move from reflection-in-action, which is subjective, is concerned with the experiential feelings and might not be possible to communicate through words, to a reflection-on-action, which uncovers the experiential content that can be externalised.

While Gray and Malins (2004) as well as Biggs (2004) are concerned with post-graduate research in the art and design field, links can be drawn to the undergraduate field as well. When it comes to the design students' journey, it is the same distinction that needs to be grasped - while building up skills in the studio is invaluable, it starts with reflection-in-action, experiential feelings. However, in order to go on to deep learning students will have to realise that these subjective feelings are just a starting point and that through critical reflection they can progress to double-loop thinking and retrospective as well as prospective reflection. This is not just crucial for researchers, but also for the level of development in undergraduate education, progressing practical work.

Studio practice can be so subjective and personal, especially for first year students - many of whom come straight from school, it seems quite difficult for them to realise that it is possible to take a step back and critically reflect on their own work. It might even be too difficult to do this at the very beginning of their studies, when they might not have any experience of critical reflection. This is where study skills as the first contextual studies module encountered can help. Here is an area where students can develop their critical and communication skills that is linked to their interests, but through giving them a historical and/or theoretical perspective, is also detached from their practice. Having developed this skill, students will later be able to transfer the critical thinking skills onto their practice to make the step from reflection-in-action to reflection-on-action (and then reflection-for-action). However, the way that the basics of critical thinking and academic communication are taught seem removed from the studio practice; at least this is how it seems to be in the minds of the students. Feedback from study skills modules at Staffordshire University suggests that these skills are often seen by students as removed from their chosen subject, an academic hoop students feel they have to jump through in order to get their university degree.

Could a model for study skills teaching be developed that took the form of an experiential programme that allowed the students to see the writing of their first critical essay at undergraduate level as an experience similar to the experiences they have in their studio practice?

A New Model

Based on the findings of the initial survey of study skills and contextual studies, a number of parameters were decided by the Director of Learning and Teaching and the Programme Area Manager for Arts, Culture and Design in consultation with the award leaders:

- There would still be one fractional member of staff responsible for the bulk of the study skills teaching.
- The 13 different study skills modules would be consolidated into three groups, 'Studying Art' for students on the Fine Art and Photography awards, 'Studying Design' for students studying 3D Design, Graphic Design, Product Design and Surface Pattern Design, as well as 'Studying Media' for students on the Animation, Media Production and Visual Effects Design awards. This would mean three cohorts of 90-125 students each.

- In order to give students a flavour of the field, rather than just exposing them to their own specific subject, there should be occasional lectures delivered by staff from each award to (and relevant for) the whole cohort.

Based on the aim to develop a study skills model that would ensure that students would become familiar with research methods, processes and principles, while also integrating theory and practice, two main hypotheses were made:

- Study skills teaching should be experiential - In order to allow students to relate to this for many unfamiliar and possibly difficult way of working, the teaching should link as much as possible to their practice by employing experiential learning strategies wherever possible.
- Study skills teaching should be embedded - The content should link as much as possible to award specific subjects in order to embed the study skills as fully as possible into the individual awards.

Since a main concern was how to engage large groups of students with limited contact time and staff, it was hoped that electronic means could be used to give students an active research experience outside of the classroom, that possibly tied into communication skills they already employed during their spare time, i.e. social networking.

Based on these parameters and hypotheses a module template was designed that aimed to take students step-by-step through the process of a research project culminating in an academic essay. An introductory session was followed by three blocks of teaching of three weeks each focusing on primary research, secondary research and writing up respectively. The last week was set aside for emergency drop-in sessions to deal with any specific questions regarding the writing of the essay. Input for making the individual sessions more experiential in nature were taken from a workshop on experiential learning by Dr. Colin Beard and his and John P Wilson's book *Experiential Learning - A Best Practice Handbook for Educators and Trainers* (2006).

The introduction to the module was in two parts. The first one was delivered by study skills staff, covering the basic university regulations, what it means to be a student and giving an overview of the individual sessions in the module. The second part was delivered to the separate award groups by award staff; here links to other modules were established and it was explained why the contents delivered in the study skills lessons were important not only for students, but also for practitioners, in their respective specialisms.

The primary research block was designed to introduce students to rigour and the skills of observation and description in an accessible way. They were introduced to note and image taking 'in the field' through an introduction to the Design Collection (Staffordshire University's in-house collection of 20th century design artefacts), a treasure hunt to help them find their way around the campus and a primary research workshop (by award staff), which on the Media courses became part of a residential study trip. Students were also introduced to presentation skills.

The secondary research block introduced students to the library and academic conventions in regards to finding and collecting sources. It also gave the cohorts the chance to test their group working skills through giving group presentations. This included a session with award staff taking them on a subject specific library tour and an introduction to library resources by library staff.

The writing block was designed to help students become accustomed to academic writing skills. They were divided into seminar groups of 30 and taken through the steps of putting their research into a larger context and finding a focus for their essay, how to structure their essay and how to use formal language. There was also a session with library staff scheduled which focused on researching journals to find further sources.

Throughout the semester lectures were scheduled by members of the awards staff to talk about important contributions to the field. These were meant to expose the students to a wider field outside of their specialism.

In order to gauge the proficiency of the students' writing they were asked to write a 500 word descriptive piece to hand in by the end of week five. This was used as a diagnostic piece to find out whether some students needed further testing for dyslexia and whether there were any problems with the hand-in procedures. Weaknesses in the majority of the students' writing were also exposed, which then fed into the teaching of the writing workshops.

A private wiki was set up for each module to give students more help with their independent study time and as a forum for discussion within a larger group. During the module tasks tying into the students' research activities were set, most of which encouraged a submission to the wiki. There was, for example, a group task asking the students to contribute to and create a page that illustrated their treasure hunt.

Findings

While running the module for the first time between September and December 2009, a number of problems were encountered that had not been anticipated and that allow only a limited conclusion as to whether it is possible and effective to take study skills teaching into a more experiential format as opposed to traditional classroom teaching.

While the experiential approach generated some good feedback and some students remarked how effective the treasure hunt was in getting a better idea of where teaching rooms were located across the campus and meeting people from other awards, others found it 'childish'. It almost seemed like these respondents had expected classroom teaching and did not want to settle for anything else. Overall due to the size of the groups it was difficult to facilitate short activities, but this is something that can be developed in future.

It also became apparent that it was more difficult than anticipated to embed links to the students' practice in the module. This was due to some breakdowns of communication between study skills and award staff. In some cases task instructions given to students by award staff differed from those provided by the study skills staff for the same task, the final essay brief being the worst example. This resulted in much confusion for the students, who complained that lecturers told them different things. However, through a detailed de-briefing and re-planning with award and study skills staff together, these issues can hopefully be ironed out for next year.

In terms of results, the outcomes were inconclusive compared to the previous approach. Comparing the new modules with an average of the respective modules from two years previously, the average pass grade improved slightly for two of them, while the pass rate fell. However, what is possibly the most interesting is that the percentage of non-submissions in one of the modules, Studying Media, almost tripled (from 8.87% to 25.69%, while the other two modules' non-submissions were around the 10% mark). While it is difficult to trace this back to the change in learning and teaching strategies specifically, it could be down to students associating a more playful rather than formal teaching approach with a less important module. What does seem clear is that the issue of motivation has not been solved yet.

The module feedback from students suggests that the sessions taught by the award staff varied in relevance - whether that was in the study skills sessions or in their more contextual lecture on contributions to the field. The latter were often seen as 'not relevant for us', so the attempt to give students a broader perspective on the field failed in this respect.

Using an electronic forum for students to engage with research seemed to get positive feedback. While throughout the parts of the module when the wiki was used anxiety was expressed by some, particularly by mature students, more than half the respondents to the module feedback questionnaires stated that the wiki was underused. If it is paired with giving students the confidence to interact with electronic media as needed, this seems to be a part of the module that could be developed much further. Again a problem here was the size of the groups, going through recent activities on the wiki became an administrative problem for the study skills staff. Looking back it seems obvious that while the potential is there, the practical use of electronic learning in this context was not properly researched in advance in order to properly embed it as a teaching and learning strategy. More research on the design of electronic learning needs to be conducted in order to turn this into a valuable experience for the students and make it work as efficiently as possible.

While the experiential aspects of this module have been successful, they were not enough to change the problem of the students' motivation. It seems that the model of organising this as few 'big' modules dealing with a number of awards in a larger field resulted in a large number of them not even handing their essays in. Consequently the decision was made to change this delivery pattern back to modules that deal with students per award and that have considerably more input from award staff. This will also include a more detailed introduction to how this module is based on the experience of research and how developing a critical perspective on an aspect of their studies will allow them to appreciate the relevance for the development not only of their essay writing skills, but also their critical thinking. There will also be more detailed links between the weekly tasks and the final essay as well as the studio practice. If the tasks could be linked closer to and embedded more firmly into the subject matter of the individual awards, students might be able to be more aware of a problem they could solve through critical intervention, rather than a task they have to fulfil in order to get their degree.

Conclusion

Based on the findings of the case study, it seems that using experiential learning strategies to integrate study skills teaching more fully into a practice-heavy undergraduate design curriculum is a possibility. However, a major element towards making this work is linked not just to learning strategies that reflect each other, but also to the subject matter. It seems that students are prone to dismiss teaching that they feel is not related to their 'real' object of study. Therefore it is important that the study skills teaching is not considered as generic in order to better engage students. Content needs to be embedded in the subject area.

It has been found that electronic activities can support study skills content, but in order to use them as part of allowing students the experience of academic research and reflection, they need to be fully integrated and built on during the teaching.

However, when planning the introduction of more experiential, embedded and electronic ways of teaching study skills it needs to be kept in mind that its particular value for students is as the first step to developing their critical reflection skills. As that (and a stepping stone to contextual studies modules to come), it is an advantage that study skills deals with less experiential feeling, the students are less involved in the subject matter than they are in their practice. The challenge is to find a subject matter which has experiential content that is removed from the students' immediate experiential feelings, yet related enough for them to (want to) engage with it.

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Originally from Germany, Alke has made her home in the North-West of England and spends two days per week teaching study skills to art and design students at Staffordshire University. Her research interests include exploring the role of writing in design and design education.

Is Model-Making Sketching in Design?

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Abstract

Considerable research has been done by various scholars to assess the significance of sketching in the early stages of the design process. However, sketching in design studies usually corresponds to drawing and the extensive research on the cognitive aspects of sketching does not always include three-dimensional sketching through physical and digital models produced in the early phases of design process. The aim of the presented research is to question whether model-making in the design process and design cognition is a form of sketching. Departing from key research on sketching which articulates its uncertain nature as a positive drive in early design phases, this paper looks at whether physical and digital models can also be counted among ambiguous design tools. The inquiry is conducted with three graduate students of architecture having similar degrees of professional experience and skills of making physical and digital models. The participants are given three architectural design tasks which are similar in terms of contextual, functional and programmatic complexity and scale and are asked to solve the given design problems by using three different mediums: free-hand sketches, physical models, and digital models. The design sessions are recorded using cam-corders and the participants are asked to think-aloud during the design protocols. The Linkography method is used for the analyses of the protocol studies and linkographs are developed for each design session. Departing from the assumption that ambiguity of a medium is positively related with the amount of lateral transformations realized during a design session, the outcomes of the linkographs are compared in terms of the transformations generated. We conclude that having too many lateral transformations is not always an indication of ambiguity.

Keywords

design; design protocols; sketching; model-making; reflective practices; cognition; computer-aided design; Linkography.

Sketching is one of the most explored activities in design cognition studies and considerable research has been done by various scholars to assess the significance of sketching in the early stages of the design process. Gabriela Goldschmidt (2003), Vinod Goel (1992), Donald Schön and Glenn Wiggins (1992), Masaki Suwa and Barbara Tversky (1997), Bryan Lawson (2006) are among researchers who have conducted analytical and empirical studies focusing both on freehand sketching with conventional methods (using pen and paper) and sketching in contemporary media using computer-aided sketching tools. However, sketching in design studies usually corresponds to drawing and the extensive research on the cognitive aspects of sketching does not always include three-dimensional sketching through physical and digital models produced in the early phases of design process. Despite the general tendency in literature to underline the importance of model-making in the design process, its effects on the cognitive process are not sufficiently articulated.

Related Work

Key research on sketching articulates its uncertain nature as a positive drive in early design phases. Goel (1992) compares the effects of different representation techniques –drawings- on the cognitive design process. The results accentuate the importance of using ill-structured representations for ill-structured problems which are corresponding to using fuzzy (ambiguous, ill-defined) drawings instead of hard-line (well-defined) drawings during the early design process. Lateral transformation is a term developed by Goel and is defined as a transformation where "movement is from one idea to a slightly different idea rather than a more detailed version of the same idea". Correspondingly, vertical transformation is a transformation where "movement is from one idea to a more detailed version of the same idea" (Goel, 1995). According to Goel, ambiguous media enable lateral transformations, and lateral transformations enable the widening of the problem space and development of kernel ideas. Widening of the problem space is directly related with productivity.

Goldschmidt (1990) proposes the Linkography technique to assess design productivity and defines it as " a representation system that uses links as input and displays structural design reasoning patterns as output. A linkograph is "a simple graphic notation in which the sequence of moves is shown on a straight line and the links are nodes at the intersections of diagonal network lines connecting to related moves" (Goldschmidt, 1992). Design productivity is related to the link index value, which is the ratio between the number of links and the number of moves. According to Goldschmidt, the higher this value is, the more productive a design session is. This implies that having a higher link index value corresponds to having denser links among moves. This is in disagreement with Goel's proposition where design productivity is associated with lateral transformations and dense links are mostly representative of vertical transformations.

Rodgers, Green and McGown (2000) analyze the progress of design projects in the studio on the basis of transformations between successive sketches of the students. They report similarly to Goldschmidt, that over a period of a semester, students' sketches show both lateral and vertical transformations but that students who do well predominantly make vertical transformations and a student whose progress is marked by many lateral transformations makes poor progress in terms of achieving positive complexity.

Productivity towards creativity can be discussed both ways. However in this paper, we assume that expanding the design space laterally in the initial/conceptual stage is more productive in terms of exploration and we take Goel's (1992) argument that ill-structured representations give way to significantly more lateral transformations than do well-structured representations as our departing point in the study.

Goel believes that the ambiguous nature of the freehand sketch facilitate lateral transformations and prevent early fixations. Goldschmidt (2003) also points out that an ambiguous representation prevents the early crystallization of ideas, thus "helps defer commitment to a solution". Paynter, Shillito, Wall and Wright (2002) discuss the role of sketching and model making in design and the reasons why the computer is presently unable to provide appropriate support in the "germinal phase" of the design process. They consider physical model-making already as a sketching tool and argue that in contrast to current CAD programs, freehand sketching and physical model-making allows a designer to communicate multiple ideas rapidly and expressively without a demand for unnecessary precision.

Drawing from this fuzzy character of sketching, this paper looks at whether physical and digital models done during the early design process are also ambiguous and enable lateral transformations. The study is developed as an empirical study that will generate its own answers and does not consider anecdotal data as facts. It benefits highly from the related work cited above while developing its own analytical approach. Considering freehand sketch as an ambiguous media, it seeks to compare the outcomes of the experiments with physical and digital models with the outcomes of the experiments with freehand sketch in order to reveal whether physical and digital models also have ambiguous properties.

Design of the Experiments

The inquiry is conducted as protocol analyses with three graduate students of architecture having similar degrees of professional experience and skills of making physical and digital models. The participants are given three architectural design tasks which are similar in terms of contextual, functional and programmatic complexity, and scale. They are asked to solve the given design problems by using three different mediums: free-hand sketches, physical models, and digital models. In order to neutralize the effect of the individuals, each participant is involved in all the design mediums mentioned. So at total, nine experimental sessions are realized. Table 1 shows the distribution of design tasks among designers and the design mediums used for each design task.

	Design Task # 1			Design Task # 2			Design Task # 3		
	Physical Model	Freehand Sketch	Digital Model	Physical Model	Freehand Sketch	Digital Model	Physical Model	Freehand Sketch	Digital Model
D1	●				●				●
D2		●				●	●		
D3			●	●				●	

Table 1 Design tasks, design mediums, designers (D1-3)

The design tasks consist of formal explorations for mixed-use buildings in urban plots. They are located at the same environment and have common specific topographic qualities such as being sloped, being next to a bridge and on the waterfront, having different levels, etc. that expectedly calls for three dimensional inquiries. The numbers on the satellite view from Figure 1 correspond to the design tasks presented in Table 1.

For design task (DT)1, the participants were asked to design a mixed-use building consisting of housing units and a cinema / a theatre. For DT2, they were asked to design a mixed-use building comprising housing units and an exhibition gallery. DT3 was again to design a mixed-use building with a dormitory and a café. Tasks were designed to be similar in terms of complexity but with programmatic differences. The reason why slight changes on the program exist is to prevent the transfer of experience from one task to another. No specific data were given about the total area of each program unit. However a simple site analysis was provided to the designers prior to the experimental sessions and the participants were allowed to ask further questions.

All the participants started the experiment first with physical model condition. They continued with freehand sketch and finalized with digital model conditions. For the physical model condition, they were provided a cardboard site model of 1/200 scale. On the model, buildings, pedestrian roads, vehicular roads, canal, and the bridge were clearly indicated. The participants were given cardboard, colored papers of different thicknesses, transparent papers, needles, glues, a ruler, and colored pens as materials. They were not allowed to sketch by making drawings to generate ideas. Cardboard and paper were chosen as the primary modeling materials since they correspond to the most commonly used modeling materials in architecture. If the experiment would have been realized by using other modeling materials (i.e. modeling clay, styrofoam) , the results could have been different.

For the freehand sketch condition, the participants were given 1/200 scale site plans and site sections of the design tasks, sketching papers, colored pens and pencils, erasers, and a ruler. The site section from Figure 1 is the site section provided for DT1.

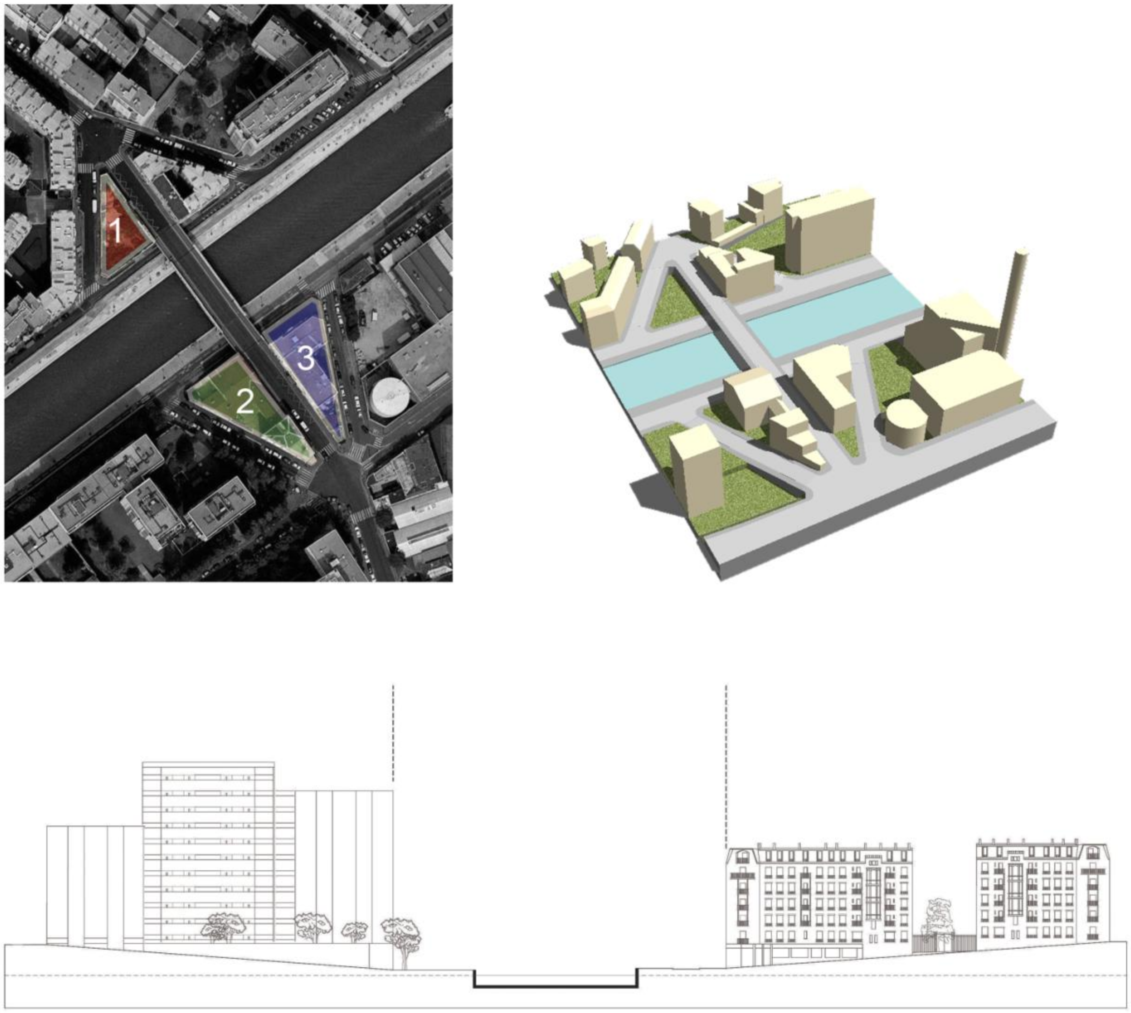

Figure 1 Satellite view, site model and site section

For the digital model condition, the designers were provided Sketch-Up, Rhinoceros, and 3ds Max models of the site comprising the same area as the physical model. Participants were free to chose among these digital modeling soft-wares. D1 has chosen Rhinoceros; D2 and D3 have chosen 3ds Max. The site model image from Figure 1 is the Sketch Up model.

A simple site analysis was presented to the participants prior to the sessions. All of the design sessions were recorded using cam-corders and the participants were asked to think-aloud during the design protocols in their native language.

Experimental Procedure

The experiment of each participant followed this procedure:

1. Presentation of the experiment

2. Presentation of the site analysis

3. A pre-interview with the participant about the experiment. He/she was asked to talk about his/her expectations about the experiment, whether he/she thinks he/she will be successful in the experiment with the given medium or he/she would be more comfortable with another medium and the reasons.

4. Presentation of the design briefs

5. Initial conceptual design phase. At this primary session, the participants were asked to generate conceptual design ideas. For the physical model condition, they were asked to make a match-box physical model of their idea that they will develop in scale further on. The physical model did not have to be in scale but had to clearly explain their ideas. For the freehand sketch condition, participants were asked to make a conceptual diagram of their design ideas. For the digital model condition, they were supposed to make a digital model representing their conceptual design idea. The duration of this initial phase was limited in terms of duration of the conception of their design ideas. It varied between 8 minutes to 21 minutes.

6. Development of the conceptual design idea. At this second stage of the experiment, the participants were asked to develop their design ideas. This time, they were asked to work in 1/200 scale for physical model and freehand sketch mediums and to fit into the given site model for the digital model medium. The sessions ended when the participants declared that they are satisfied with the result. However in cases when they exceeded 60 minutes, they were reminded to straighten up their designs.

7. A post-experiment interview. The participants were asked whether they were right in their expectations about the design session, what the difficulties they have faced were and whether they could have been more successful using another design medium.

Methods of Analysis

In order to analyze the protocols, first the transcripts of the protocols are written. While writing the protocol transcripts, both the verbalizations from the think-aloud sessions and the physical movements the participants have made are noted together with the exact movement time. Later, the protocol transcripts are segmented to the design moves. According to Goldschmidt (1995), a design move is "an act, an operation, which transforms the design situation relative to the state in which it was prior to that move" or "an act of reasoning that presents a coherent proposition pertaining to an entity that is being designed". This definition is taken as reference while segmenting the protocols to its design moves.

The Linkography technique is used for the analyses of the protocol studies. For this study, linkographs are generated only for the initial conceptual design phases since otherwise the linkographs would have been too long to manage. So, it is very important to underline that the following discussion concerns the initial conceptual design phase of a design process and not the detailing phase of a design idea.

The outcomes of the experiments will be analyzed first regarding the quantitative data obtained from the linkographs. Comments and observations of the authors concerning the protocol analyses will be made afterwards.

Limitations of the Study

There are certain severe limitations of the proposed experimental research acknowledged by the authors. These limitations are due to the methodology used to gather and analyze data, the quality and the quantity of the participants, the nature of the design tasks and the sequence of the experimental procedure. It is therefore, of crucial importance to cite that the protocols presented in this paper are not used to state generalizable facts concerning models and model-making in architecture.

Despite the fact that the protocol analysis method is counted among the most commonly used empirical research methods for the study and analysis of cognitive processes in design, it is also commonly criticized for creating an unnatural design process by forcing the designers to solve a design problem within a limited time while they are constantly filmed. Thinking-aloud during the protocol studies is also mainly criticized for obstructing the natural sequence of thoughts of the designers by demanding that they verbalize each thought.

Further on, the Linkography method, which seems as an objective analysis method, is criticized mostly for lacking objectivity in different levels: determining the moves (segmentation process), judging the links among moves (coding process) and interpreting the meaning of the resulting linkograph (analysis process). In order to overcome the subjectivity within the segmentation and coding processes of linkographs, inter-coder arbitration is advised (Mc Neill, Gero, & Warren, 1998).

The results of experiments may vary if the subjects, the design tasks, the settings of the study, the procedure of the study, the materials and software provided to the subjects, the time given for each task, the order of the design tasks were different. Therefore, this paper, instead of ending with a *de facto* argument, presents these protocol studies as an example of how ambiguity of model-making can be sought within design cognition studies and discusses the results only with reference to these specific protocols.

Generated Linkographs

With an understanding of the construction of a linkograph, one is able to comment on the design behaviour without studying the design protocol (Kan & Gero,2005). For each designer, three linkographs are created. These linkographs are shown on Table 2. The difference in length in horizontal direction is due to the number of moves generated to complete the design task. Duration of the experiments is not present on this table as a variable. Therefore lengths of the linkographs do not differ because of the time spent to complete the task but because of the number of design moves generated.

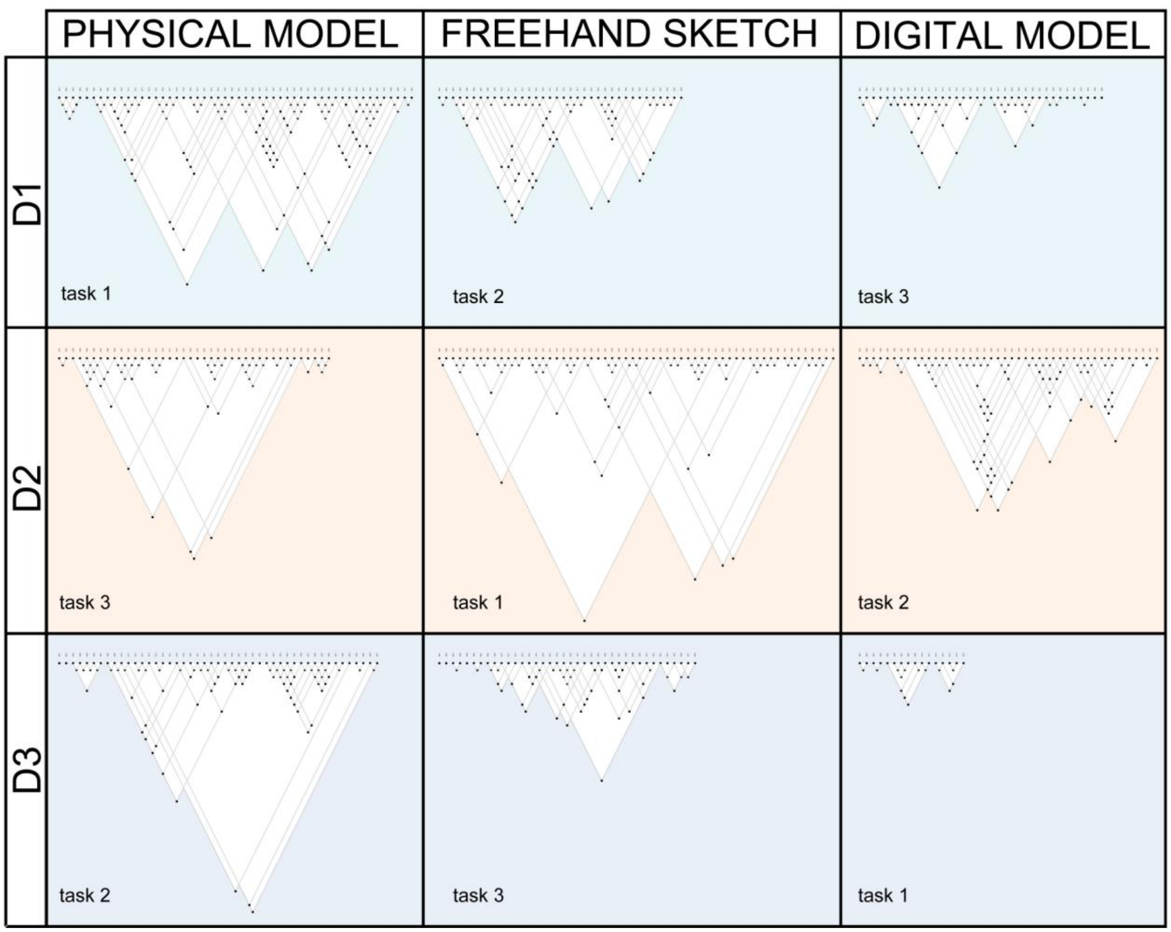

Table 2 Linkographs

Designer	Design Medium	Total # of moves	Total # of links	Link index	Time elapsed	Moves / min	Links / min
D1	Physical model	52	111	2,13	10' 50"	4,8	10,2
	Freehand sketch	36	59	1,63	8' 30"	4,2	6,9
	Digital model	36	36	1	20' 55"	1,7	1,7
D2	Physical model	40	47	1,17	15' 55"	2,5	2,9
	Freehand sketch	58	62	1,06	19' 30"	2,9	3,2
	Digital model	44	77	1,75	9' 25"	4,7	8,1
D3	Physical model	47	70	1,48	21' 50"	2,1	3,2
	Freehand sketch	38	43	1,13	9' 25"	4	4,6
	Digital model	16	14	0,87	9' 30"	1,7	1,5

Table 3 Total number of moves and links, link index values and duration of protocols

Table 3 shows link index values of each participant's design sessions with three design mediums. Time they have spent to finalize the initial conceptual design phase is also indicated and the moves and links they have generated per minute is calculated.

According to Table 3, the link index number was higher for D1 in physical model condition (2,13) compared to freehand sketching (1,63) and digital model (1,0) conditions. Time spent to complete the initial conceptual design phases however was more in the digital model condition (20'55") than the physical model (10'50") and freehand sketch (8'30") conditions. These values indicate that the design session using physical model was the most productive and the design session using the digital model was the least productive process for D1.

For D2, the link index number was higher in the digital model condition (1,72) compared to physical model (1,17) and freehand sketch (1,06) conditions which have closer values. D2 spent very less time to complete the initial conceptual design phase in the digital model condition (9'25") when compared to physical model (15'55") and freehand sketch (19'30") conditions.

According to these values, the design session using the digital model was the most productive and the design session using freehand sketch was the least productive process for D2. For D3, the link index number was higher in physical model condition (1,48) compared to freehand sketch (1,13) and the digital model (0,87) conditions. However, the time spent during the physical model condition (21'50") for the conceptual design generation is comparatively very high than the freehand sketch (9'25") and the digital model (9'30") conditions. For D3, the design session using physical model was the most productive and the design session using the digital model was the least productive process. So for D1 and D3, physical model condition resulted with the highest link index value and the digital model condition, ended with the lowest link index value. On the other hand, D2 had the highest link index value with the digital model condition and lowest with freehand sketch condition.

Link index numbers might be useful in discerning productivity of the design sessions (Goldschmidt,1992) however are not sufficient to analyze the protocols. Linkographs can generate different linking patterns. Designers who start the design process with exploring different options and then select one to develop will produce a very different linkograph compared to designers using a holistic approach without exploring different options (Kan & Gero, 2005).Therefore analysis of these linking patterns are also necessary along with quantitative data while commenting on design productivity.

Through linkographs, Goel's (1992) typology which distinguishes between lateral and vertical transformations can be read. Linkographs can easily indicate what types of transformations are being made by displaying link patterns: dense clusters of links correspond to vertical transformations while scattered links denote lateral transformations (Goldschmidt & Tatsa, 2005). Correspondingly, vertical transformations generally form chunks and webs, while lateral transformations remain as non-interlinked moves or form sawtooth tracks. In this study, linkographs of the nine experimental session are observed with the aim of determining vertical and lateral transformations. Figure 4 shows how this exploration is done through the linkograph of the freehand sketch session of D3. On the given linkograph, first the links forming chunks and webs are identified as triangular areas and those triangular areas are colored to be easily perceived. Later the links that exist only between two sequential moves are explored and the triangular area between two moves are colored. The total number of triangular areas that are formed on the linkograph iscounted.

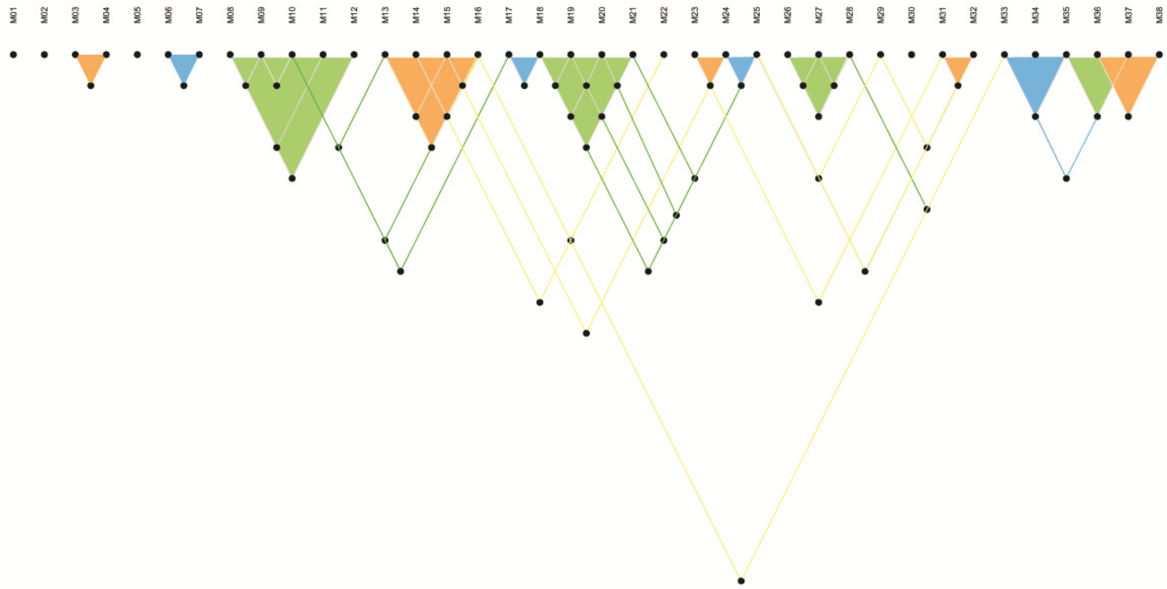

Figure 4 Example of Lateral Transformation Determination on Linkographs

Moves that are unlinked with other moves are also considered as lateral transformations since they are sudden changes in the design process. The sum of these unlinked moves is added to the number of the colored triangular areas. The final value gives the total number of lateral transformations that appear during the design session. Links that are not within a chunk or a web, but are back-links to previous ideas are also indicated on the graph. However since they are not new ideas the triangular areas formed with these back-links are not colored and are not counted as lateral transformations. Vertical transformations are not easily identified as the lateral ones. Kan and Gero (2008) have developed a method where they consider the linking nodes as points in Cartesian coordinate system and find the mean value of X, which is the average location of the nodes in the X-axis and the mean value of Y, which is the average location of the nodes in the Y-axis. The mean value of X is calculated to find whether more nodes appear through the beginning or through the end of the design session. The mean value of Y, is calculated to find out how deep the ideas process, therefore to find out the lengths of the links. In this study, Kan and Gero's method is used to calculate the mean value of Y of the linkographs and those values are used to compare the design sessions in terms of vertical transformations. Table 4 shows the number of lateral transformations and the vertical transformation value of each design session along with the link index numbers.

	Design Medium	Total # of Lateral Transformations	Vertical Transformation Value (Mean Value Y)	Link index
D1	Physical model	15	5,85	2,13
	Freehand sketch	18	6,05	1,63
	Digital model	25	2,66	1
D2	Physical model	16	4,53	1,17
	Freehand sketch	29	5,16	1,06
	Digital model	16	5,98	1,72
D3	Physical model	21	4,88	1,48
	Freehand sketch	17	3,42	1,13
	Digital model	6	2,28	0,87

Table 4 Lateral Transformations and Vertical Transformation Values

According to this table, D1 has made quite a high number of lateral transformations during the design session with the digital model (25) compared to the design sessions with freehand sketching (18) and the physical model (15). However, the vertical transformation value is very low for the digital model condition (2,66) compared to the freehand sketching (6,05) and the physical model (5,85) conditions. These values, together with the link patterns of the linkographs presented in Table 2 indicate that D1, during the protocol with the physical model and the freehand sketch, had generated ideas that she also could develop. Her protocols with these mediums display dense clusters of links. Moves are generally inter-related but not totally connected indicating that there are multiple opportunities for good ideas for potential development. During the digital model session, on the other hand, she has jumped from one design move to another but her moves are random trials that do not have a contribution to the design concept. Her protocol with the digital model, therefore, displays many unrelated moves or moves that are only related to directly preceding them. This indicates that either there are no converging ideas, and hence, low opportunity for idea development, or that the process is progressing but not developing (Kan & Gero, 2008). Link index values of these sessions also corroborate this interpretation with the highest value for the physical model condition and the lowest value for the digital model condition.

During the design session with freehand sketching, D2 made many lateral transformations (29) than in his design sessions with the physical model (16) and the digital model (16). The session with the digital model has the highest vertical transformation value (5,98) and the session with the physical model has the lowest vertical transformation value (4,53).Therefore, D2's protocol with the digital model displays dense clusters of links compared especially to his protocol with the physical model. In his protocol with the physical model, there are quite a number of moves but the chunks are not deep. This indicates that D2, with the physical model, either, could not deepen his ideas, or that he had an already crystallized idea that he did not need to explore further.

D3 had the biggest number of lateral transformations (21) and highest value of vertical transformation (4,88) from the design session with the physical model and the smallest number of lateral transformations (6) and the lowest value of vertical transformation (2,28) from the design session with the digital model. Similarly, her protocol with the physical model displays dense clusters of links forming chunks and webs when compared to her two other protocols. Her protocol with the digital model is radically poor in moves and links. The very few number of design moves indicates that either she could not make use of the design medium to generate ideas, or she had an early crystallized design idea. Eventually, links that are very few in number could not form webs or chunks, indicating that she could not deepen her ideas with the digital model medium.

Observations and Remarks About the Experiment and Comparison with the Linkographic Data

Data deducted from the linkographs concerning the design protocols might be sufficient to analyze the protocols. However personal observations and remarks of the authors must also be taken into consideration.

According to the linkographic data, D1 and D3 had the highest link index value with the physical design medium, while D2 had a comparatively low value. The linkographs of the physical design condition of D1 and D3 displayed dense clusters of links while in D2's linkograph links did not deepen. This difference however is probably not due to the physical model medium but to the design approach of the individual designers. D1 and D3 did not have an early crystallized design idea during the protocols. They explored the problem space with different options and progressively developed their design. D2, on the other hand, had an holistic approach. He came up with a very early idea about the form of the building, and during the protocol, he did not search for other alternatives. This approach continued at the second phase of the experiment where the designers were asked to develop their initial conceptual ideas with a 1/200 scale model as well. D1 and D3, while developing their ideas through physical models, have made unexpected discoveries, but comparatively D2 had very few discoveries of that sort.

D3, at the pre-experiment interview had stated that she was used to conceptualize her ideas through physical models and she thought she would be more comfortable designing with physical model. Although she had the highest link index value with the physical model medium, she spent more than twice the time she spent with freehand sketching and the digital model to generate the conceptual design idea. She later claimed in the post-experiment interview that being supposed to think-aloud was confusing her ideas and that she could not focus on her design. She said that while she is on her own, she makes random moves without knowing the consequences and that these moves end with surprising discoveries. However, she argued that since she is asked to verbalize each move, she could not benefit from that discovery process.

Another very important observation to underline is concerning D2's design session with the digital model medium where he ended with the highest link index value. He might have had the highest link index value with the digital model medium, but most of the moves presented on the linkograph were moves conceived because of his verbal acts and were not totally related with a search or exploration with the digital modeling media. So, it can be said that at least during the initial conceptual design phase of the experiment with digital model, he made intensive use of the mental imagery instead of searching alternatives through digital modeling media. Linkographs however do not reveal this fact.

The reasons why D1 and D3 had the lowest link index values with the digital design medium in the early conceptual design phase are different. D1 had control over the CAD software, she knew the commands and she could do what she wanted to do. However, she did not have control over the design process as much as she had with the physical model condition and the freehand sketching condition. She could not develop her ideas and she made random trials which are not connected with each other. Goldschmidt (1992) notes these kinds of design sessions as being non-productive. D3, on the other hand, did not have control over the CAD software. She spent a lot of time searching for the right commands and ended up by using very few of them for generating her design. She claimed that this caused too much discomfort during the design session and that probably while searching for ways to control the interface of the software, she lost the sequence of the design process and missed good ideas.

Conclusion and Further Discussion

Goel's (1992) experiment reveals the importance of using ill-structured (ambiguous) representations for ill-structured problems instead of well-defined ones in the early design process. His experiment shows evidence that significantly more “lateral transformations” are developed with the ill-structured representations than with the well-structured representations. According to this argument, the ambiguity of the design medium is positively related to the number of lateral transformations done during a design process.

We have utilized linkographs in order to detect lateral and vertical transformations and find linkography very successful for the task. We assumed at the beginning of the research that the reverse was also true and that higher the number of lateral transformations is, the more ambiguous is a design medium. We tried to identify and count the lateral transformations within the nine experimental sessions for the three design mediums in order to be able to comment on the ambiguity of these mediums. However, we perceived that having too many lateral transformations is not always an indication for the ambiguity of a design medium and that considerable amount of lateral transformations may also occur when the designer faces a well-defined design medium. This work thus complements Goel's argument about the relations between lateral transformations and ambiguity. Our follow-up research focuses on identifying factors of ambiguity in the acts of model-making rather than with reference to the generic characteristics of its medium alone.

Despite the immense number of cognitive studies on freehand sketching, there are very few cognitive studies concerning physical and digital models. Further research can be done to compare the design productivity of these mediums in the way that Goldschmidt defines it. We find it challenging to discuss the sketchy aspects of physical and digital models on that level.

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Human Photographs on trust in bank websites

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Abstract

On the Internet, trustworthiness is an issue and becomes more important as financial transactions continue to grow. According to our analysis of the top 20 largest US banks, fifty-five percent of the banks' homepages used human photograph(s). The purpose of this study is to examine how image choices of a male, a female, a family, a small group of people in an office, or a diverse group of people in photographs on a bank homepage will have the most positive effect on customers' perceptions of trustworthiness with regard to the website. For the research method, five mock-ups of a bank homepage were created with carefully modified and selected photographs from each image group. Then a web-based survey was conducted. The result, as determined by this study, reveals distinctions among ethnic groups. Asian participants tended to trust homepages using photographs of families the most and Caucasian participants tended to trust homepages using photographs of a small group the most.

Keywords

Bank website, Trustworthiness, Human photographs, Web design

Technology has changed the way people communicate. Dabholkar (2006) demonstrated that fifty-nine percent (59%) of online consumers visit aggregator sites before accessing websites to purchase (p.259). Consumers gather information, make comparisons, and access decision-making guides. Even though Internet technologies have grown fast and retail outlets have spread their businesses via e-commerce, a majority of the Internet users in the United States feel uncomfortable making payments online for the merchandise they want to purchase (Wang and Emurian 2005, p.106). Seventy percent (70%) of online shoppers abandoned a purchase because of security concerns (verisign.com, 2009, p.1).

Research provides some indications about which factors influence consumers' choices when rating a website (Dabholkar, 2006, p.259). Dabholkar's research showed that website credibility is an important consideration. Online customers want to be assured that they are safe in using the sites, and that the sites are reliable for the purchase they are considering.

Fogg et al. (2001) from Stanford University researched how people evaluate a website's credibility. In this study, participants viewed professionally designed websites and were asked to evaluate them for trustworthiness. Fogg and his associates interviewed 2,440 people to assess how web users determine credibility. Fogg's study found design features are more important than contents. In addition, design structure and layout are also important components in web site evaluation (Fogg et al., 2003, p.24). Fogg et al. mentioned that users' gather their own credible judgments about the websites they visit. Their first look at the website's design is the main issue in determining whether users keep looking for other sites or in determining whether the user will return because they do or do not trust the site (2003, p.26). There are a number of considerations in the way websites are constructed that enhance visitor confidence in the site and therefore also increase return visits.

Trustworthiness is an abstract and subjective concept. However trust must be, at least partially, an element of the first impression of an e-commerce website. Wang and Emurian determined that trustworthiness is conveyed through four characteristics of web design: graphic design features, structure design, content design, and social-cue design (2005, p.106). Fogg's web credibility research supports that 'design look' and 'information design/structure' are top categories which determine online user's credibility of a website (2003, p5). The first contact of the website impacts impressions of credibility (Wathen and Burkell, 2002, p136). Naturally, the initial look of a website is affected by its design elements: color, typography, graphics, and layout.

According to our analysis of the top 20 largest US banks, fifty-five percent of the banks' homepages used human photograph(s). This analysis leads to a question on how viewers will perceive trustworthiness of various photos with different genders, single people, families, or diverse groups.

Steinbrück et al. conducted an experiment on how a portrait image affects customer trust on the site of a German online bank. They designed the site in three different versions. Version 1 showed a portrait photograph of a person with a label identifying that person as a customer service employee. Version 2 showed no label but used the same photograph as version 1. Version 3 did not have a photograph. The empirical study with three identical mock-up websites showed that Version 1, the portrait photography with label, was perceived as the most trustworthy compared to the two others (Steinbrück et al., 2002, p.749). Conversely, Riegelsberger and Sasse (2002) studied the tendency of some homepage images to produce feelings of distrust. This is true when the homepage images lead negative reactions. There are two reasons. One was that non-shoppers do not trust the photographs on a homepage. They believed the photo depicts a fake employee of the company. Another negative influence was when the shoppers believed adding photographs decreased usability by adding clutter and reducing access speeds (Riegelsberger & Sasse 2002, pp742-743). Li et al. studied different images of agents to find out how familiarity affects the trust. They found an agent which resembles the user trusted more than an unfamiliar agent (2007, p194-198). Another study by Riegelsberger et al. (2003) examined the effectiveness of images with genders. Homepage photographs of females received higher credibility ratings than males. However, no research found any changes in trustworthiness of homepages with multiple human photographs.

The purpose of this study is to examine how the image choices of a male, a female, a family, an office grouping, or a diversity group of people in the pictures on a bank homepage will have the most positive effect on customers' perceptions of trust in the website. This study will determine the type of human images that will appeal to most people in building trustworthiness of the bank's web page.

Research Methodology

Web designers need to understand how images, colors, and layout affect the communication of the website. To determine common web design elements of financial institutions, this study selected and analyzed the top 20 banks' homepages (accessed between April and November 2008). The top 20 bank's websites were selected from the US Online Banking Report. (onlinebankingreport.com)

Among the top 20 banks' websites, nine (45%) of the banks' homepages did not display any photographs of humans. Five websites, (25%) of the twenty bank sites studied, showed one person. Twenty-five percent of the banks studied placed the image (25%) of the main image area while five (25%) used one, usually small, human picture on the left side of the homepage (Table 1).

Table 1. Number of Portrait Photographs on main image area of 20 bank websites

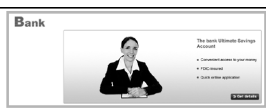
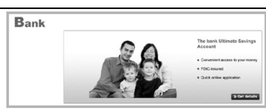
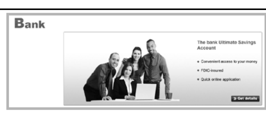
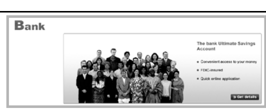
Portrait Photographs	No	One	Two	Five or more
Number of bank websites	9	5	4	2
Percentage (%)	45%	25%	20%	10%

Overall, fifty-five percent of the banks' homepages used some form of human photograph(s). With this analysis, the research method was developed.

As the research method, five mock-ups of a bank homepage were created with carefully designed and selected photographs representing each group stated above. A self-administered web-based survey was tested to discover how the five-mock-ups work to give the impression of trustworthiness to the users.

All human pictures were purchased at http://www.photos.com, except the ethnic group picture borrowed from http://question.bahai.org/ taken in March 13, 2009. Table 2 shows the five mock-ups of the website and its variables.

Table 2. Breakdown of five mock-ups of a bank website

Photographs	**Websites**	**Design Variables**		
		Apparel	Position / Gesture	Facial expression
A male		Suit	Sitting/put hands on desk	Smiling
A female		Suit	Sitting/hold hands together on desk	Smiling
A family		Casual wear	Sitting/parents hold their children	Smiling
A small group		Suit	One is sitting, three are standing	Smiling
An ethnic group		National costume	All standing	Smiling

The photographs were re-touched to minimize visual variables, which might affect visual perception. All pictures were cut to show their subjects' upper body while the sitting. For consistency, the female and small group pictures were transformed so the human figures seemed to lean more towards the left-hand side (from the viewer's point of view). Pens located in the man and women's hands were removed from the images. In the five photographs depicting a business setting, the subjects wore a suit, and used the upper part of the body. All of the humans' expressions included a smile or a near smile. Also all colors were converted to black and white to reduce the effect of this variable.

With those five mock-up websites, two questions were asked for this survey:

1. If these are pictures on your bank's website, which would cause you to trust the bank the most? and
2. Why did they select the photographs as the photographs that generated the most feelings of trust?

The survey collected participants' demographic information including gender, major, ethnicity, income range per month, experience with retail banks, experience with online banking, etc.

The participants were students enrolled at University and were 18 years of age or older. Survey participants were contacted by three methods—email, word-of-mouth, and fliers. One hundred eighty-eight participants completed the survey during spring 2009.

One hundred fifteen females and seventy-three males participated in the survey.
The ethnic background of the participants broke down as follows: one hundred twenty-seven Caucasian, fifty Asian, eight Hispanic, and three African American. The participant population was dominated by students from the College of Design (63.8%); one hundred and twenty students participated. The total number of participants outside the Design College was sixty-eight (36.2%)—thirty-eight females (20.2%) and thirty males (16%). Table 3 shows that most respondents of this survey were undergraduate students (69.1%). There were one hundred fifteen females (61.2%) and seventy-three males (38.8%), who participated.

Table 3. Participants by gender, statuses, and ethnicity

	Female				**Male**				**Total**		
	Caucasian	Asian	African American	Hispanic	Caucasian	Asian	African American	Hispanic	Female	Male	Total
Under-graduate	60	11	0	5	33	18	0	3	**76** (40.4%)	**54** (28.7%)	**130** (69.1%)
Graduate	21	9	1	0	8	4	1	0	**31** (16.5%)	**13** (6.9%)	**44** (23.4%)
PhD	3	5	0	0	2	3	1	0	**8** (4.3%)	**6** (3.2%)	**14** (7.4%)
Total	**84**	**25**	**1**	**5**	**43**	**25**	**2**	**3**	**115** (61.2%)	**73** (38.8%)	**188** (100%)

One hundred and one students responded they were accessing the Internet eight or more times daily (53.7%). Only two female participants from Caucasian and African-American backgrounds used the Internet less than once daily, but eighty-four (39.7%) participants connected to the Internet between two and seven times daily. One hundred seventy-seven participants (94.1%) had visited a financial homepage before the survey. There were eight (4.3%) participants who did not have a chance to visit any bank websites yet.

Table 4 shows that twenty participants (10.6%) did not interact with Internet financial websites, however, one hundred sixty-seven (88.8%) had knowledge of banking through the Internet.

Table 4. Online Banking Experience

	Female				Male				Total		
	Caucasian	Asian	African American	Hispanic	Caucasian	Asian	African American	Hispanic	Female	Male	Total
Yes	77	21	1	3	37	23	2	3	**102** (54.3%)	**65** (34.6%)	**167** (88.8%)
No	7	4	0	2	6	1	0	0	**13** (6.9%)	**7** (3.7%)	**20** (10.6%)
Not answered	0	0	0	0	0	1	0	0	**0**	**1** (0.5%)	**1** (0.5%)
Total	**84**	**25**	**1**	**5**	**43**	**25**	**2**	**3**	**115** (61.2%)	**73** (38.8%)	**188** (100%)

Discussion and Findings

Overall, the results indicate a small group photograph (35.1%) was perceived the most trustworthy followed by a family photograph (33%). The analysis shown in Table 5 indicates 7 participants (3.8%) selected the male photograph as the least trustworthy. This result supports Riegelsberger's research (2003). Eleven participants (5.9%) reported that human pictures do not create an impression of trustworthiness on the bank website. This result indicates that single images of females or males do not effectively create a trustworthy impression of the bank web site. Both single images were rated lower than the homepage without images.

Table 5 Analysis of results: Photographs and Trustiness

	Female				Male				Total		
	Caucasian	Asian	African American	Hispanic	Caucasian	Asian	African American	Hispanic	Female	Male	Total
A male	2	1	0	0	3	1	0	0	**3** (1.6%)	**4** (2.1%)	**7** (3.7%)
A female	5	1	0	0	2	1	0	0	**6** (3.2%)	**3** (1.6%)	**9** (4.8%)
A Family	27	11	1	1	11	10	0	1	**40** (21.3%)	**22** (11.7%)	**62** (33%)
A small group	35	5	0	2	18	5	1	0	**42** (22.3%)	**24** (12.8%)	**66** (35.1%)
An ethnic	9	6	0	2	5	6	1	2	**17** (9%)	**14** (7.4%)	**31** (16.5%)
None of these	6	1	0	0	2	2	0	0	**7** (3.7%)	**4** (2.1%)	**11** (5.9%)
Not answered	0	0	0	0	2	0	0	0	**0** (0%)	**2** (1.1%)	**2** (1.1%)
Total	**84**	**25**	**1**	**5**	**43**	**25**	**2**	**3**	**115** (61.2%)	**73** (38.8%)	**188** (100%)

When breaking the data down by ethnic group, the result indicates that the family photograph appealed to more Asian participants than Caucasian participants in creating feelings of trust. The results of this study indicate that perceptions of trust for a financial institution's website increases, for Asian participants, by the inclusion of a family photograph and for Caucasians by a small group photograph. Because the African-American and Hispanic populations had only a small number of participants, the conclusion was indeterminate with regard to these populations.

This study used the SPSS (Statistical Package for the Social Sciences) program to analyze the data. The data indicates that a statistically significant correlation exists between ethnicity and perceptions of trustworthiness. Because the survey group was predominantly Caucasian and Asian, it was possible to compare these two racial groups. If the number in 'Asymp. Sig' of the Chi-squared table is less than 0.05, there is significant correlation. Table 6 reveals a pattern among Caucasian and Asian participants who were asked to select an image-based homepage they would be inclined to trust. Caucasians reported a sense of trust in response to the small group picture, but Asians reported that the family picture inspired the greatest sense of trust. There was evidence of a weak (0.62), significant correlation (table 6).

Table 6 Chi-Squared Test: between Caucasian and Asian

	Value	DF (degree of freedom)	Asymp. Sig (2-sided)
Pearson Chi-Square	10.529a	5	.062
Likelihood Ratio	10.748	5	.057
Linear-by-Linear	0.038	1	.846
N of Valid Cases	175		

As mentioned above, the participant population was dominated by students from the College of Design. However, Table 7 shows no significant correlation between the preferences of design and non-design college participants.

Table 7 Chi-Square of picture data comparing design and non-design participants

	Value	DF (degree of freedom)	Asymp. Sig (2-sided)
Pearson Chi-Square	18.790a	15	.223
Likelihood Ratio	20.703	15	.147
Linear-by-Linear	.033	1	.855
N of Valid Cases	186		

Question 2 asked participants why they selected the pictures of human subjects as the pictures that inspired the most trust.

The qualitative data corrected from question 2 indicates that participants perceived trustiness when photographs looked friendly and comfortable. Some participants' comments are as follows.

A small group photograph (35.1%)
Participants received professional and happy feelings from the small group picture. The reason most participants selected the small group picture was mostly because:

• Appropriate number of people to effectively run a bank.
• Looks like a friendly group, who appear they like to work together for customers.
• Combination of professional looking people.
• Looks like friendly bank employees.
• A small group makes me feel more like I am being taken care of best.

Another response was the group picture had a computer and it made the picture look more like a professional team. Since only option 4 contains a computer, this might have been a source of bias in this study.

A family photograph (33%)
Overall, answers about the family picture were that participants could trust this picture because it is family-oriented and the family structure provides a safe and honest feeling. Asian male participants said that 'family oriented' was important and it portrayed more powerful influences. Most participants who selected the family photo mentioned ideas such as:
• Feeling protected, comfortable, and safe.
• Family picture seems more comfortable, honest, and friendly.

An ethnic group photograph (16.5%)
The main reason for this answer was that there were many people from different backgrounds — both in diversity and national origins. It reminded participants of a bank with services connected to other countries. Participants received the impression from the image that the multi-racial people in the picture were a group or a team at a financial institution. Some participants answered that this picture reminded them of 'Verizon network coverage' as part of their positive judgment. Some other answers are as follow:
• A wide range of people letting me know they are there to help whoever is in need."
• Prefer to work with a group rather than an individual.
• Seems like they are all staff at a bank.
• Diverse staff at part of a bank.

None of these (5.9%)
Only two females and one male of Caucasian out of six were provided comments about this picture. One said it did not really matter if a human picture was included on a bank website, but its services and protection were what mattered most. Another respondent mentioned none of the choices elicited trust.

A female photograph (4.8%)
Caucasian female participants read the woman's leaning-forward body language in the picture as the reason why it created feelings of trust. Another answered, "she looks professional and authoritative." An interesting comment from an Asian female was that she "trusted women more than men."

A male photograph (3.8%)
The lowest ranked percentage was the male picture. However, some of the participants mentioned it looked more business-oriented and the male seemed to be an expert.

Conclusion

Internet banking is fast becoming one of the most popular online activities. Even though people dream about a more convenient life, they face important ever changing issues, such as online security. Each bank had differences in the design style of the homepage, which varied according to the number of human photographs, colors, font types, and layout. Through the existing bank analysis, this research found that more than half of bank web sites use some type of human photographs on their homepage. Based on the analysis, this research explored five different photographs to find out which photograph will generate feelings of trust.

This study found that a small group or family photograph can increase perceptions of trust on an online bank website. Overall, the small group photograph was perceived the most trustful of the photos. However, if the online target population is largely Asian, a family photograph is likely to produce friendly and honest feelings.

Also this study found cultural preferences in perceiving trust with human-subject photographs. Asian participants favored a family photograph over a small group photograph. This result supports the well-known cultural dimension: individualism and collectivism. The United States is known as an individualism country and Asian countries such as China, Korea, and Japan are known as collectivism countries (Hofstede, 1997, p.53). This result indicates that understanding the target audience is important on designing websites to appeal and communicate with them.

An aesthetically appealing website design provides online users a pleasant feeling and invites them to trust the website more positively. Design features, design structure, and layout are important components to build feelings of trust in a website (Fogg, et. al, 2003, Wang and Emurian, 2005). The human photographs are an element among the components to enhance trustiness. All design components and usability should be considered in building a trustworthy website.

Limitations

This research has several limitations. First, mock-ups for this research were sized smaller most current websites. There were some technical issues that restricted image file sizes in the online survey website (surveymonkey.com). Second, the total population of the participants (188) was students studying at one state university in a Midwestern location in the United State. They were limited in this area as undergraduates, graduates, and PhD students. Therefore, these results may not be the same for other areas of the United States. Future studies should include a wider population sample. Third, the dominant population of participants (63.8%) was design majors in this study. The research had been contacted by three methods: email, word-of-mouth, and fliers. The research asked the participants to access the survey website individually. In these reasons, it could not be controlled the percentage of participants' majors. However, this could have biased the results even though there was no significant correlation between design students and non-design students (table 6).

Forth, the human pictures for the five mockups could not be able to be set exactly the same body language such as hairstyles, color of clothes, forms of body representation. These variations were remained to develop more accurate result on the study of credibility for the future steps.

Future research

The results of this study suggest several directions for future research. The most immediate direction is to obtain more precise research data. To do this an even larger population is indicated, particularly with regard to Hispanic and African-American groups. It appears there are correlations that relate human photographs and ethnicity. Therefore, future research should make additional efforts to incorporate cultural difference in diverse ethnic groups.

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Seeding social technologies: strategies for embedding design in use

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Abstract

This paper reflects on the changing nature of participation and design in the context of social technologies and, in particular, our evolving understanding of what it means to do design. When designing social technologies we are effectively creating containers or scaffolds; their shape is formed through participation and user driven contributions and that shape changes over time. In designing successful social platforms around which communities grow, evolve and share, our role as designers extends beyond researching, defining, creating and releasing a product. The facilitation of participation by the 'future community' also becomes a central concern.

In this paper we present, explore and reflect upon the notion of seeding as a useful concept for approaching the facilitation of participation in social technologies. Seeding is concerned with the process of embedding and connecting design within the real world. It draws our attention to the work that needs to be done for design to become part of people's everyday lives, and our role as designers in creating conditions under which this is likely to occur. The theoretical reflections and arguments presented in the paper are based on empirical research into the impact of social technologies on exploratory design research methods used in the early stages of a design project. We present potential strategies for seeding early in the design process that emerged from our research and reflect on the questions about participation, protocol and practice that they raise.

Keywords

design practice, methods, participation, seeding, self-reporting, social technologies

This paper reflects on the changing nature of participation and design in the context of social technologies and, in particular, our evolving understanding of what it means to do design. When designing social technologies we are effectively creating containers or scaffolds; their shape is formed through participation and user driven contributions and that shape changes over time. Services such as Facebook, Flickr and YouTube not only invite engagement, but also depend on contributions to be successful. Furthermore, through our contributions and participation we affect the experience of others. As designers, we may have always conceptually understood design to be 'actualised' in use (Dourish, 2001) however social technologies bring a renewed attention to the relations between design and use because so much of their form is constituted *through use*. Social technologies put a new emphasis on user participation.

In designing successful social platforms around which communities grow, evolve and share, our role as designers extends beyond researching, defining, creating and releasing a product. The facilitation of participation by the 'future community' also becomes a central concern. This is particularly so in community and social settings where uptake and use of systems by individuals is voluntary. Our responsibilities as designers extend to include helping to ingratiate the project with potential users (DiSalvo, Maki, & Martin, 2007); transferring project ownership from designers to the user community (Merkel, et al., 2004) and allowing design to change and grow through user participation (Dittrich, Eriksén, & Hansson, 2002). This points to new skills for designers whose expertise has traditionally focused on the creation of artefacts (Brereton & Buur, 2008; Merkel, et al., 2007). It also suggests changing priorities during the design process.

It is one thing to build a participatory platform, but another to have people take it up and use it. In developing collaborative mapping tools for use by members of the public, DiSalvo et al. (2007) found that more attention needed to be paid to engaging the so-called stakeholders or participants of the system. It is quite possible that at the beginning of the design process there will be no clearly identifiable existing community of users, rather this community will have to be 'brought into being' as part of the project (ibid). DiSalvo et al. warn of falsely assuming a motivated public willing and eager to participate and emphasise the actual work that has to be done to move from the idea of a participatory system, to an actual 'functioning' one.

In this paper we explore the notion of seeding as a useful construct for considering how we can approach the facilitation of participation. Seeding is concerned with the process of embedding design in the world. It draws our attention to the work that needs to be done for design to become part of people's everyday lives, and our role as designers in creating conditions under which this is likely to occur. It refers to the work that we might do as part of the design process to try and 'bring into being' a community around a project. We present three strategies for seeding early in the design process as the basis for theoretical reflection and discussion. These strategies emerged out of practice-led research into social technologies and their impact on early design research methods.

The research in this paper extends earlier work on the concept of seeding (Hagen & MacFarlane, 2008); our motivation is to contribute to an ongoing discussion on the nature of design and participation in the context of social technologies. Whilst for the sake of readability we use the term 'designer' in the paper, we anticipate that the notion of seeding and the theoretical reflections about participation documented here will be applicable to both researchers working in academic contexts as well as designer/researchers working in industry.

The paper begins with a brief discussion of context and motivations, including a summary of the empirical research upon which the paper is based. The concept of seeding is defined, and then the three potential strategies for seeding early in the design process identified in our research are presented. These examples inform the following discussion and reflection about approaches to managing participation and the shifting priorities in design that seeding suggests. The final section draws attention to challenges involved in 'selling' seeding to clients and the nature of design in the wild. The paper concludes with a summary of the issues raised.

Background

This paper reports on one aspect of a larger practice-led research project into the impact of social technologies on early design research methods. Interested readers can find a fuller account of the research here (Hagen, Robertson, & Gravina, 2007) and here (Hagen & Robertson, 2009). For the purposes of grounding the paper we provide a brief background of motivations and a summary of the research below.

Our research is motivated by the changing nature of design and participation in the context of social technologies and the methodological challenges and questions this raises for designers. Traditional methods designed for stationary, workplace contexts cannot be expected to account for the emergent and complex nature of social technologies and designers attempting to apply conventional methods in the context of social technologies face various challenges.

For example traditional contextual methods assume the ability to identify and access the context of use, but users of social technologies are diverse, geographically distributed (Bergvall-Kåreborn & Ståhlbröst, 2008) and potentially anonymous (Clement, 2008; Ehn, 2008). The form of social technologies themselves is emergent and use is constituted through co-experience (Battarbee, 2003). In addition, technology use is now mobile, domestic and woven through complex, ongoing social contexts (Bødker, 2006; Isbister & Höök, 2009). Researchers and designers attempting to gain access to authentic situations of use are challenged both by the pervasive, diverse and emergent aspects of social technology as well as its increasingly personal and social nature.

One way in which designers are responding to these challenges of access is through the extension of self-reporting methods (Hagen, Robertson, Kan, & Sadler, 2005). Increasingly, traditional self-reporting methods such as diaries and probes are being augmented with social technologies *themselves* as tools for documentation, e.g., (Hulkko, Mattelmäki, Virtanen, & Keinonen, 2004; Palen & Salzman, 2002; Pering, 2006; zilverinnovation, 2009). We refer to this emerging group of techniques as Digital Self-Reporting (DSR).

Our empirical research focused on the iterative design and evaluation of a DSR method, Mobile Diaries, in a commercial context. To summarise here, the method was designed over two field studies and then deployed on two further commercial projects. Participants were given mobile phones and cheap video cameras from which they were able to create rich personal messages and document snap-shots of their lives through audio, text and images. In the later two studies these were posted to private research blogs or 'participant diaries'. These blogs became a platform for reflection, comments and discussion between participants and researchers.

The DSR method was intended as an early design research method for use in the design of community platforms and it was evaluated from two perspectives: its capacity to immerse designers in the everyday worlds of potential users, and its ability to support participants to contribute to, and participate in, the design process. We found that the digital, mobile, networked qualities of the tools enhanced the *in situ* nature of the method increasing the sense of immersion for designers. We also found that the *in situ* nature of the method, and the use of social technologies *themselves* as tools for design opened up new opportunities for people to participate in the design process by blurring practices of research, design and use. Specifically activities that were usually understood to be part of *using* social technologies, (such as generating content, sharing daily experiences through image and text, interacting and communicating through blogs and sms) became available in the design research phases. For the remainder of the paper we explore these opportunities through the concept of seeding. We reflect on the assumptions about practice and protocol the concept of seeding prompts us to reconsider, and the larger implications for design, research and participation it suggests.

Seeding

According to the Macquarie Dictionary ("Macquarie Dictionary," 2003) the term *seed* refers to the germ or beginning of anything. *Seeding* is a commonly used metaphor in texts that address design, use and participation e.g., (Botero & Saad-Sulonen, 2008; Darren, 2007; Fischer, 1998; Light, Briggs, & Martin, 2008; Merkel, et al., 2004). It is often used to refer to activities that can act to germinate participation. For example, in an online marketing campaign a solid and well-targeted seed list of email addresses increases the chances of campaign success because of the higher number of likely send-ons. In the development of early virtual communities, the use of seed content, conversations and groups was an important strategy for encouraging, prompting and guiding new contributions and members (Figallo, 1998; Merkel, et al., 2004; Rettig, 1998; Rheingold, 1993). In developing community tools for use in civic contexts, Botero & Saad-Sulonen (2008) make use of living seed prototypes to understand how people might put new technologies to use in context, while Merkel et al. (2004) draw attention to the need to seed ownership of design within communities.

As a design concept then, seeding allows us to talk about the movement and relations between design and use, specifically, the work that needs to be done to move design from the ‘abstract’ into what Lee (2008) refers to as the concrete places where people live. Successful designs are taken up as part of people’s existing ‘ecologies of devices’ in people’s ‘already ongoing life-worlds’ (Ehn, 2008). Seeding draws attention to how it is that happens, and our role in creating conditions for that to occur.

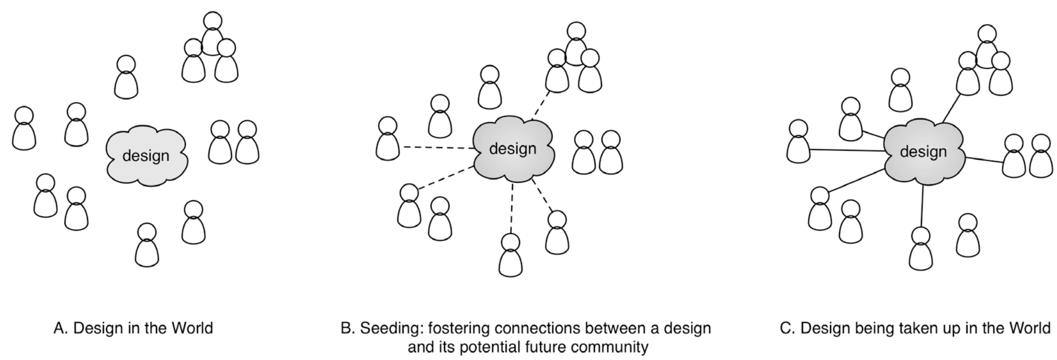

Figure 1. Three different states of design.

Figure 1. depicts, in simple terms, three different ‘states’ of design. Design existing or ‘released’ into the world as a public object (A). The seeding of connections between the design project and people’s daily lives (B), and (C), design having been appropriated and taken up as part of (some) people’s existing ecology of devices. Seeding serves to name activities we can do within the design process, as designers, to try and bridge the gap between A and B; to embed design in the world and to create connections between the design project and the people who may use it. In (C) the design is not taken up by all the people, because, even in such a simplistic representation, it is important to acknowledge that we can only create conditions *for* participation through seeding, we cannot guarantee it.

Seeding, in the context of this paper, places value on opportunities to embed the design project in its potential, future context of use, during project-time. This is based on the assumption that building a sense of interest, ownership or connection with potential future community members during the design project, increases the likelihood that those individuals may then take up the design as a public object, and appropriate it into their everyday lives.

Strategies for Seeding

In this section we present three potential strategies for seeding design early in the design project. We identify these as: socialising the research; bridging gaps between current practices and future practices; and developing early content. Below we describe these three strategies and how they emerged as a result of our research into social technologies as tools for self-reporting.

Socialising the research

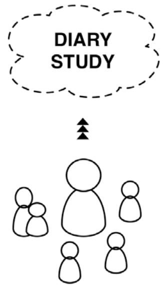

Figure 2. Participating in the diaries becomes a shared activity for participants.

Socialising the research describes the seeding of interest and momentum around the project through participants sharing the research with their wider network. We found that the use of social technologies and tools such as mobile phones and blogs encouraged participants to socialise the research project with friends and family. It was common for participants to include others in the creation of their diary reports, and to share the images and comments from their private blog-diary. The act of participating in the research generated discussions with friends, family and colleagues around both the research and the topic being explored. At least one participant shared experiences of the study on her MySpace page whilst another asked permission to post her diary material on MySpace as well as on the private blog. Figure 2 depicts participation in the diary study as an inclusive activity.

This sharing and socialising of the project takes on a particular significance in the context of developing community platforms. The inclusion of friends, family and peers connects the design project with a larger group of people, increasing the visibility and momentum around the project. Even in small numbers the individuals recruited for the studies could become an important seed community, sharing and promoting the project or future system with wider networks.

Sharing the research is a way in which participants are able to exercise ownership over the process, appropriating the project into their daily lives, activities and relationships. In doing so they indicate how the design project intersects with existing energies and interests in their lives offering designers potential start points and direction for the next steps in the design. We attribute the propensity for participants to 'socialise the research' to the nature of the research tools; in using these tools for research we had appropriated both the tools of social technologies as well as the practices of sharing and communication they made possible.

Bridging the gap between existing and future practices

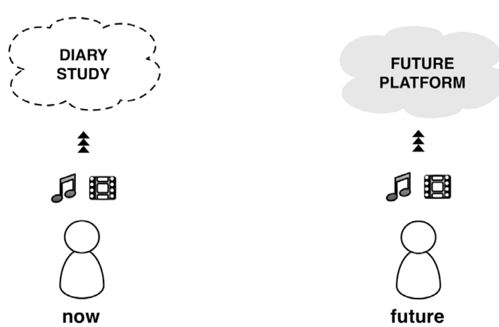

Figure 3. Activities and skills required for the research are the same, or similar, to that of using the future platform.

This strategy talks to the ways in which some design methods can act to bridge the gap between existing practice and future practice. In discussing their use of living research prototypes Botero and Saad-Sulonen (2008) state: “the types of engagements that prototypes and interventions afford offer an interesting and viable path to develop not only systems themselves but the practices that surround them and ultimately make them viable” (p. 269).

We found that digital self-reporting created a similar ‘path’. Participants created videos, sent picture messages, sent mobile blog posts (mo-blogs) and commented on blog messages. As Figure 3 suggests, the activities were similar, if not the same, as those that characterise participation in community platforms. In many cases participants were using these technologies for the first time. By participating in the studies, participants were developing the skills and technology knowledge needed to participate in the social technologies we were aiming to design. In addition to providing insight into future users, the self-reporting method allowed participants to develop skills and seed practices that would make our future designs viable by bridging current and future practices.

Developing early content

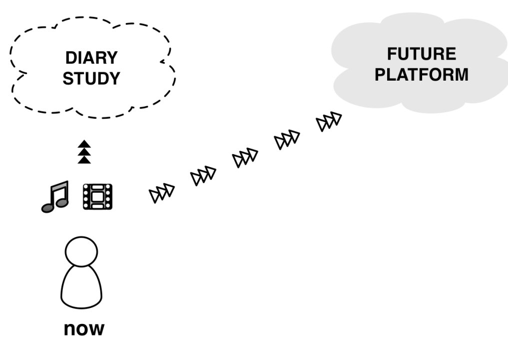

Figure 4. Material generated in the study could also be interpreted as seed content.

Social technologies are driven by the contribution and interaction of users and these contributions shape their form. Our research showed the potential of creating User Generated Content (UGC) early, prior even to development of a specific platform.

In the digital self-reporting studies, we found at times little difference between the material participants produced and what we would hope to see on the user generated sites or platforms we were designing, other than the framework under which it was produced. Figure 4 indicates how material generated during the studies could also be interpreted as seed content. This was due both to the subject matter of the reports i.e., personal images, stories and videos about a particular topic of interest, as well as the format in which they were produced i.e., MMS, blog-posts and MPEG-4 video, all formats developed for publishing and distribution.

UGC developed early in the design process can act as seed content around which the design of the platform can be shaped. Themes, navigation, taxonomies and potential features could evolve in response to this early understanding of the kind of content people might contribute. Whilst acknowledging that participants would censor their material in different ways were it public, reading the early self-reporting material as potential seed content gives insight into how the topic becomes meaningful in peoples lives, as well as how people might go about communicating and sharing it with others. It also creates a greater personal connection between the design project and participant - inviting them to play the role of author and contributor prior even to the development of the platform itself.

Summary

Socialising the research, bridging current and future practices and developing early content are examples of strategies for seeding early in the design process, identified in our research. They demonstrate ways in which the project started to take on its own energy and momentum within the lives of a particular group of participants and their wider networks, in some cases well beyond the formal boundaries of the design research project. The project became a public object in the world 'bringing into being' interested and willing potential community members.

Reflections on seeding, design and participation

In the previous section we identified a number of strategies for seeding design early in the design process. Here we discuss how our capacity to leverage these opportunities was limited by assumptions embedded into our design and research process about participation and the role or relationship of participants to the project. Seeding suggests new values and priorities within design research not necessarily accounted for in traditional approaches. We reflect on these assumptions and findings below as part of developing a better understanding about how such design activities could be framed and supported.

Managing participation

The limitations we encountered are interrelated and stem from assumptions about the kinds of contribution and modes of participation that are possible so early in the design process. Many of our traditional frameworks and protocols for managing participation are modelled around the assumption that activities of research, design and use progress in a relatively linear sequence. Early design research focuses on activities such as understanding user needs (Rhea, 2003), informing and inspiring design (Sanders, 2005) and potentially ideation and concepting (Sanders & Stappers, 2008). These assumptions about what design and participation look like do not anticipate the kinds of participation emphasised through our examples of seeding, or the blurring of research, design and *use* that social technologies make possible.

In traditional early design research, the value of the method is largely realised in the material that is generated. Whether it be to inform understandings of practice e.g., (Grinter & Eldridge, 2003), inspire design e.g., (Gaver, Dunne, & Pacenti, 1999) or foster empathy e.g., (Mattelmäki & Battarbee, 2002) the emphasis is on the generation of design material. This frames the value of the activity around tangible research deliveries, and participation around the generation of that material. It also limits participation to the specific design research project, e.g., a self-reporting study. A close relationship is fostered with participants over this period of time, but when the study stops, so does any formally resourced relationship with participants. Rather than participating in the design process as a whole, participation is limited to that particular research activity.

It is standard research protocol to protect the identity of participants when the outputs from design research activities are then published or shared beyond the immediate design team. These consent protocols don't anticipate the potential to transition or reinterpret the design material into published content, limiting the use of the material produced to the purposes of the research project. Consent forms that assume participation should be represented anonymously make less sense in situations where we might want to facilitate, or make it possible for, participants to engage in the design process in the role of author, contributor or content creator.

These protocols assume a division between the private practices of research and the public spaces in which we live that does not necessarily exist, or that may no longer make sense in the context of social technologies. Predicating participant engagement by guaranteeing anonymity restricts designers and clients in their capacity to develop authentic relationships with participants, and assumes particular roles for participants in the design process. Strategies for seeding such as ‘socialising the research’ and the development of seed content encourage much more public, uncontained and shared levels of participation. Activities usually associated with use, such as generating content and *using* social technologies, move into the early phases of research and design, making it hard to tell where the research stops and the community starts. Our obligation to our participants needs to be rethought in the context of social technologies and the forms of participation in design that they encourage and make possible.

Another barrier to seeding is the tendency to model participation and user involvement around the notion of ‘representative users’. Recruitment is often focused on identifying people who represent different ‘user types’ from an identified ‘target audience’. Under this model participants’ primary role is that of ‘representative user’, rather than as an individual. Seeding, on the other hand, emphasises opportunities to build connections with potential future community members, authors and contributors. This places value on the relationships we can build with specific individuals and their networks.

The concept of seeding suggests that our frameworks for managing participation need to enable different kinds of relationships with participants that privilege them as community members, and empower participants to take on a range of ongoing roles in the design process. When our goals are to seed content, connections and community our protocols for consent need to embrace, support, and appropriately protect participants while also enabling them to participate as authors and contributors, choosing how and with whom their context is shared.

Approaches we might learn from include Participatory Action Research (PAR) and Participatory Design. For example in discussing issues of consent McIntyre (2008) describes the negotiation of consent as a collaborative and evolving process to be renegotiated with participants throughout the process. Participatory Design has always understood research to go beyond data collection and promotes continuous collaboration throughout the ongoing process of design (Ehn, 2008).

Changing priorities and values in design

Putting value on opportunities for seeding participation during project-time also shifts the priorities within the design process. As our goals in the design process begin to expand to include seeding participation and bringing ‘into being’ community (DiSalvo, et al., 2007), what were once opportunities to conduct contextual research, such as self-reporting, also become opportunities to build momentum and interest about a project in the context of where it might be taken up.

The concept of seeding sensitises us to the value of new design experiences such as socialising the research, and seeding content, and other less tangible outputs including the value of maintaining relationships with participants beyond the various formal research and design activities they might be participating in. The relationships, momentum and connections that are built up with individuals and their networks as a result of the participating in such activities go beyond the time frame of the study and outside the bounds of the research phase.

In presenting an argument for rethinking the nature of the ‘design project’ Ehn (2008) suggests that we understand design tools (he uses the example of prototypes) as both representations of the evolving state of design, as well as socio-material public things which support communication or participation across the design project; "they are potentially binding different stakeholders together" (p. 95). Ehn's statement suggests that in the context of designing for participation, the value of design methods is not just to support and inform the creation of artefacts, but also to foster connections between design projects and their potential future community. Seeding puts emphasis on the potential for making connections and content, and even more importantly, maintaining energy, interest and momentum around the project during project-time. In order to prioritise and place value on these additional design outcomes, strategies for seeding design need to be written into our design briefs and effectively resourced.

Selling seeding: design in use

We have suggested that seeding is a way to strategise and communicate about embedding design in use. However embracing the notion of seeding into the design process, and 'selling' it to clients, is not without its challenges. As a design metaphor the concept of *seeding* sensitises us to a number of important aspects to designing social technologies. Two aspects in particular that we have encountered in the course of our research pose particular challenges for selling seeding to clients, these are the risks inherent in seeding and its lack of measurability, and the open-ended approach to design that seeding privileges.

In the context of design, planting seeds doesn't guarantee the survival or sustainability of a project, but it may increase the likelihood of that project being taken up in the world. We may put effort into seeding activities, into building relationships with future community members, but we can't ensure they will be successful, or lead to observable outcomes. This is simply the nature of design in the wild (Hutchins, 1995). Both the risk and the intangibility is something that we need to be able to effectively articulate to clients as an inherent aspect of designing for participatory technologies.

Similarly, the act of seeding necessarily means relinquishing some control over its form whilst simultaneously opening up opportunities for it to be shaped by that exposure. Seeding is about embedding the design in the world, which means making design "a public thing open for controversies" and, "from which new objects of design can emerge in use*"* (Ehn, 2008 p. 96). *S*eeding acknowledges the shaping of the nature of the project through the way in which it becomes meaningful to people in the real world.

The majority of commercial design projects are brokered with the assumption of specific tangible outputs at particular milestones, for a particular cost. Seeding, as an alternative approach suggests the value of investing in design activities that can orient the design around existing momentum, interest or energies in the community. This requires a greater degree of flexibility by the client. Botero & Saad-Sulonen (2008) found that their client, the local council, was initially unwilling to invest in seed prototypes, though they embraced the process once the results were demonstrated. Further case studies and appropriate frameworks will assist clients in building confidence about such open-ended approaches.

Concluding remarks

Traditional Human Centred Design methods equip us well for asking how we might research, ideate, iterate and produce a design object; they prepare us less well for how we bring into being a community around that object. We suggest seeding as a useful concept for approaching and strategising about this increasingly important aspect of design. The examples and discussion above sensitise us to a number of aspects important to consider in the development of social technologies and raise a number of questions for future work. The participatory nature of social technologies prompts us to reflect on, and perhaps reconsider how participant involvement in design is being managed, and the kinds of assumptions some traditional approaches have embedded in them about how participation takes place. The emphasis on participation and the role of users in actualising the design of social technologies also brings to the fore a number of issues with regards to our relationship to clients and the way we structure, resource and strategise about 'design projects'.

We propose the notion of seeding can inform and support an evolving approach to managing the relationship we have with participants, and our own evolving roles and skills as designers. It can also assist us in framing new shapes for design, naming and describing the work important to embedding design in use. In the design of social technologies we are encouraged to find opportunities to move research and design out into the wild, where it can take seed and be nurtured as part of people's already ongoing life-worlds.

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Understanding Senior Design Students' Product Conceptual Design Activities:

A comparison between industrial and engineering design students

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Abstract
This paper reports an experimental study with a purpose to investigate and compare the design thinking processes between final-year industrial design (ID) and mechanical engineering design (ME) students. Two types of conceptual design activities were observed and analyzed. One was to solve a realistic problem for the current market and the other was to generate "blue-sky" visionary concepts for the future. A qualitative method, derived from design protocol analysis, was proposed to explore the structure of observed design processes. The preliminary result demonstrated the disciplinary difference, between ID and ME students, on formulating and approaching design problems. In contrast with the previous perception that ID process is more solution-led while that of ME is more analysis-oriented, ID students were observed to spend much more time on systematically analyzing target-users and possible contexts of usage, in order to establish new design goals and requirements with regards to the above analyses. Whereas ME students were more dedicated in solving the problems identified from the given design brief and conducted little analytic work before concept development.

Keywords

Variations of design thinking; design protocol study; structure of design processes.

Design thinking is one of the most important issues in design research. During past three decades, design researchers constantly sought to identify the shared core features across all design professions, in order to generalize the cognitive mechanism of designers into a distinguished way of thinking and knowing from sciences and humanities (Archer, 1979; Cross, 1999, 2008; Goel & Pirolli, 1992; Owen, 2006). The term "design", however, does not refer to a homogeneous activity; instead, it includes an extraordinarily broad spectrum of activities, with one end linking to engineering and the other end to fine arts (Lawson, 2004). Normative studies (Akin, 2001; Lloyd & Scott, 1994, 1995; Roozenburg & Cross, 1991) have also identified that significant differences existed in the design models between industrial design and engineering design, which implies there are many variations within the general design approach. This study therefore attempted to analyze empirical evidences from design process to evaluate or refute these pluralism arguments of design thinking. Insights on similarities and differences between different design disciplines are also expected to contribute to the generalization of design cognitive patterns during various design processes.

Conceptual Framework

Our explorative approaches for the variations of design thinking were: (1) to select several related design disciplines within a specific design field and (2) to observe and compare their design cognitive processes.

Product design is the focused area of this study. Two related design disciplines were selected, i.e. Industrial Design (ID) and Engineering Design in particular Mechanical Engineering Design (ME), which are believed to respectively represent the synthetic- and analytic-oriented aspects of product design (Owen, 1998, 2006). It is thus hypothesized that, given the same design problems, these two design disciplines will show distinguished differences between how they approach the problems and synthesize the concepts and solutions.

One way of investigating design thinking is to portray the structure of design cognitive mechanism while performing a particular design task. Dorst (2003) argued that design cognitive processes were nested; analysis, synthesis and evaluation activities were not proceeded in a spiral sequence or simple iterations, but rather in a form of complex nested network of “cycles within cycles”. Our pilot study confirmed this argument. This paper aims to empirically explore the detailed cognitive structure between both ID and ME students’ conceptual design processes and compare the ways of how design activities (i.e. problem analysis, idea generation, etc) were organized within conceptual design processes.

Another concern of our study is the nature of design tasks. The purpose of design tasks and the amount of constraints linked to task type may also alter designer’s cognitive strategies and thus produce different patterns on design processes.

Research Methodology

Design protocol study (an observational, experimental research method, see Cross, Christiaans, & Dorst, 1996; Jiang & Yen, 2009) was adopted as the primary method in this research.

Factorial Research Design

A 2X3 factorial experimental design (shown in Table 1) was applied to this study. Two factors, i.e. major independent variables, are design disciplines and types of design tasks.

Table 1 Comparative Dimensions of Design Experiment

	ID teams	ME teams	Mixed teams
Task A: realistic problem solving for the present (with hard & unalterable constraints)	4 teams	4 teams	4 teams
Task B: visionary concept design for the future (allowing wild imagination)	4 teams	4 teams	4 teams

Final-year ID and ME students from National University of Singapore were recruited voluntarily as the research participants. The unit of participation was a design team consisting of two persons. Three participation categories were designed in this study: ID teams (both participants come from ID), ME teams (both from ME) and Mixed teams (one from ID and the other from ME). A total of twelve teams were observed and analyzed.

This study focused on design conceptualization phase, which is considered as the most creative element of design activities. Two different types of design tasks were assigned to each team. Task A is to design a coffee maker for a Singaporean start-up company. Based on the context of current market, the purpose of this assignment is to create realistic commercial problems with several hard and unalterable requirements. Task B is a visionary concept design, i.e. to design a next-generation personal entertainment system/device for a world leading electronic corporation. Compared with the former task, task B allows much more space for wild imagination and subjective interpretation.

Experiment Procedure & Setup

Each experiment session was conducted as the procedure shown in Figure 1. A pre-test questionnaire was designed to recruit voluntary participants. Their demographic information, basic understanding of design and perception of design process were also collected. All participants were asked to execute both task A and B and a lunch break was provided between these two tasks. In order to balance the sequence effect, half of the teams in each category performed task A first and the other teams performed task B first. After the completion of each task, the participants were allowed to make a short presentation within 5 minutes to explain their ideas.

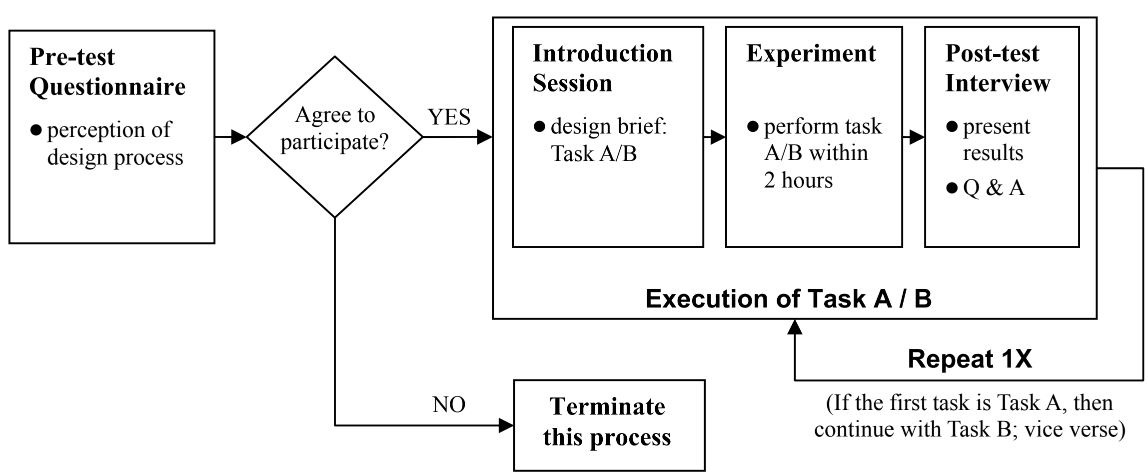

Figure 1 Experiment Procedure

The experiments were conducted in a design-studio-like setting shown in Figure 2. Both traditional design tools (e.g. pencils, pens, sketching markers, paper, etc.) and digital design tools (i.e. a laptop computer which was accessible to internet and pre-installed with CAD software packages) were provided. A white board nearby the workstation allowed designers to write, draw, and use post-it tips to share and collaboratively develop their design ideas.

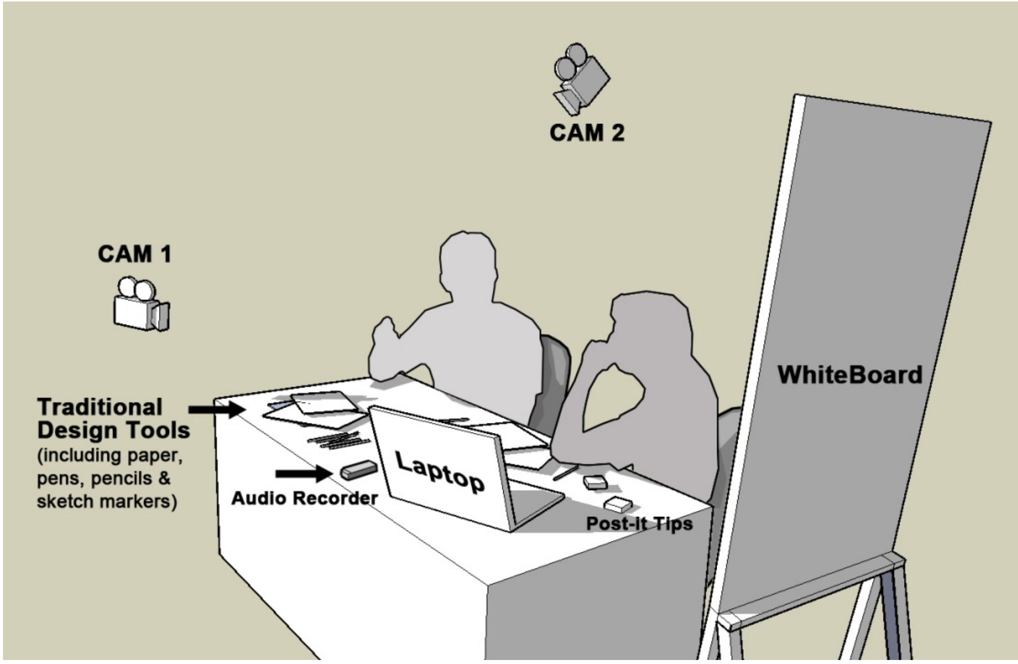

Figure 2 Experiment Setup

Two cameras and one high fidelity audio recorder, illustrated in Figure 2, were set up to capture the details of the observed design process. Thereof, CAM 1 took the overviews of designers' performance (lower part of Figure 3) while CAM 2 emphasized the specifics of designers' work, like sketching processes (upper-left part of Figure 3).

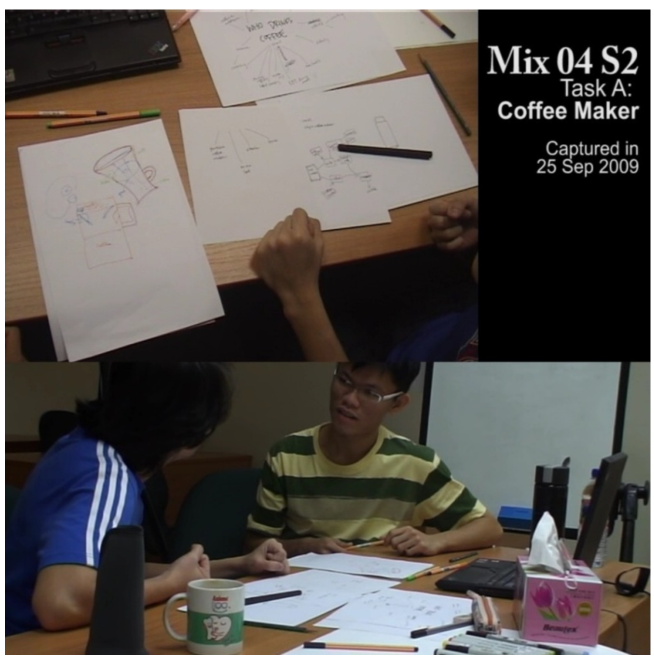

Figure 3 Snapshot of Multimedia file for analysis

After all session, the outputs of CAM 1 & 2 and audio recorder were synchronized into a combined multimedia document (exemplified by Figure 3). All conversation and utterances within the design activities were transcribed in textual form and non-verbal behaviors were recorded as the notes in the transcriptions. The sketches and drawings produced during design processes were collected and numbered with regards to the occurrence sequence. The multimedia documents, text transcripts and sketches collectively constituted the tripartite design protocols for latter analysis, which were considered as the externalizations of cognitive processes of these observed collaborative design activities.

The data of pre-tests questionnaire and post-test interview served as extra references for making sense of design protocols.

Methods for Analysis

One of the most common techniques for design protocol analysis is to segment a protocol (i.e. the record of a complete process) into micro-actions of seconds, code them with a set of priori categories and then explore the coded segments qualitatively and/or quantitatively. This technique can identify the alternations of topics and designers' intentions within a design process, but the connections between micro-actions are severed (Dorst, 1997; Dorst & Dijkhuis, 1995). The observed design process was thus flattened into a simple sequence with iterations between several behavioural categories, rather than maintaining the nested structure of design activities.

"Linkography", on the other hand, is a technique proposed to analyze the interconnections of design actions within a process (Goldschmidt, 1995; Goldschmidt & Weil, 1998). But content of each protocol segment is omitted in this technique. All design actions are simplified as homogeneous design "moves" in a linkograph, i.e. a diagram visualizing the interconnected moves. It is hard to show patterns about major design phases (e.g. problem analysis, idea generation) and their structures.

In order to investigate the nested nature of design processes and relationship between major design phases, a revised version of design protocol analysis balancing the content and interconnection of micro-units of design activities was developed.

Rather than coded with a priori set of categories, we adopted a data-driven approach. A protocol was segmented according to its semantic meanings. The semantic transitions were adopted as the criterion of splitting protocols, like verbal hints that suggested designers were shifting their intentions, as well as silence situation lasting more than 5 seconds which indicated a process breakdown. These segments were usually clusters of several finer design actions. With regards to the dynamic nature of design activities, these segments varied from 1~2 seconds to several minutes.

After segmentation, each protocol segment was then coded based on its semantic meaning rather than a priori coding system. This allows a flexible coding process. New categories of code will be easy to generated and added into the coding scheme, and the existing codes are vulnerable to rearrangement. Table 2 summarized codes applied in our study. The organization of the applied codes resembled Purcell et al.'s (1996) coding scheme of design strategies. The immediate design actions could be mapped to three broader categories of analysis, synthesis and evaluation. Another set of actions, which we tentatively called "strategy", referred to the management of or reflection on design actions. They could be categorized as "meta-cognition", i.e., monitoring, evaluating and regulating people's own cognitive actions (Fayena Tawil, 2007; Jaušovec, 1994).

Table 2 Data-driven Coding Categories

Categories	Sub-categories	Interpretation	Example in transcripts
Problem Analysis	Info	Searching for external information	"Check the ice blend coffee (action: browsing WebPages)"
	Name	Identifying elements related to current design situation	"What factors are essential for entertainments? Audio… visual … touch .. and? (action: drawing a mind map"
	Analysis	Elaborating relevance of identified elements to design procblem	"The interface is important for an entertainment device"
	Requirement	Establishing requirements or specifications	A: "So what do you want attributes of? ... What the ..." B: "Of course you must look trendy, sporty, professional…"
Solution Synthesis	Ideation	Proposing a new (partial) solution	"Playing music with heart beats, or mood of the day (action: brainstorming through post-it tips)"
	Revision	Modifying a proposed solution	"Yah, it must have some transparent thing here" "Maybe put it at the bottom, so it can be easily accessed"
	Synthesis	Combine several partial solution into one coherent solution	"I think these two ideas both
Solution Evaluation	Interpretation	Interpreting and analyzing the proposed solution	"Because there is the ice, there is the coffee, there is the … It sounds you need a lot of coordination" "Basically, when the water is boiled, the coffee is added here, the steam will eventually produce high enough pressure to force the boiling water up to here…"
	Evaluation	Making positive or negative judgments on proposed solution	"I like this idea, very ipod-ish … cool, man" "This is really cute. I want to buy one when it's released"
Strategy	Management	Proposing a design global or local strategy on organizing design process	"Let's do some brainstorming, about 10 minutes … hum, till 10:45, then we exchange ideas"
	Reflection	Evaluating and reflecting on current design strategy	"I think we move on too fast, let's focus on what is users really want at this moment. A: "Do we continue doing mind map?" B: "I think had better move on to concept generation"
Others	No code	The irrelevant verbalization for our study	"This color is quite cool" (comments on the marker we provided) "Wait me a second, I need go to toilet first"

Due to the explorative nature of this stage, the coding of protocol was conducted by a pencil-and-paper approach. No quantitative analysis was executed after coding process. Instead, we proposed a technique to visually manipulate coded protocol segments at a macroscopic view. Inspired by affinity diagram (Beyer & Holtzblatt, 1998), these coded segments were grouped and rearranged in a hierarchical structure, according to their similarity on design topics. Meanwhile, each segment's duration and position in timeline were still maintained. The structural pattern of design cognitive process was thus able to be read from the reconstructed sequence or the "flow" of design activities.

Findings and Discussion

Figure 4 exemplifies the visualization of coded segments. Generally, the top-level of protocol groups, which are not further grouped into another group as a component, could be seen as the phases in a stage-like designing process model. Most of such phases can be well aligned with three broad categories of coding scheme, i.e., problem analysis, solution synthesis and evaluation. Meanwhile, the actions of "strategy" was scattered along with a design process.

However, a closer examination of this visualization shows that the observed designing process was not a simple sequence of these three broad activities. Instead, a nested structure of design cognitive process was found to emerge from the reconstructed sequence or the "flow" of design activities. Nearly all types of actions can be found within each phase. For example, in both sessions of Concept Generation 1 and 2 shown in Figure 4, these two "synthesis" phases include "requirement establishment" actions (that are attributed as "analysis" category) and actions of "evaluation of the generated design alternative" (that are a subcategory of "evaluation" activity) as their components. This finding is consistent with Dorst's (2003) argument of the nested structure of design cognitive processes.

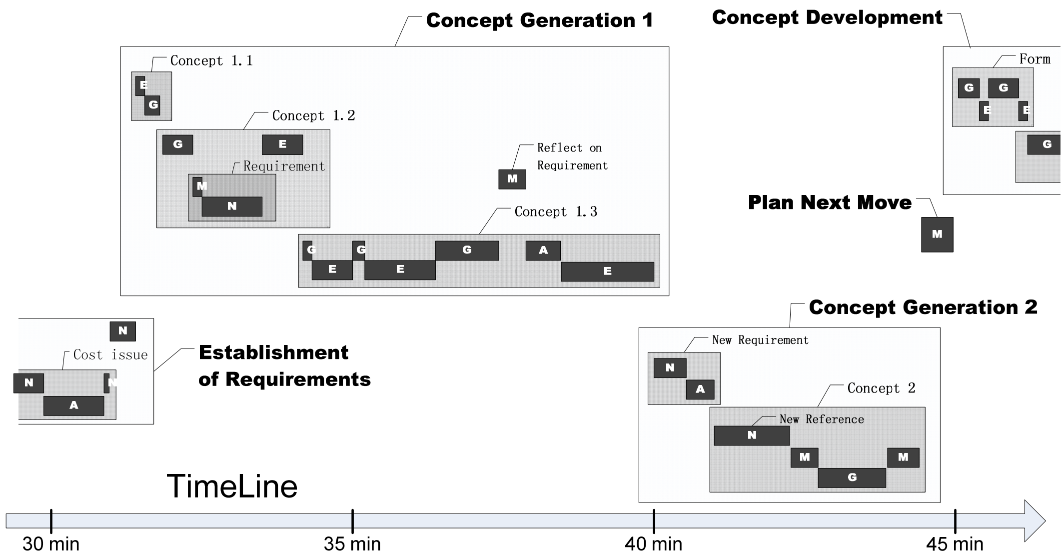

Figure 4 Nested Structure of a Design Process (an example based on a partial process)

Through examining both structural visualizations and the contents of protocol transcripts, some significant features of design processes in each factorial category were identified. Table 3 summarizes the preliminary findings based on qualitative examination at a macroscopic level. The results will be discussed in detail from two perspectives: the dissimilarities of process structure according design disciplines and experimental tasks.

Table 3 Preliminary findings of design protocol study

	ID teams	ME teams	Mixed teams
Task A	• Process: Analysis-Synthesis • Duration of Analysis: 1/3- 1/2 • Content of Analysis: Generic context; product features • Concept: 1 or 2 main concepts with several variations • Emphasis of concept: User experience	• Process: Analysis-Synthesis • Duration of Analysis: 1/5- 1/4 • Content of Analysis: Understand existing products • Concept: 1workable concept • Emphasis of concept: Working mechanism	• Process: Analysis-Synthesis • Duration of Analysis: 1/3- 1/2 • Content of Analysis: Generic context; design precedents • Concept: 1 main concept with several variations • Emphasis of concept: User experience
Task B	• Process: Analysis-Synthesis • Duration of Analysis: 1/3- 3/5 • Content of Analysis: Generic context; product features; design precedents • Concept: 1 major concept but initiated by several crude ideas • Emphasis of concept: User experience	• Process: Synthesis • Duration of Analysis: < 1/5 • Content of Analysis: recognize problem from design brief; hardly found an explicit analysis phase • Concept: 1workable concept • Emphasis of concept: Functions	• Process: Analysis-Synthesis or Analysis-Brainstorming-Evaluation-Synthesis • Duration of Analysis: 1/3- 1/2 • Content of Analysis: Generic context; design precedents • Concept: many crude ideas • Emphasis of concept: Functions

Design Processes: Analysis-oriented vs Synthesis-oriented

It was claimed that, within the comparison of ME and ID's designing process, the process of ME was more analysis-oriented, focusing on "finding" or discovering, whereas that of ID was more synthesis-oriented, emphasizing "making" or invention (Owen, 2006). But the empirical findings of this study appear to demonstrate a reverse phenomenon.

In the observed design sessions, ID participants dedicated a considerable amount of time (more than one third of total time) into problem analysis or design context analysis. Their process was usually initiated by a general exploration of broader design context without consideration of any expected design outcomes. When an unfulfilled need or a more promising potential was identified, the focus of design discussion was relocated to the features of product concepts, or design requirements. Design brief like statements were explicitly made before they went into generating design concepts.

ME participants, conversely, showed a very solution-led strategy. They were observed to spend little time (usually less than 10 minutes) on problem analysis and quickly jumped into the details of design solution. Their analytical work was also closely related to particular aspects of solutions, e.g., understanding existing products' working mechanism.

The general contexts (usually not explicitly concerned with specific product concepts) that were discussed in detail by ID students were seldom observed in ME processes. Only 2 out of 8 ME sessions explicitly, though very briefly, considered their target-user, usage context and design requirements before approaching possible product concepts. Other sessions either stated the abovementioned considerations as hindsight, or simply omitted them.

Moreover, ME sessions spent much less time on problem analysis. Their process thus seemed more "efficient"; the average time of ME sessions was 33 minutes shorter than that of ID sessions, which lasted about 91 minutes on average per session.

The processes of Mixed teams stood somewhere in the middle, depending on which participant was more actively involved in the process.

The above results demonstrate significant dissimilarities between ID and ME students' design strategies. These structural differences of designing processes seem to be correlated to the very different understanding of design held by ID and ME students.

According to the pre-test questionnaires, ME students treated design as a particular type of problem-solving activities. For them, the problem situations were already given or prescribed in design brief; a designer's job is to gather them and identify one or two feasible ways to solve them accordingly. ID students, however, apprehended design from the perspective of its ultimate purpose, i.e., a means of "improving human lives" (excerpted from an ID student's response to pre-test questionnaire).

It is likely that, guided by the different views of design, ME students spend very little time on the problem analysis and tend to consider the designed product as a system. The interactions of subsystems or product components are thus their specific concerns. For example, issues, like proposing a scheme to breakdown components or “functional modules”, were frequently discussed in ME protocols.

In contrast, ID students valued the role of human much more than that of a product. They are thus willing to spend more time to systematically go through the analysis of potential user’s profile and possible usage contexts, and to explore the potential opportunities to create something new and more appropriate. The product concepts, most of time, are discussed under a broader user-product-context framework while the internal structures of designed product are less important. Human-centred values are their major concern. For instance, during the design process, “experience”, “fun”, “feeling” and “interaction” were the terms most mentioned by ID students.

Influences of the Nature of Design Tasks

The structure of designing process seems not only to be influenced by the constituting members of design teams, but is also subjected to the type of design tasks (Table 3); the abovementioned disciplinary differences were more significant in visionary concept design task.

In task A, the processes of all three categories followed an “analysis- synthesis” sequence in general. Most sessions generated one or two design concepts based on their initial analysis. ID students usually experimented with several variations on form or ways of how people could interact with designed product, whereas ME students appeared to be more committed to a single workable solution. The evaluative actions intermediately followed actions of synthesis, thus no extensive evaluation stages came up.

Situations changed in task B, i.e., future-oriented visionary concept design task. ID teams followed a similar “analysis-synthesis” strategy; ideas of expected product were triggered by the analysis and then naturally evolved. ME teams, instead, proposed the possible solutions in the very beginning, and the final outcome seemed to be a simple assembly of everything they had thought of. Both ID and ME sessions, for task B, adhered to the development of a single concept; very little variation of product concept was considered.

The Mixed sessions in task B showed a very different story. Two Mixed teams’ processes resembled those of ID teams, i.e., synthesis stages followed analysis of problems. However, the other two Mixed teams were stuck at the analysis stage, without emerging a promising direction to pursue. Participants resorted to a formal brainstorming for idea generation. The consequence of brainstorming was that designers had to face a variety of solutions (7 and 22 in two sessions respectively); an explicit “evaluation” phase was thus required to perform in order to identify which idea, or an integration of several ideas, was appropriate for further development. These two teams adopted an “analysis-synthesis-evaluation- synthesis” strategy in visionary conceptual design.

In our original conception, task A and B represents two design problems of different nature. According to theory of problem finding (Dillon, 1982; Getzels & Csikszentmihalyi, 1976; Runco, 1994; Starko, 1999), there is a distinction among presented problems, discovered problems and created problems in terms of whether or not there are explicit problems, standard solving methods and/or possible solutions known to solver and/or others. Compared with task A, task B contains more potential and implicit elements requiring designers to identify and actively formulate. It is supposed that task B will involve a longer problem analysis and formulation phase. ID and Mixed sessions confirmed with this hypothesis, but ME sessions did not. This phenomenon is difficult to be accounted for by the traditional view of problem solving, which frames the design processes by analysis, synthesis and evaluation activities, but it can be possibly explained from the view of problem finding and formulating. One probable explanation is that ID and ME students held very different problem formulating strategies.

According to Thomas and Carroll (1979), design is not necessarily associated with a particular type of problem. More precisely, design is rather “a (particular) way of looking at a problem” (p. 5) and any problem can be viewed as a design problem if the solver treats it as ill-defined. In our experiments, a longer problem analysis phase in task B suggests ID students made a greater endeavour to understand the problem situation and create a workable problem when they encountered a visionary design task. On the other hand, the very short phase of ME problem analysis may be explained by ME students’ “convenient” but passive strategy in which they tended to frame the problem situation as well-defined and simply select an available problem representations according to their experience. Retained from reconstructing the problem situations by other possible problem representations, ME students were thus easier to follow an adaptive or variant designing process, rather than conducting an original deigning process (Pahl, Beitz, Feldhusen, & Grote, 2007). The examination of designed outcomes also showed a strong fixation effects in ME sessions.

The different strategies concerning with design problems were consistent with Harfield’s (2007, 2008) two different design “problematization”, i.e., “problem as given” and created problem “as design goal”. They also indirectly refute the argument of design as a particular way of looking at a problem (Thomas & Carroll, 1979). Various ways of looking at a problem may co-exist within design activities.

Experiment Effects

All participants reported the experiment setting was similar to their design studio. They did not feel anything uncomfortable when working in this controlled environment. The observed design activities could represent their daily design processes.

However, a sequence effect (sequence of performing task A or B) was found in our study. No matter which task was performed first, the second task took less time to complete. The total experiment time was reduced almost 1/3 for ID teams and 1/5 for Mixed teams. The proportion of analyzing the second problem also decreased significantly in ID and Mixed sessions. The decrease of total experiment time in ME sessions was less obvious, but their second tasks were also found to last for a slightly shorter time. The latter effect, i.e. the alternation of ratio of analysis to synthesis, however, was not found in ME sessions, as ME students hardly explored the problems while performing task B.

Conclusion

The qualitative examination of design protocols shows significant dissimilarities between ID and ME design processes. This finding reflects different attitudes of ID and ME students to the tasks provided in this study, i.e., treating design brief as a given problem or as an impetus to formulate actual design problems to solve. This conclusion provides evidences for variations within design thinking and cognition.

Due to the explorative nature of this study, it actually raises more questions than it has solved. This study suggests that ID and ME students differ in their problem finding activities. A more detailed analysis will be conducted to investigate their problem finding processes and how problem finding actions are related to synthesis of design outcome.

The current analysis is a qualitative examination of design process structure at a macroscopic view. Further studies will include creating a sophisticated coding scheme and quantitatively analyzing both content and process aspects of design thinking (Goldschmidt & Weil, 1998).

In addition, the design strategies (including problem finding and solving) and understanding of design were taught, directly or indirectly, in the educational programs. Further study should include the discussion of the curricula of ID and ME programs in the National University of Singapore and identify the differences between these design trainings.

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Design Education as a practice of affiliation: facilitating dialogue between developed and developing nations

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Abstract

Exploring Design research and Design education that straddles developing and developed world contexts is the aim of this paper. It is a bold ambition to identify the key debates that inform these two significant aspects of Design – much too big to cover in the limited space here. Nevertheless we speculate on some of the issues that emerge from within Architecture, Urbanism, Philosophy, Sociology, Geography, Education and Design. We do this through the idea expressed by Lang that ‘affiliation’ is the need that links to all other human needs. We hypothesize that affiliation, and our need for belonging not only within our local communities, but also at a global scale, is a central concern that links research and education in developing and developed world contexts. Some design practitioners are shown to be tackling this problem, but too often these are single projects limited in scale. We maintain that these worthwhile and noble efforts must be scaled up to deal with problems of urban planning through first, second, third and fourth order design concerns, recognizing that whilst contemporary design is increasingly occupied with ‘interaction’ and ‘environment’, the established preoccupation with ‘symbols’ and ‘things’ remains out of reach for millions of urban poor. In fact, urban designers consider ‘symbols of affiliation’ as central to city dwelling. Design research and design education must therefore aspire to a material democracy that judges the appropriateness of each given situation on its merits, recognizing the need at times for basic material provision.

Keywords

affiliation; design education; social-actualisation; design for the dispossessed, urban design

In his depiction of the kind of design problems tackled by professional designers, Victor Papanek (1984, p. 57) showed us that professional designers are concerned mainly with a very small share of ‘real’ problems. In the 1960s Papanek indicated that the professional designer’s share is at the ‘tip of the iceberg’, sitting above a world of real problems. Since then, our understanding of design, and the work of professional designers, has moved on. But we might ask what has stopped designer from engaging with the real. The visual coincidence of Papanek’s pyramid depiction matches the same diagrammatic representations often seen in Abraham Maslow’s (1954 [1987]) ideas about self-actualization. We learn from this visual comparison that if, using Maslow’s terminology (1954 [1987], pp. 57–59), ‘motivation and personality’ is too much predicated on ‘one’s own needs’ and ‘individualism’ it is clear why so many ‘real’ problems remain unaddressed. Jon Lang (1994, p. 160) tells us that Maslow expressed dismay at interpretations of the desire to self-actualize, and a disregard for the needs of others. This demonstrates a tension between the self and the social, bringing into question the scale at which this takes place as representation and the notion of social-actualization.

Space does not allow for a full critique of Maslow’s work here, but apparently he believed that most people strive for esteem, but never self-actualize, and it has been argued that the full implications of this in terms of urban design are as yet unclear (Lang, 1994, p. 161). This paper therefore attempts to explore this by examining the step before esteem and self-actualization. Maslow called it *belonging*, but it is also named *affiliation* by Lang (pp. 158–160). Lang argues that affiliation needs are complex and interact with all other needs.

> ‘Participation in a supportive social system is necessary for an individual’s survival with a modicum of psychological comfort. This is particularly so in an urban world. Once their need for survival is met reasonably well, people feel most keenly the need for membership in a group or, more likely in the modern world, a set of groups’ (Lang, 1994, p. 252).

Understanding affiliation is necessary when we attempt to address the real problems identified by Papanek that professional designers are said to ignore. If better understood, this may help the scaling-up of design activity to tackle some of the urban planning challenges associated with the urban poor. See figure 1.

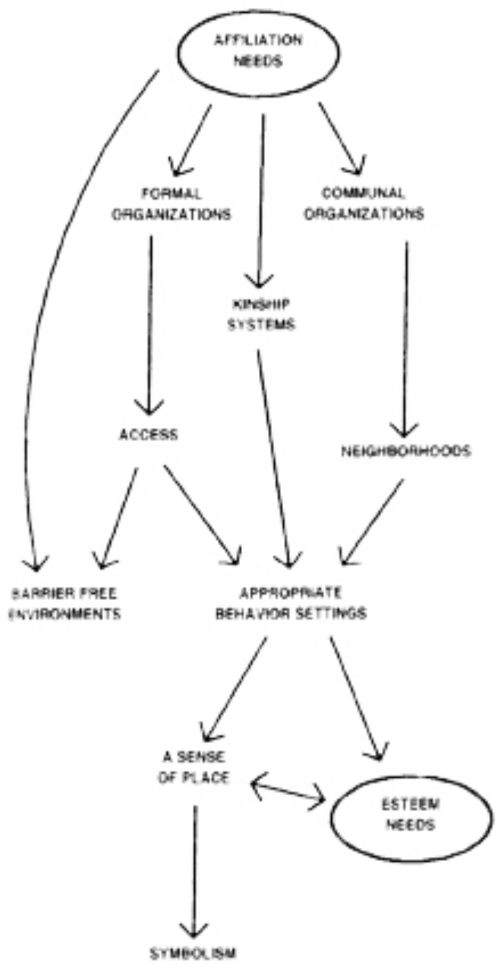


Figure 1. Affiliation Needs
Source. Lang, (1994) p. 253.

This work in progress is being undertaken in the context of developing an approach to design education that can straddle developed and developing world contexts. The potential for knowledge exchange in design research between developed and developing countries is immense. Developed countries have the benefit of history on their side in using design to create prosperous social, cultural, and economic contexts. However, as developed nations aspire to explore the potential for design and 'immateriality', rather than the traditional concerns for material objects, there is the potential for opportunities to be lost, or at very least, disjointed. Especially so when many people remain without basic material needs such as shelter. Developing countries are still yet to mature in their use of design for material gain that benefits the majority. Think of the increasing prevalence of the informal housing and urban homelessness across the world, and the need that millions of people still have for basic amenities that are realized through design in the physical sense. ‘A society cannot claim to be harmonious if large sections of its population are deprived of basic needs while other sections live in opulence’ (UN-Habitat, 2008). How much do we value affiliation in design, research and education? In this paper, it is argued that emphasis on 'affiliated' design research is critical if more social- rather than self-actualization is to be achieved.

What do we mean by affiliation?

The word *affiliate* originates from the Latin *affiliare*, meaning 'adopted as a son'. In modern terms it is commonly associated with officialdom, in the sense that it conveys a formal attachment to an organization, either in person, or as an organization, connected to a larger group or body. Lang (1994, pp. 158–160) uses the term *affiliation need*, placing importance on the process of 'identity-formation' for individuals as part of a group, as much as a need for individual distinctiveness. Special significance is given to the concept of the individual being part of a 'social and moral order' through the sense of belonging to a group. 'People need to have a sense of belonging, community, and relatedness, as well as to receive affection and approval from other people' (p. 158). Critically, this desire places value on participation rather than isolation, and engenders a 'feeling of psychological security' as opposed to worry and withdrawn tendencies. (Privacy is part of this in the sense that public participation also requires private periods of recuperation). The presentation of symbols, unconscious and conscious, subtle and clear, as representations of group membership, is important until the individual and group are synonymous with each other (at which point the display of symbols is less important). In direct relation to the built environment 'the symbolic aesthetic of the places we inhabit is fundamental to our group identities'. It is generally thought that in terms of urban design this is represented in the social interaction that happens in social places such as cafés, bars, pubs and plazas (Lang, 1994, p. 159).

With this in mind, we are concerned in this paper with the symbolism associated with affiliation, in terms of how a *symbolic place aesthetic* is constructed, and whether it is desirable. In this sense we turn to design, and a perceived need for design education that is sensitive to the importance of symbolic representation, through a process of development. This is in respect to how some symbols associated with habitat may project negative impressions, and yet possess positive human values. For example, we might assume that the image of a shantytown, or favela, is a negative symbol, despite the close affiliation of inhabitants with each other. And yet the individuals who occupy these dwellings may be far from negative!

A shantytown or favela is a representation of a certain kind of economic, social and cultural identity. They are associated with poverty, rapid urbanization and the growth of mega-cities such as Mumbai or São Paulo, and smaller cities such as Nairobi. These environments have become 'symbols' of rapidly developing urban environments in developing countries, characterized in familiar images of the modern high-rise building adjacent to shacks. These kinds of image show the habitat of the 'haves' and 'have- nots', and demonstrate the difference between formally and informally designed environments. Design education, or lack of it, is clearly a significant factor in the expectations and quality threshold of occupants in both cases. These images depict in material terms the formal and informal economy.

In this paper we discuss the need to reconcile the intentions of formal design education with the needs of those generally found to be living in conditions associated with the 'informal sector'. Although this distinction might be found in any city in the world, it is most prevalent in those that have significant shantytown populations. It is a worldwide phenomenon. The 2008 UN-Habitat State of the World's Cities 2008/2009 states:

> 'One out of every three people living in cities of the developing world lives in a slum. UN-HABITAT estimates indicate that in 2005, more than half of the world's slum population resided in Asia, followed by sub-Saharan Africa and Latin America and the Caribbean. Slum prevalence – or the proportion of people living in slum conditions in urban areas – is highest in sub-Saharan Africa; 62 per cent of the region's urban population lives in a slum or suffers

> from one or more of the five shelter deprivations that define a slum. In Asia, slum prevalence varies from a high of 43 per cent in Southern Asia to a low of 24 per cent in Western Asia, while in Latin America and the Caribbean, 27 per cent of the urban population was classified as living in slum conditions in 2005.' (UN-Habitat, 2008, p. 90).

Finally, concomitant to these figures there is also the uncountable occurrence of homeless street people, mainly living in the city centre of the contemporary metropolises. It is a troublesome social problem, a human tragedy that prompts design responses to change the situation, in practice and education.

'Developed' and 'developing'.

The use here of 'developed' and 'developing' are terms consistent with those used in Geography in recent decades, although for some time 'North' and 'South' were prevalent in the 1980s and 'Third World' has also been used at times (but less so now). These terms relate to economic wealth. However more recently social well-being has become more a factor, as well as economic growth, and this has resulted in countries being designated as 'more developed', 'newly industrialized' and 'less developed', before the adoption in the 1990s of 'high', 'rapidly increasing' and 'low' classification of Human Development Index that indicates 'quality of life' rather than 'standard of living' (Waugh, 2000, p. 630). A fundamental contribution to broadening the concept of development as well-being and freedom has been the preoccupation of Amartya Sen. According to him development and freedom are intimately related. By freedom he means well being in five categories: political participation, economic well being, social integration, information access and personal security. Thus 'development has to be more concerned with enhancing the lives we lead and the freedoms we enjoy' (Sen, 1999, p. 14). Here, we use the term 'developed' and 'developing' in relation to the concept of world development, and the need for continental affiliation between, made explicit here:

> Few can deny that the world's wealth is highly concentrated. The populations of North America and Western Europe eat well, consume most of the world's fuel, drive most cars, live in generally well serviced homes and usually survive their three full score years and ten. By contrast, many people in Africa, Asia and Latin America are less fortunate. In most parts of these continents a majority of the population lack balanced diets, reliable drinking water, decent services and adequate incomes. Many cannot read or write, many are sick and malnourished, and too many children die before the age of five.'
> (Waugh, 2000, p. 630, citing Gilbert's 'An Unequal World')

It is reasonable to assume most people agree that action is required to change this situation. According to Simon (1981, p. 129), and his broad definition that design changes existing situations into preferred ones, the activity of design is critical in creating 'preferred' situations. How this is done is of major significance. We value close affiliation between the 'developed' and 'developing'; 'North' and 'South'; 'less', 'newly' and 'more' developed countries, in the sense that all humans must benefit from affiliation no matter how close or distant they may be. Social-actualization on a global scale is the ultimate goal.

The design of cities has never been so important than now, at a time when predictions about half the world's population living in urban environments have been surpassed. Educating the 'designers' of cities must deal with two distinct aspects of urban form: what has already come into existence, and what will be created in the future.

Learning and human nature

How can design and design education improve the lives of those living in the poverty of shantytowns, and other less desirable urban environments? We can learn about the environment by studying the environment. But Kaplan (1973, p. 64) points out that this process is vulnerable to self perpetuating institutionalized views, and 'Man is, in these terms, what he has learned.' Another approach is to recognize that despite the lack of macro design planning that has resulted in the spread of shantytown developments, an innate creativity and design awareness resides in the activities of the urban poor, who demonstrate creative ways to adorn their dwellings using image making techniques applied in the arts, such as collage (R. Harland & Loschiavo do Santos, 2008, p. 12). This important aspect of human nature is acknowledged by Kaplan who suggests *human nature* is an important factor in change making. Though not specifically talking about shantytowns, he argues that ‘all programs for reform and all proposals for burning-it-all-down-and starting-over rest alike on certain implicit conceptions of human nature’ (p. 64). Through this, he is arguing for a more ‘intuitive’ (and, perhaps, design lead) response guided by four major types of knowledge:

1. *Where one is*. The identification of one’s current situation is a critical starting point for adaptive behaviour. This requires both perception of the present stimulus array and memory of immediately preceding events.

2. *What is likely to happen next*. The identification of a range of future situations and the estimation of the relative probabilities of occurrence are the essence of prediction.

3. *Whether it will be good or bad*. The question of evaluation of the goodness or badness (or payoff) of predicted situations is also critical in decision making.

4. *Some possible courses of action*. The adaptive organism must not allow himself to become lost in thought

Intuition is part of the designers approach to problem solving, and ‘intuitive’ knowledge offers a framework for dealing with the kind of ‘wicked problems’ (Rittel & Webber, 1973, p. 155–169) likely to occur in attempts to improve of living condition for shantytown dwellers. Design education is in a unique position to make explicit the difficulties and the enormous human tragedies associated with these sorts of problems. The understanding of these wicked problems that shape our times challenge design students from all over the world that are aware of their social responsibility, thus facing the broader issues of our contemporary societies. In these terms, design cannot be ignorant of issues such as homelessness, environmental degradation, social injustice and so on. An interesting example that attempts to collectively address these challenges is the *Moonlight* project for affordable LED Lighting in rural Cambodia. The authors are Industrial Design students from the TU Delft: Ana Maria Alvarez, Loucas Papantoniou, Stephanie Wirth e Doortje van de Wouw. They proposed a new paradigm, from the hegemonic Western approach of design, they provide us with the opportunity of looking at an urgent need in a Cambodian rural village. From the dominant approach of design in urban areas, they invited us to consider the design intervention in rural areas. So, the team had the ability to think and design sociologically, they proposed a shift of values and they have worked based on an ethnographic and participatory research methodology. In cooperation with the local company Kamworks they designed an affordable solar-powered LED lamp for the rural population in Cambodia. This project was awarded the CIFIAL Feel the Planet Earth Award in the year 2009, in Portugal (see figure 2), and offers an example of how design students want to be affiliated to the main pressure issues of our societies, stressing concretely the making dimension of design.

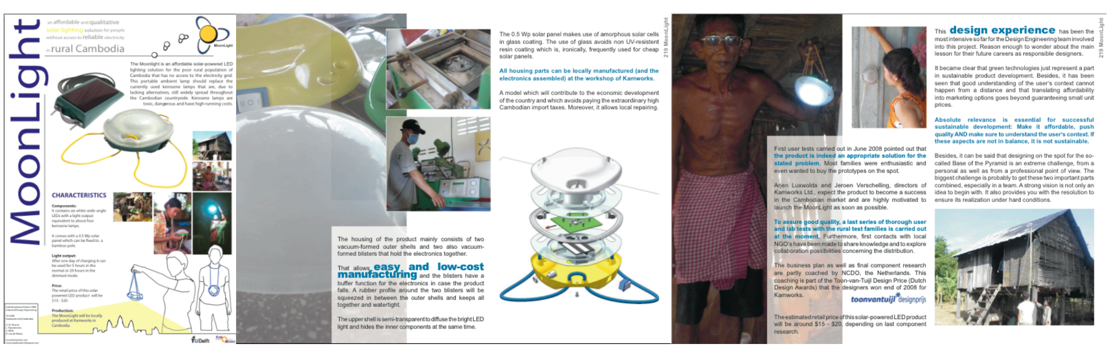


Figure 2. The Moonlight is an affordable solar-powered LED lighting solution for the poor rural population of Cambodia that has no access to the electricity grid. Awarded the CIFIAL Feel the Planet Earth Award in the year 2009, in Portugal.

We have given an indication about *where we are.* What happens next is speculative. But if we allow ourselves to speculate, it is likely that problems associated with poverty will be compounded in the face of continued population increase in the urban environment, especially due to the continuing development of so called ‘megacities’. This is not an original speculation, simply one well-worth restating from the design education and design research perspective. For example, it is forecast that the number of megacities will increase between 2007 and 2025 from 19 to at least 26 (see Table 1). Significantly, Moscow is the only European city, and one other city, Istanbul, is likely to exceed 12 million people over the next 15 years.

2007 population (thousands)		2025 population (thousands)	
1 Tokyo	35,676	1 Tokyo	36,400
2 Mexico City	19,028	2 Mumbai	26,385
3 New-York Newark	19,040	3 Delhi	22,498
4 São Paulo	18,845	4 Dhaka	22,015
5 Mumbai	18,978	5 São Paulo	21,428
6 Delhi	15,926	6 Mexico City	21,009
7 Shanghai	14,987	7 New York-Newark	20,628
8 Kolkata	14,787	8 Kolkata	20,560
9 Buenos Aires	12,795	9 Shanghai	19,412
10 Dhaka	13,485	10 Karachi	19,095

Table 1: The world’s megacities, 2007 and 2025
Source: UN-Habitat, 2008, p. 6

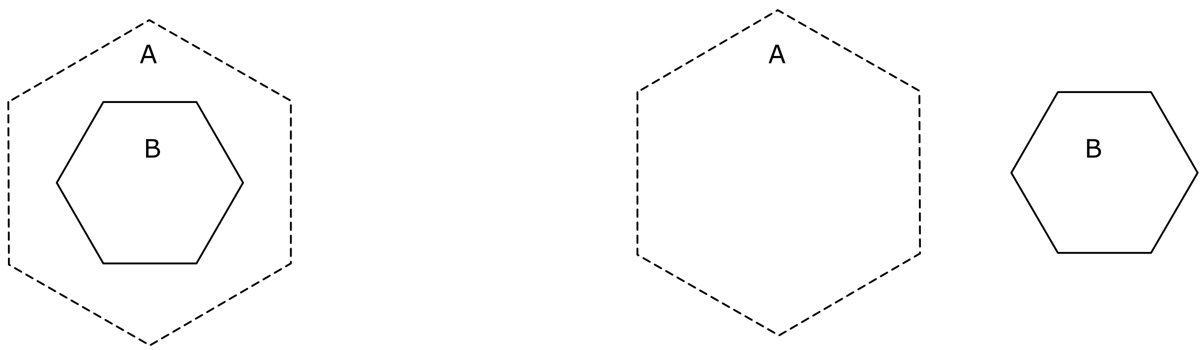
It is of major significance that European cities are not generally growing anymore, according to data spanning 1991–2001 (UN-Habitat, 2008, p. 13). In fact many inner cities are decreasing in size in countries such as UK, Germany, Italy, and Poland, allegedly for reasons associated with increased suburbanization in the surrounding areas. This is attributed to low population increase and decentralized urban development. This is no accident.

The presence (or absence) of design makes a significant contribution to this contrasting scenario. The meaning of design in this context is not only as a ‘visual phenomenon’, but also what Punter and Carmona (1996, p. 2) define in terms of broader social and environmental terms, as well as ‘design as a process’. The attitude to design by metropolitan authorities is therefore critical if it is used for positive affect. ‘Metropolitan growth can happen spontaneously, or by design’ (UN-Habitat, 2008, p. 187).

Materiality and immateriality, and the new ‘order’ in design.

When we talk about ‘material’ or ‘immaterial’ there are two distinct meanings. Material is about the matter used to make something. Immaterial is not – it is not physical (in philosophical terms it means spiritual). There is often-used dual terminology to describe the contrast: for example ‘physical’ or ‘metaphysical’, ‘tangible’ or ‘intangible’. The difference is usually associated with things perceived through the senses or through the mind respectively. We will not examine this in detail here. But although ‘design’ is a ‘disputed’ term (Salustri, undated) it is concerned with what Buchanan (2001, p. 9) offers in his formal definition: ‘Design is the human power of conceiving, planning, and making products that serve human beings in the accomplishment of their individual and collective purposes’. In the conceiving, planning and making, there is a distinction between cognitive (conceiving, planning) and concrete (making) practices that result in material things (or systems). This distinction is shown here in basic diagram form in figure 3, whereby that which is not so visible (cognitive) is indicated with a dashed line, and that which is solid (concrete) has a solid line (R. G. Harland, 2009, p. 10). Some may prefer to separate the two in terms of a division of labour, but we do not differentiate in this way preferring the view that ‘making is thinking’ (Sennett, 2009, p. ix). In this sense design is craft, technology, making and thinking residing in a singular domain. Archer (1976, p. 11) captured this in his definition of design as ‘the area of human experience, skill and understanding that reflects man’s concern with the appreciation and adaptation of his surroundings in the light of his material and spiritual needs.’

A. Immaterial (conceiving and planning)
B. Material (making)



Making as thinking

Thinking and making apart

Figure 3. The material and immaterial dimension of design
Source: Harland, 2009

We place emphasis on this because Buchanan (p.12) argues that the focus in the early part of the twenty first century is no longer on ‘material systems’ (or systems of ‘things’, as he also puts it) but on ‘human systems, the integration of information, physical artifacts, and interactions in environments of living, working, playing and learning’. He goes on to say:

> We are now in the early formative stage of understanding how third- and fourth-order design will transform the design professions and design education, but the beginning has been made. It is difficult to see how design thinking can go back to its earlier centers of attention without a sustained period of exploration of interactions and environments.’ (p.12)

The differentiation between material and immaterial concerns is still highly relevant, but clearly non-material concerns are becoming increasingly significant and expansive. Buchanan’s first and second order concerns of ‘symbols’ and ‘things’ remain important but ‘action’ and ‘thought’ form the basis of third and fourth order future concerns. He states that the ‘visual symbols’ and ‘things’ that so concerned design in the twentieth century in terms of ‘form, function, materials and manner of production’ remain important, but this must now be informed by inquiry into ‘usefulness, usability, and desirability’. Affiliation is one approach to this. For example, Lang (1994, p. 274) discusses how ‘symbols of affiliation’ adapt to formal and informal applications and settings. We might therefore ask the question how do we scale up this approach to resolve the large-scale problems in cities? Or is it that some urban environments are already well advanced in their understanding of third and fourth order design priorities, having addressed first and second order needs at earlier stages in their development process. For example, think of the significant slum clearing activities in major UK cities in the twentieth century.

Working towards a material democracy

How will this development of third- and fourth-order concerns address the basic needs of millions of people? Many are still yet to benefit from first and second-order design thinking. Some are attempting to deal with this through design for social change, or what is often referred to as 'human-centred' approach, now being undertaken by various organizations and individuals in the private and public sector. We identify some of these initiatives here.

IDEO have developed their programme of 'design for social impact' that aspires to have social and environmental impact for 'under-served and disadvantaged lower income communities worldwide' (IDEO, 2009). Since 2002 staff and postgraduate students at the Faculty of Industrial Design Engineering at TU Delft University of Technology in The Netherlands have been undertaking projects focused in developing countries for the benefit of the estimated four billion poor people in Asia, Latin America and Africa who live on less than $3260 per year (Kandachar, de Jongh, & Diehl, 2009, p. 7). This responded to the Millennium Development Goals adopted by the United Nations, and the failure by the 'World Bank, donor nations, various aid agencies, national governments, and civil organizations' since the 1950s to eradicate poverty. The variety of project work is wide-ranging and situated in many countries in the southern hemisphere.

Further to work in industrial design and engineering, since 1999 Architecture for Humanity (www.architectureforhumanity.org) bring together the efforts of 40,000 professionals who dedicate time and services in design, construction and development services for the benefit of those who otherwise could not afford design. Their work in inclusive design aspires to create lasting change in communities through:

- Alleviating poverty and providing access to water, sanitation, power and essential services;
- Bringing safe shelter to communities prone to disaster and displaced populations;
- Rebuilding community and creating neutral spaces for dialogue in post-conflict areas;
- Mitigating the effects of rapid urbanization in unplanned settlements;
- Creating spaces to meet the needs of those with disabilities and other at-risk populations;
- Reducing the footprint of the built environment and addressing climate change.

In the context of the 'wicked problems' related to the housing situation described above, small gestures of design can bring relevant accomplishments, stressing thus the importance of keeping the connection between the cognitive and practical dimensions in design. For example, consider the design of a shelter for the homeless. It must be a practical concern of design practitioners and we must maintain sight of the need to improve the material experience of less fortunate people. In this situation, design ~~can~~ helps to create a sense of dignity and belonging for people who may have few social connections. Also design enables communities to understand and accept the location of homeless facilities overcoming the 'nimbyism' – not in my backyard – always present in the neighborhoods close to these shelters.

Some examples of the notion of design in relation to material benefits can be pinpointed in the work of architects Janna Leavitt, Osamu Ishiyama, Sam Davis. In this context, Japanese architect Osamu Ishiyama has undertaken an outstanding project - the House of Hiroshima in Phnom Penh, Camboja, located in the compound of the largest Buddhist, Temple Unalom, Camboja. It is a school, an orphanage, a factory of prostheses for amputees and an art gallery, where people can reflect on PEACE. The architectural approach combined the alternate layers of concrete and red brick in a rough building without any kind of finishing or polished material. At the façade he used hollow brick exploring different directions and textures, making the structure light and the space airy. At the top of the building there are two cover structures that bring light to the core of the building. The programme is placed in two blocks: one for services and the other for housing and living rooms. It is remarkable the way he placed the bath area under a mushroom/flower shaped structure giving the user a feeling of taking a bath inside/outside, due to the presence of natural light and visual contact with the outside environment.

Canadian architect Janna Levitt has another innovative project to provide housing to adult people previously living on the streets or in shelters. The Strachan House project, in Toronto, Canada. The project is an 80-bed residence, divided into four to seven bedroom shared ‘houses’ in a three-storey brick and timber turn-of-the-century warehouse. The project is comprised of 12 houses – 4 on each floor – with a main "street" or corridor connecting the houses on each level. At either end of each floor level, the street terminates at a stair built in a three-storey atrium space. These open areas provide a strong vertical connection, linking the community as a whole.

American architect Sam Davis also was involved in the design of innovative solutions for the problem of homelessness. He designed the Larkin Street Youth Center in San Francisco, California, providing thus safe temporary housing for most vulnerable youth ages 12-24.

Designs for social relief encompass not only the design activity for the urban homeless, but also the design for the refugees of all kinds of catastrophes. In this sense it is relevant to mention the work of Habitat for Humanity that has been active in hurricane and tsunami relief; Madhousers engaged in building temporary emergency shelters for the homeless; the Rural Studio, based in Auburn, Alabama, has helped provide housing for the rural poor since 1993; and Shelter for Life, a volunteer group based in Oshkosh, Wisconsin that built houses in Afghanistan.

Conclusion

The scope of this paper is wide. Too wide. We have attempted to identify some key concerns moving forward that enable the continuation of a design education and dialogue between northern and southern hemisphere continents. Affiliation has emerged as a potential focal point around which a design education and a design research agenda can be built. This links together design educators, design students, and the less fortunate people who must benefit from their efforts. The idea of affiliation scales up and down, and crosses many disciplines. In this sense it is a social concern that demonstrates potential for social-actualisation, realised in a material democracy. We have seen that some are already working towards this by using their design abilities for good causes. In this sense design and designers are increasingly foregoing the self for the social, and addressing the kind of problems Papanek spoke of. As design continues to be explored across a wide range of disciplines in the spirit identified by the likes of Bruce Archer, increased recognition of design education as a practice of affiliation may be a central concern. We have seen that design for social responsibility is an increasingly frequent practice among young students, and affiliation could serve as a force to bind them together.

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Embodiment, Immediacy and Thinghood in the Design of Human-Computer Interaction

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Abstract

This paper is concerned with the design of Human-Computer Interaction (HCI). It criticizes the position that proposes ‘Embodied Interaction’ to be the underlying principle of the transition from textual, to graphical, to tangible interfaces.

Firstly, it is hypothesized that it is not the level of embodiment that has increased, but the level of immediacy. It is furthermore proposed that the concept of thinghood, as described in the works of Heidegger, is a fruitful starting point for the design of human-computer interfaces.

In the second part of this paper, the recent history of HCI practice is reviewed, with regard for its involvement of embodiment, immediacy and thinghood. It is then argued that embodiment has always been there unchangedly, while immediacy and thinghood have changed – not only in degree, but also in kind.

In the third part, three projects are reported. Each of the projects researches, through design, the physical display of digital entities. The projects do so by picking up Heidegger’s characteristics of thinghood: extendedness, substantiality, and proximity.

It is concluded that making digital entities physically graspable can help us to make the immaterial accessible and, in doing so, ready-to-hand.

Keywords

embodiment; design; HCI; thinghood; immediacy; philosophy.

Human-Computer Interaction (HCI) has been dominated by Graphical User Interface (GUI) for the past two decades. Recent positions, however, postulate that a transition is in progress: From graphical to embodied interaction (Dourish, 2001).

A trend can indeed be observed in recent developments, for instance in Tangible User Interfaces (TUIs) (Ishii & Ullmer, 1997), in Natural User Interfaces (NUIs) (Seow et al., 2009), and in Reality-Based Interfaces (RBIs) (Jacob et al., 2008). However, this paper proposes that, in such developments, it is not the level of embodiment that increases, but, instead, changes occur in the levels and kinds of immediacy and thinghood.

A definition of ‘Embodied Interaction’ can be found in Dourish’s work ‘Where the Action is: The Foundations of Embodied Interaction’ (Dourish, 2001), as the combination of ‘tangible computing and social computing’.

While embodiment may seem suitable to conceptualize the current trend in HCI, this paper proposes two alternatives: immediacy and thinghood.

Immediacy

Immediacy is a term used in media theory. Bolter and Grusin refer to immediacy as a form of remediation (Bolter & Grusin, 2000): According to Bolter and Grusin, remediation can be observed in the transition between developmental phases of media (e.g. from painting to photography) and takes one of two forms: hypermediacy and immediacy.

'Hypermediacy' refers to the vanishing of content behind a type of media – for example, the vanishing of what can actually be seen on Niépce's first photographs behind what is visible in the second place: the potential of photography as a media itself.

Immediacy, on the other hand, refers to the vanishing of the media behind the content. In the progress of media adoption, a type of media can become, according to Bolter and Grusin, sufficiently integrated into a beholder's experience to allow him to focus on the content.

A similar notion can be found in 20th century existential philosophy. Heidegger coined the term ready-to-hand, for tools that 'become one with us' and thereby vanish in their usage (as compared to present-at-hand). It might be interesting to see parallels between these concepts and Bolter and Grusin's work.

Another Heideggerian term that could be of potential utility in HCI is thinghood, which will be elaborated on in the following section.

Thinghood

In 'Being and Time' (Heidegger, 1927), Heidegger introduces a set of three characteristics for thinghood. It consists of extendedness, substantiality, and proximity.

Extendedness

Heidegger notes extendedness to be one central property of thinghood (Heidegger, 1996, p. 96). Malpas adds, with regard to spatiality, that Heidegger uses '(...) space as that realm of extendedness in which a multiplicity of (...) entities [,] can be located' (Malpas, 2007, p. 48). But which other 'realms of extendedness' do exist, if not spatial ones?

He also points to an inherent structure of containment: The 'place' or topos of a thing is thus understood to be the inner surface of the body (where 'body' here means simply the thing in its physical extendedness) within which that thing is enclosed (Malpas, 2007, p. 69).

Malpas points out that 'Heidegger does indeed distinguish between two senses of spatiality – (…) objective spatiality (…) [and] (…) situatedness (…)'. He continues to elaborate on the latter: '[N]o conception of space as objective will be adequate to the understanding of that situatedness – objective space allows only for standardized 'locations', not for situatedness as such. The result is that we cannot treat situatedness as based in the measurable extendedness, and yet, since situatedness also has a spatiality of its own, we must distinguish between space understood in 'objective' terms and an alternative conception of space, (...) which we can refer to as 'existential.' (Malpas, 2007, p. 79)

'If there is any sense in which the bodily being of being-there is spatial, then, it is in a sense that is secondary to temporality in much the same way as the various modes of spatiality are also secondary. For this reason, Heidegger is unable to give any central place in his analysis to embodiment - indeed, since he has already committed himself to the dependent character of extended spatiality from almost the beginning of his analysis, the body as such simply falls outside the frame of Heidegger's discussion. (...) the body is secondary in the structure of being-there, (...) it threatens to make being-there into something spatial. (...) spatiality also threatens the loss of any sense of the 'there' in the stretched-out dimensionality of pure extendedness' (Malpas, 2007, p. 129).

What Malpas proposes here is that Heidegger's view of extendedness is two-fold: A spatial perspective, and an 'existential', conceptual perspective. The two of these will be taken into consideration when historically reviewing HCI practice for its usage of extendedness.

Proximity

Citing Heidegger, Malpas defines Proximity as 'simple and immediate presence' (Malpas, 2007, p. 56). He continues: 'The structure of equipmentality establishes, and indeed consists in, an ordering of things and thereby establishes a certain structure of relations in which things are brought into proximity with one another.' What becomes clear here is that no human is required for proximity, merely 'two things'.

Malpas adds: ‘However, that structure, although it consists in certain places and regions, does not, as such, establish anything as proximate to Being-there - indeed, that structure does not itself bring any particular 'there' with it. The structure of equipmentality is thus an ordering of things (...).‘ (Malpas, 2007, p. 85)

Malpas also adds that proximity an inherent facet of ‘place’ is: ‘Occurrence 'in ... proximity' is itself an occurrence in and of place - it is an occurrence that needs no special such ‘place’ but, is rather the happening of place as such.’ (Malpas, 2007, p. 307)

What becomes visible here is that such a review of Heideggerian aspects of Embodiment cannot lead directly to actionable guides to the design of Embodied HCI, but help one to see things from a new perspective.

Substantiality

Substantiality, after Heidegger, is characterized by Malpas as ‘(...) the usual conception as tied to material extendedness alone’ (Malpas, 2007, p. 260). He also adds the potential of manipulability: ‘(...) the treatment of the natural world as a source of 'raw material' for human production and as open to human manipulation and control (...)’ (Malpas, 2007, p. 281).

If transferred to HCI, the concept of manipulability would be considered the input. As for the corresponding output, Malpas notes for the perceivable presence: ‘Heidegger, of course, looks especially to (…) what Aristotle called 'ousia', the really real, the primary being, 'substance'. Heidegger claimed that one of the great breakthroughs in his own thinking was to realize that this Greek understanding of being was based in the prioritization of a certain mode of temporality, namely the present, and so understood the being of things in terms of the 'presence' or 'presencing' of things in the present - in terms of the way they 'stand fast' here and now.’ (Malpas, 2007, p. 61)

From Theory to Practice

The previously reviewed concepts are, by their very nature, abstract and purely theoretical. The preceding part of this work has reviewed these concepts, as they may help us to analyze the paradigms underlying current and past HCI through a new analytical lens.

The following part of this paper will do so: It is a historical analysis of HCI practice, analyzing the involved characteristics of embodiment, immediacy, and thinghood.

The last part of this work is an investigation of how we could interact with digital contents in the future in a more immediate way. As the means of investigation, we propose a Research through Design approach. This seems worthwhile, as the target field is dominated by interplay of theory, bodies and artefacts. Producing concrete artefacts that represent abstract theories may prove to be a suitable means to learn how human-computer interaction could be designed in the future, and if immediacy is a valuable model for this endeavour.

Embodiment, Immediacy and Thinghood in HCI Practice

In this section, we will review the practice of HCI in different developmental stages of the past decades: Command-Line Interfaces, Graphical User Interfaces, and Tangible User Interfaces. Each stage will be analyzed for its characteristics of

- *Embodiment* (Dourish, 2001),
- *Immediacy* (Bolter & Grusin, 2000), and
- *Thinghood* (Heidegger, 1927).

Command-Line Interfaces

In Command-Line Interfaces (CLIs), digital content is interacted with through textually articulated commands and responses. The primary input is the keyboard; the primary output is a text-based display.

Embodiment in Command-Line Interfaces

Working with computers that utilize CLIs is a physical activity. Content is manipulated through physical buttons, and work occurs often in social context. It may be argued that digital content is not physically represented, but that does not affect the physicality of the keyboard. This media, the keyboard, is even *ready-to-hand* after having used it for a sufficient amount of time: Command-Line Interfaces draw on embodied skills.

Immediacy in Command-Line Interfaces

Digital content in CLIs is displayed on a screen, in written, textual form. This style of output matches the manipulatory input: *Written* commands, regardless of the type of digital content at hand. For instance, a car traffic simulation would have to be programmed into the system textually, and result in number results, rather than rich graphical results (e.g. a map, or a graphic chart). Text is the mediator, which may be useful in some cases, but inappropriate and cumbersome in others.

Thinghood in Command-Line Interfaces

Most digital content in CLIs is displayed *virtually* and *mediatedly.* They may retain their substantiality, extendedness and proximity, but none of these properties is directly available to users in any interactions. Users have to interpret the verbal descriptions: CLIs thereby operate on the level of *described* things.

Graphical User Interfaces

In Graphical User Interfaces (GUIs), digital content is accessed through graphical and textual items on different representational levels. It is manipulated through mouse and keyboard interactions.

Embodiment in Graphical User Interfaces

Interacting with GUIs is predominantly shaped through interacting through a mouse. A keyboard may be involved, too, but for clarity reasons, we will focus on the mouse here. A mouse inherently picks up on embodied skills: Spatiality and pressure (as in clicking). Also, interaction often occurs in social contexts – people have learned to cope with the fact that a mouse is a single-user device. GUI Interaction is embodied, and can, similar to the CLI, become ready-to-hand just through sufficient practice.

Immediacy in Graphical User Interfaces

Digital contents are represented graphically in GUIs. This leaves more room for representational styles than the CLI does: Things can be represented iconically, symbolically, or indexically (Peirce, Houser, & Kloesel, 1998). Interpreting these signs can be much easier than interpreting textual representations, and so can be manipulating them: Changing the size of a digital object can be achieved through pointing to its edge with the cursor, mediated through the mouse, grasping it, mediated through the mouse button, and altering it through a respective movement. The interaction is still mediated, but less mediated than in the CLI: Representation and Manipulation occur in the same space, virtual graphics, even though through tools (like mice) that make this space accessible for users.

Thinghood in Graphical User Interfaces

Digital content in GUIs is displayed *virtually* on a screen, but can be displayed in more *immediate* forms: Images. Thereby, they gain thinghood on the levels of *extendedness*, *substantiality* and *proximity* – represented in virtual space, on a screen*.* GUIs operate on the level of *depicted* things.

Tangible User Interfaces

In Tangible User Interfaces (TUIs), digital content is physically manifest, and thereby physically manipulated and perceived.

Embodiment in Tangible User Interfaces

TUIs draw on embodied skills: They represent digital contents physically, and often also react to physical input. This display and manipulation can occur socially accessible in the real world. It should be noted that almost every user interface hardware, including mouse and keyboard, is necessarily tangible, as it needs to allow manual interaction.

Immediacy in Tangible User Interfaces

TUIs have the potential to map input and output closely together, which makes interacting with their digital inner a seemingly analogue activity. Here, the term *immediacy* seems to describe particularly well what occurs to the user: Physical representations can be manipulated physically, directly, leading to changes in the digital layer.

Thinghood in Tangible User Interfaces

In his paper 'Tangible Bits' (Ishii & Ullmer, 1997), which is considered the starting point of TUIs, Ishii draws on Heidegger to explain the possible benefits of the TUI paradigm. Indeed, the characteristics of things proposed by Heidegger can be observed in many TUIs: physical *extendedness*, physical *substantiality*, and physical *proximity*.

TUIs operate on the level of *physical* things.

Summary

Comparing the historical phases of HCI, from CLIs to GUIs and TUIs, the level of embodiment has not changed: All human-computer interaction is both physical, as computers necessarily are, and social, as humans always have been.

Immediacy, however, seems to have increased. The styles of textual, graphical and physical representation bring digital contents more closely to us. They also foster the coincidence of input and output (Ishii & Ullmer, 1997), which makes interacting with them a seemingly *direct* experience.

Thinghood also provides an interesting view on things: All interactions operate, necessarily, on some level of thinghood. The level of CLIs is the level of *de-scribed* things, the level for GUIs is the level of *de-picted* things, and for TUIs, it is the level of *physical* things. The prefix 'de-' suggests that the -*picting* and –*scibing* originate in something: The object itself. It may be well possible that the physical representation of the TUI is more direct, as it is by no means 'de-materialized', but rather the contrary, *material*.

Making Digital Content Graspable

Heideggerian thinghood is increasingly prominent in Tangible User Interfaces. It might be interesting to see if the Heideggerian concepts can help us to make digital contents more ready-to-hand.

To investigate this matter, we present three projects from our research that have taken different steps to make immaterial digital content, as a first step towards readiness-to-hand, present-at-hand.

Substantiality: Weight-Shifting Mobiles

Fig. 1: The Weight-Shifting Mobiles prototype.

In this project, weight is considered a physical pendant of *substantiality*. The mobile phone developed here is able to shift its centre of gravity by moving an iron mass on its inside.

Users appreciated the fact that they were now able to ‘feel’ the digital content. They were able to estimate the weight’s position on the device’s inside at a considerable niveau of accuracy, and enjoyed the subtleness of the approach (Hemmert, Hamann, Löwe, Zeipelt, & Joost, 2010b).

Extendedness: Shape-Changing Mobiles

Fig. 2: The Shape-Changing Mobiles prototype.

In this project, a deformation of a mobile phone’s case is investigated as for its utility as a display for digital contents. In this example, immaterial digital entities are represented through physical volume: *extendedness*. For instance, digital items that are off the screen of the mobile phone can be displayed through a thickening of its casing toward the respective edge.

Users intuitively understood the mapping, and appreciated the leveraging of their hands sensitivity, rather than being visually overloaded even more (as they often experienced it in GUIs) (Hemmert, Hamann, Löwe, Zeipelt, & Joost, 2010a).

Proximity: Ambient Life

Fig. 3: The Ambient Life prototype.

This project operates on another level. It proposes a metaphor for digital content: life. The project investigates signs of life like breath and pulse as a means of display for the inner state of a mobile phone. For instance, the phone can be ‘calm’ when no calls have been missed, no new text messages have arrived, and the battery level is sufficient. It switches to ‘excited’ mode as soon as it needs the user's attention. This metaphor draws on our perception of living beings, and also exaggerates the already close relationship between user and mobile phone: It explores the role of *proximity*.

Users typically fell into one of two groups, with the first group being attracted by the 'cuteness' of the system, and the second group being disgusted – an interesting circumstance, as the simulation caused reactions that would normally occur as reactions to animals, and not as reactions to phones (Hemmert, 2008).

Conclusion

The three projects presented here investigate the three characteristics of *thinghood* proposed by Heidegger; Users generally appreciated the directness of these approaches. However, such physical displays seem to be generally limited in their communicative bandwidth: They are often only one- or two-dimensional, being able to display only a small number of data points. The richness of these displays does not lie in the number of things they can display, but in the quality of the few things that can be displayed.

The means of this investigation, *research through design*, have shown their strength in order to make abstract concepts manifest, experiential and situated in both the researchers' and the users' life-world.

We conclude that *thinghood* is a fruitful source of *inspiration for the design* of *immediate* interaction. A physical body in a social world is our medium to interact with computers, which is the reason why HCI is, as it always has been, embodied.

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The Inclusive Incapability-Culture-Economy Cube: A design framework for complex barriers

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Abstract

Inclusive design is an evolving and complex concept, the definition of which can be extended to address not only age and disability, but also race, income, education, and culture. As most of products are originally designed in developed countries, conventional elder-care products present serious difficulties and exclude users with different cultural customs and lower economic status. There is an urgent need for a design framework, based on an expansive understanding of not only age and disability, but also income, education and culturally related barriers, which will lead to a minimizing of the impact of these differences and thereby extend the effectiveness of “inclusive design”. Through case studies of Thai elder care product development, this paper aims to explore the inclusive design approaches that are suitable for all ranges of users with different capability, culture and purchasing power. Techniques for this research, in the first phase, include contextual interview and observation as well as self-documentary of 50 pairs of Thai elderly and their caregivers. The subjects were selectively chosen based on age, gender, length of dependency, the relationship to each other, functional dependency in ADL, living conditions, and equipment used for elder care. These enable us to identify the details of inclusive design barriers and to develop population profiles based on three expanded design dimensions for greater inclusion: individual incapability, cultural specificity and economic limitation. In the second phase, the relationships between design approaches and included user groups were analyzed through 150 design case studies of Thai eldercare product development. The findings enable the development of the “Incapability-Cultural -Economic Cube” (I.C.E Cube), an active inclusive design framework for all ranges of users with different capability, culture and purchasing power. The model is illustrated in this paper by a range of product examples from Thai elder-care case studies.

Keywords

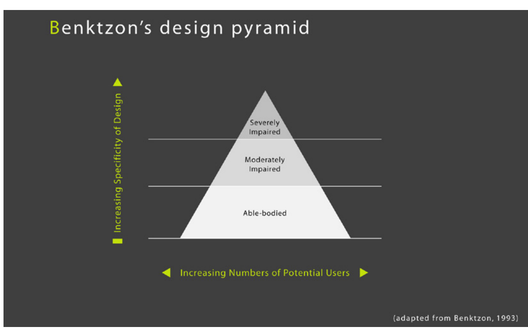
Inclusive design; cultural factors; economic factors; elder care; design framework

Inclusive design refers to designs that accommodate the widest range of potential users. Inclusive design is an evolving and complex concept, the definition of which can be extended to address not only age and disability, but also income, education, and culture. Besides individual capabilities, cultural differences and economic status are important barriers to inclusive design. These are the reasons why most inclusive solutions and guidelines carried out in developed countries present serious difficulties and exclude users in the developing world. This research aims to explore the complex barriers of inclusive design and to develop an inclusive design framework for all ranges of users with different capability, culture and purchasing power.

1. Inclusive design

Inclusive design is an approach to the design of all products and environments to be as usable as possible by as many people as possible regardless of age, ability or situation. It accommodates people with disabilities, older people, children, and others who are non-average in a way that is not stigmatizing and benefits all users. Designing for a broad range of users from the beginning of the process can increase usability of an environment or product without significantly increasing its cost. It results in easier use for everyone and it reduces the need for design modifications later when abilities or circumstances change. Other terms for Inclusive design used around the world include Design for All, Universal Design, and Barrier-Free Design. Terminology and meanings differ from one country to another and often reflect each nation's societal values. Significant cultural differences between countries have influenced how the movement has been adopted and evolved in each location but the common goal of social inclusion transcends national laws, policies, and practices.

During the past 25 years, considerable advances have been made in the fields of designing for disabled and elderly user. Many design approaches were proposed focusing on the suitability of users' capabilities. The User Pyramid design approach (Benktzon, 1993) reflects the wide range of user capabilities and their impact on the design process by categorizing the target user capabilities: able-bodied, moderately impaired and severely impaired (Figure 1). Building on Benktzon's User Pyramid, Keates et al (2000) have developed the 'Inclusive Design Cube' model that relates capability level, population profile and suitable design approaches consisting of: user-aware design, modular/customizable design, and special purpose design (Figure 2).



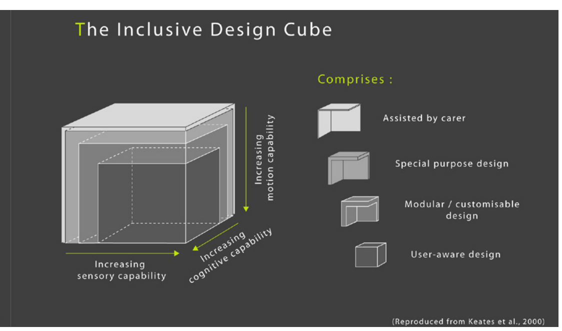


Figure 1 The Design Pyramid (Benktzon, 1993)   Figure 2 The Inclusive Design Cube (Keates, 2000)

However, "Inclusive design" is an evolving and complex concept the definition of which can be extended to address not only age and disability, but also race, income, education, and culture. Design can exclude and discriminate against certain groups in society with different cultures and economic status. As most of products are originally designed in developed countries, the market sector in the developing world is being ignored and large sections of the population are being excluded. Thus, conventional products present serious difficulties and exclude users with limited capability, different culture and lower economic status. There is an urgent need for the development of design methods, based on a comprehensive understanding of not only age and disability, but also income, education and culture related factors. Through a case study of Thai elder care product development, this paper aims to extend the dimensions of inclusive design and to present a methodological design approach for implementing inclusive design across incapability, cultural and economic diversity.

2. Thai elder care

The demographic trends of the past decades are leading to unprecedented increases not only in the absolute numbers of older persons but also in the relative share of the population that belong to the elderly age groups. The countries of the Asian region, without exception, will experience a rapid growth of their aged populations and an overall ageing of their national populations over the next few decades. This will occur in a context where the extent to which family resources, which have traditionally been the major source of support for the aged, are likely to be diluted. The dilution will occur due to the higher ratio of older people to economically active people, to greater female workforce participation outside of the home, and to fundamental changes in the structure and functioning of the family (Hugo, 1996). In Thailand, the elderly population increased from 1.21 million in 1960 to 4.02 million in 1990 and will reach 10.78 million in 2020. However, the matter which is seriously considered is population aging. Population aging means an increase in the elderly share of the total population. In 1960 only 4.6% of the whole population was elderly people aged 60 and over. In 1990 the elderly population share in Thailand was 7.36% of the total population. They will represent 15.28% by 2020. In 1960, the total dependency ratio was 91.55%, of which almost all of the dependent populations were children. During the process of population aging, aged dependency ratio increases. The aged dependency ratio will be inevitably higher than the child dependency ratio (Jitapunkul and Bunnag, 1999).

While much design and research related to elder care has been carried out in the West, only a portion of it can be applied to the Thai context. Besides the difference of elder care by untrained family caregivers in Thailand, the culture and ways of life are also different from the West. There are still specific problems and unmet needs in Thailand that have not been studied, such as the fact that Thais are used to sleeping on the floor, and also think it is safer than sleeping in a bed. Suitable equipment that has not been produced in the West, is thus needed. More over, economy is also an important barrier to the application of western design guidelines. In some cases, it creates an even greater problem, for example, some are unable to afford adult disposable diapers and/or do not understand the proper sanitary treatment of them. They try washing, reusing, or extending the usage of each diaper, which causes health problems. These barriers are left unexplored, negatively affecting the lives of both the caregivers and the elderly (Israsena & Boonvong, 2007).

3. Research objective

1). to uncover inclusive design barriers in Thailand, through the exploration of Thai elder-care problems and limitations in applying products, originally designed in the developed countries, in Thai context.

2) to explore the inclusive design approaches that are suitable for all ranges of users with different capability, culture and purchasing power.

4. Research methodology

4.1 Subjects

Fifty pairs of elderly and caregivers were selectively chosen from Chulalongkorn Hospital, a public hospital in Bangkok, Thailand. The subjects were selected based on age, gender, length of dependency, their relationships such as being family members, a maid, or a trained caregiver, the elderly's level of self-reliance, the elderly's functional dependency in ADL, the types of caring activities demanded, the living condition, and equipment for elder care.

4.2 Data collecting methods

In the first phase of this research, in order to closely study inclusive design barriers, two data collecting techniques were employed in this study: self-documentary study and contextual interview & observation.

4.2.1 Self-documentary study:

In order to collect information of real daily activities, subjects were asked to record details of challenges in a diary with questions for the causes of the elderly's dependency, the schedule of daily activities of the elderly and the caregiver in 24 hours, and details on mobility, bathing, toileting, feeding, uses of medication, sleeping and monitoring. The caregiver was to record the steps in each elder care activity, problems in each step, the advantages and disadvantages of the environment and products used, using either a disposable camera or a digital camera to record pictures, and provide a description attached to the pictures.

4.2.2 Contextual interview and observation:

To get information in the real context, researchers went in to observe and interview elderly and caregivers during daily care activities. The interview consisted of questions similar to the self-documentary study mentioned earlier.

4.3 Analysis methods

The information from the self-documentary study and contextual interview and observation is processed using qualitative analysis methods in the form of tables and diagrams to study inclusive design barriers, the relationships between the challenges in elder care and the living conditions as well as the equipment in the home.

In the second phase of the research, to better understand the relations among inclusive design barriers, dimensions and design approaches the process of elder care design development was analyzed. The problems and barriers found in the first part of the research were set as objectives for design development. Analyzing the design development processes employed, a pattern of design approaches suitable for each target group was identified. The findings enabled the development of the "Incapability-Cultural-Economic Cube" (I.C.E Cube), an active inclusive design framework for all ranges of users with different capability, culture and purchasing power.

5. Results & discussion

5.1 Phase I: Inclusive design barriers in Thailand

The results to be discussed in the first part are from the self-documentary study and the contextual interview and observation, which explain the causes of inclusive design barriers in Thailand. The study found that most families with purchasing power in the city, where a primarily Western lifestyle is adopted, are using imported products and are facing only individual incapability (sensory, cognitive, motion) barriers similar to those of the West. On the other hand, low-income families who both live in the city and the countryside have to deal with problems that are specific to Thailand which are left unexplored and unsolved. With limited space, this paper will not describe or illustrating all the problems found in Thailand, but will focus only on the local-specific problems that have severe effects on the elderly and caregivers. The findings point out Thai barriers in applying products originally designed in the developed countries in 3 dimensions: cultural, economic and incapability.

5.1.1 Thai local cultural barriers:

While much design and research related to elder care has been carried out in the West, only a portion of it can be applied to the Thai context. Besides the difference of elder care by untrained family caregivers in Thailand, Thai culture and ways of life also very different from those of the West. Thai cultural barriers in applying western products include:

a). Lifestyle practices: sleeping on the floor, dining on the floor, wearing a wrap-around instead of pants, eating with one hand using a short spoon, showering using a bowl.

b). Customs: respect for the elderly, the forbiddance of standing and passing things over the elderly's head, the importance of "low" and "high" parts of the body (e.g. using separate towels for the head, body, behind, and feet), and the importance of food arrangement for people of status.

c). Preferences and attitudes: not favoring things to be permanently installed and things that need a technician to install (e.g. a grab bar), not favoring buying a whole product for elder care but preferring to buy parts to retrofit to existing products in the household, preferring to easily modify things or to find a short cut and save costs, but without considering the consequences.

d). Information processing: Thai elderly and caregivers have a limited literacy level or do not like to read. They choose to remember things and pass them along, particularly the elderlies' drug prescriptions and processes of elder care. Without writing them down, understanding them, or giving importance to processes that they view as complex, matters of hygiene and nutrition are missed.

e). Environmental arrangement: As most houses are quite small, Thai people in the countryside choose to sleep on the floor while many urban inhabitants who have beds tend to place a side of the bed along the wall. A higher importance is given to social interaction with family members than for privacy, such as moving the elderly, who has difficulty in using the stairs, to sleep in the living room downstairs in order to be surrounded with family members. Thais tend to use a space for various functions by moving things in and out according to activities, so they do not like to install anything large permanently. Instead, Thais prefer foldable and mobile furniture, which are not so strong, such as foldable tables and chairs.

5.1.2 Thai local economic barriers:

Financial limitations in Thailand make it difficult to afford costly equipment and disposable products such as adult diapers. This factor causes people to find other ways to solve problems, which have both good and bad results in elder care. The origins of Thai economic barriers include:

a). Caregivers lack the opportunity to work and earn a living as many have to quit their jobs or take leave during the day to care for the elderly.

b). Certain activities demand much more energy than family members, who are aging or have health problems, can handle. Thus, families resort to hiring maids, caregivers, or nurses.

c). Certain activities in elder care require high expenses, particularly in toileting, where costly disposable items like adult diapers and catheters are needed.

5.1.3 Thai local incapability barriers:

Local specific problems in Thai elder care arise from cultural origins mentioned earlier, Thai local incapability barriers will be detailed as follows under mobility, bathing, toileting, feeding, use of medication, sleeping and monitoring activities.

a). Mobility: Thai houses are quite small and narrow. The use of walkers and wheelchairs is not always possible. The elderlies have to hold on to foldable tables and wall-hung sinks which are not steady and unsafe. The narrowness of Thai houses also result in beds being placed along the wall or choosing to sleep on the floor. The elderlies who sleep on the floor are unable to get up by themselves. Moving from the floor to sit in a chair or a wheelchair is very difficult while sliding seated on the floor is slow and problematic. Caregivers choose to pull them on the floor or not to move them at all. Instead, caregivers make room for the elderly to sit against the wall, stretching out their legs, for various activities such as eating.

b). Bathing: Where many families move the elderly to sleep in the living room, the elderly has to use maid's or guest's bathroom. This type of bathroom has no space for a shower chair and requires the elderly to move in a longer distance to the bathroom. Without the installation of a grab bar, elderlies have to stand holding on to the unstable wall-hung sink or sit on the toilet bowl to bathe. Both are difficult for them to maintain balance. In cases where the elderly sleeps on the floor, the caregiver pulls their mat outside to bathe them on the patio, forcing uncomfortable positions.

c). Toileting: The problems of toileting inside the bathroom brought about by moving the elderly to sleep in the living room are: lack of privacy, narrow bathrooms far from the sleeping area without separate wet and dry areas, the risk of slipping, the difficulty of moving, and lack of appropriate ergonomics. Toileting outside the bathroom by using an adult diaper is very problematic due to hot climate and unaffordable expense. Some have the wrong idea that disposable diapers can be reused, which lead to health risks. Some Thais try to find cheaper solutions such as modifying a plant watering can into a bigger urinal container so the caregiver does not have to take it out to empty as often. As the catheter is costly, wastefully, and requires a caregiver with skills, some have tried using in-house items such as a tube connected to a liquid soap dispenser or a soap bar sharpened into a cone shape, or a finger without wearing a glove. Some of these modified items are usable, whereas others pose health risks.

d). Feeding: Most low-income people in the countryside eat on the floor, either at a small low table or on their lap. This forces them to be in a bending position for long periods. Thais are used to eating with a short spoon using only one hand. With age, the elderly loses energy and precision in cutting and spooning the food, leading to leaks and spills. Another difficulty with elderly food is tube-feeding, which requires expertise and skill. There is a lack of knowledge, understanding of the correct way of sterilizing and properly organized environment. Most Thais do not invest in modern devices such as equipment steamer specifically for the elderly. Instead, they try modifying the process and make use of existing in-home items, such as immersing the feeding devices into an electric water boiler.

e). Use of medication: Most Thais do not have the basic language skills to be able to read and write Thai and English. Caregivers and the elderly try to remember what doctors and pharmacists prescribe, without reading or noting it down. In preparing medicine, most Thais use in-home items in cutting and crushing pills, such as a knife, a cutting board, and a spoon, or even cutting with their fingernails. These methods are sometimes unhygienic. Pills often bounce away and get lost. The limited knowledge and understanding in the use of medicine put the elderly at risk.

f). Sleeping and monitoring: As mentioned earlier, Thai houses are usually very small and narrow, causing people to place the bed along the wall or sleep on the floor. The hot weather, the use of mosquito nets, plastic sheets for urine spills, and adult diapers contribute to sleeping discomfort. Thais give great importance to social ranking and seniority, so caregivers cannot sleep higher than elderlies. Most caregivers sleep on the floor and become a barrier in the walking path.

Local specific problems in Thai elder care arise from economics and cultural origins mentioned earlier are important barriers to the application of western design and guidelines.

5.2 Phase II: Inclusive design approaches

Setting design objectives based on the problems and barriers discovered in real Thai elder care practice, the design team has developed more than 150 design solutions suitable for all user groups in Thailand. Examples can be seen on figure 3.

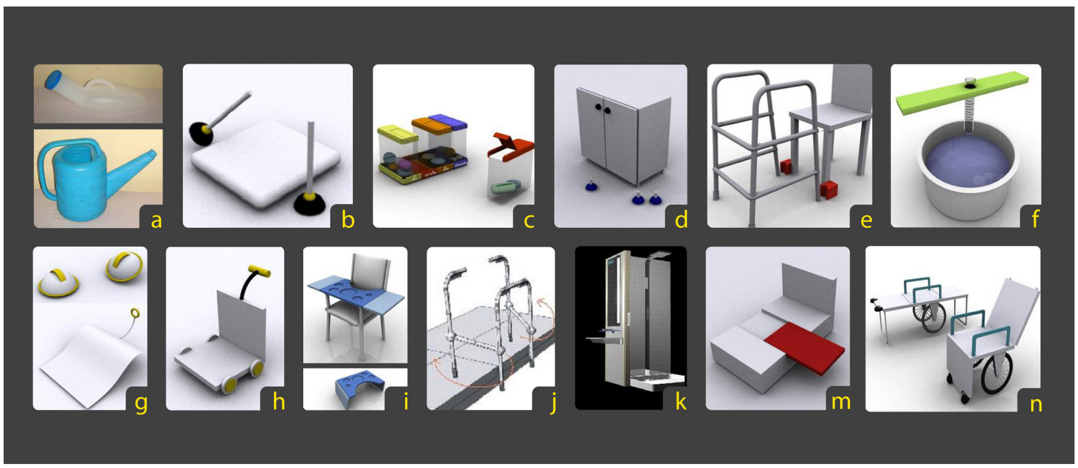


Figure 3 Examples of design solutions generated from integrated inclusive design approaches

The team has employed various inclusive design approaches in developing the design solutions. The Inclusive Incapability-Culture-Economy (I.C.E.) Cube was developed based on the analysis of the relations between the employed design approaches and the included user groups. Some examples are illustrated on table 1. Analyzing the relations between the inclusive design approaches employed in developing each design solution (namely: total solution design, retrofits for existing devices, ideas for in-home adapting, global solution design, adapted solution design, local solution design, user-aware design, modular/customizable design, and special purpose design) and the include users regarding culture (local, blended, and global culture), economy (no, low, and high income), and ability (no, reduced, and fully capable), a pattern of suitable approaches could be identified. Derived from a better understanding of the complex barriers, inclusive design approaches and their relations to the included users, the 'I.C.E. Cube' model was developed. The 'I.C.E. Cube' model (Figure 4) is represented in simple graphic form to communicate the finding and guide the inclusive design process in the future.

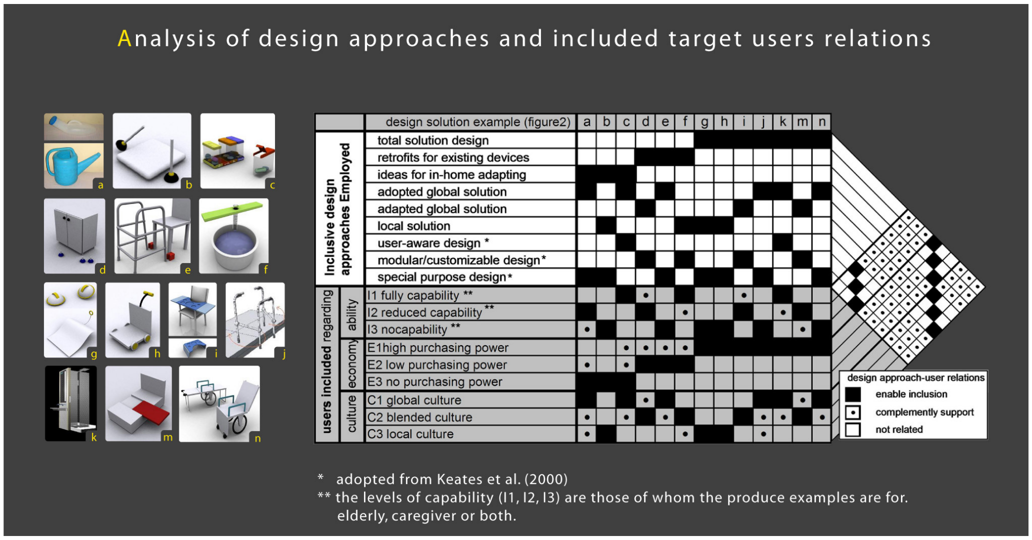


Table 1 The analysis of inclusive design approaches and included target users relations

Building on the concept of the User Pyramid (Benktzon, 1993) and the Inclusive Design Cube (Keates et al, 2000), the author has developed 'The Inclusive ICE Cube' to model the whole population in three dimensions (3 axes), with regard to individual incapability, cultural specificity, and economic limitation. Figure 4 (left) presents the whole Thai population as profiles divided horizontally in three layers ranging from the bottom layer which represents users with lowest risk of exclusion to the top layer which represent users with highest risk of design exclusion according to three dimensions of barriers: individual incapability, economic limitation and cultural difference.

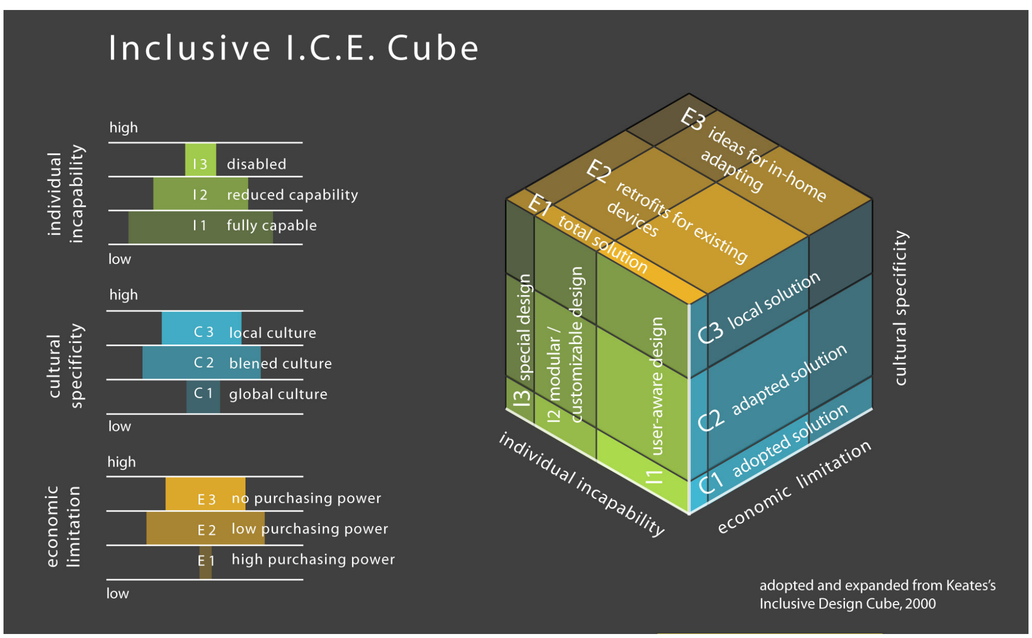


Figure 4 [left] profiles of Thai population at risk of design exclusion as a result of individual incapability, economic limitation and cultural different barriers; [right] The Inclusive Incapability-Culture-Economy (I.C.E.) Cube

The ‘Inclusive ICE Cube’ relates the three dimensions to population (included in the enclosed volume) and suitable design approaches that can be used in conjunction: total solution design (E1), retrofits for existing devices (E2), ideas for in-home adapting (E3), adopted solution design (C1), adapted solution design (C2), local solution design (C3), user-aware design (I1), modular/customizable design (I2), and special purpose design (I3). For example, ideas for in-home adapting (E3), local solution design (C3), and user-aware design (I1) approaches should be used in combination for low-income users with specific culture.

5.2.1 Inclusive approaches for individual incapability barriers

Adopted from Keates’ Inclusive Design Cube, the capability axis represents cognitive, motor and sensory capabilities of individuals ranging from full capability to no capability.

a). Special Purpose Design (I3)

At the low capability end, it is likely that many of the needs of daily living will be met by care givers. As capability increases, special purpose design (I3) will provide products to suit specific needs, wheelchairs for example, where such products are not intended for general use by the whole population.

b). Modular or customizable design (I2)

Modular or customizable design (I2) allows for variations in products to accommodate a wider range of abilities. These can be done by designing of components that can be assembled in a variety of ways to meet individual needs.

c). User aware design (I1)

User aware design (I1) is intended to result in products with appeal to as wide a range of capability as possible.

5.2.2 Inclusive approaches for economic limitation barriers

The economic axis represents the users’ purchasing power ranging from unlimited/full purchasing power to limited/no purchasing power.

a). “Way”- ideas for in-home adaption (E3)

At the no purchasing power end, the suitable approach would be designing creative ways for users themselves to adapt household items or environment (E3). Appropriate technology design will provide solutions with no financial barrier. For instance, making a mitten from a wash cloth and modifying a plant watering can into a bigger urine container (figure 3-a).

b). “Part”- retrofits for existing devices (E2)

As purchasing power increases, designing low-cost retrofits for existing devices in the home (E2) provides greater value from a smaller investment and extends the life of existing equipment, such as, metal cup placed in an electric water boiler to warm up liquid food or sterilize feeding equipment (figure 3-f).

c). “Whole”- total design solution (E1)

Finally, total design solutions (E1), by either product redesigning or creating a new product class, will enable more efficient solutions for users with higher purchasing power. A two layer adult diaper allows the elderly to remove a layer during the night by themselves or an easy-to-install bathroom can be placed near sleeping area. As most of the Thai population has limited purchasing power, ideas for in-home adapting (E3) and retrofits for existing devices (E1) are most useful. Interestingly, while the two approaches are essential for the low-income users, they are preferred for the whole population as well.

5.2.3 Inclusive approaches for cultural specificity barriers

The cultural axis represents lifestyle practice, customs, preference, information processing, and environmental arrangement related to users' culture. The range of cultural specificity is from global culture, to blended culture, and to local culture. To overcome the culture barriers several design approaches can be used.

a). Local solution (C3)

At the local culture end, local solution design for specific culture practice and customs (C3) will provide products to suit specific needs, for example a softer mat could be designed to have a pulling handle and body strap for safely sliding the elderly across the floor, as was discovered to be a practice of convenience (figure 3-g), or lower wheelchairs to allow users who lie on the floor to move around without having to pull themselves up (figure 3-h). Such products are not intended for general use by the whole global population.

b). Adapted solution (C2)

Adapted global solution (C2) allows a global product concept and technology to accommodate a wider range of users within different cultures. For example a foldable food tray with cup and plate holders that can be used both with a chair and on the floor (figure 3-i).

c). Adopted solution (C1)

Finally, adopted global solution (C1) is intended to result in products with appeal to as wide a range of users in global culture as possible.

To optimize inclusive design effectiveness, design approaches in the three dimensions of the I.C.E. cube should be used in combination. Results from in-depth interviewing and observation pointed out that design solutions and approaches intended for users with reduced capability (I2) are also preferable for fully capable users (I1). Similarly, solutions and approaches intended for users in blended culture (C2) are acceptable in global culture (C1), while those intended for low-income users (E2) are applicable for high-income users as well. On the other hand, solutions and approaches intended for users who are disabled (I3) or in local culture (C3) are so specific that they are usually not applicable for other user groups (figure 5). Interestingly, many design solutions intended for no-income users (E3), if done well, can be preferred by higher income users (E2, E1) as well (figure 3-c). Making a mitten from a wash cloth is a good example (figure 5).

6. Research application

The "Incapability-Cultural -Economic Cube" (I.C.E Cube) could be used as an active inclusive design framework for all ranges of users with different capability, culture and purchasing power. The detail findings in the first phase of this research can also be applied to other contexts, with the consideration of the following:

a). Excluding the problems specific to Thailand, the general problem findings and solutions can be applied to any other country. Solutions can be carried out in a more innovative level in countries with financial and technological advantages.

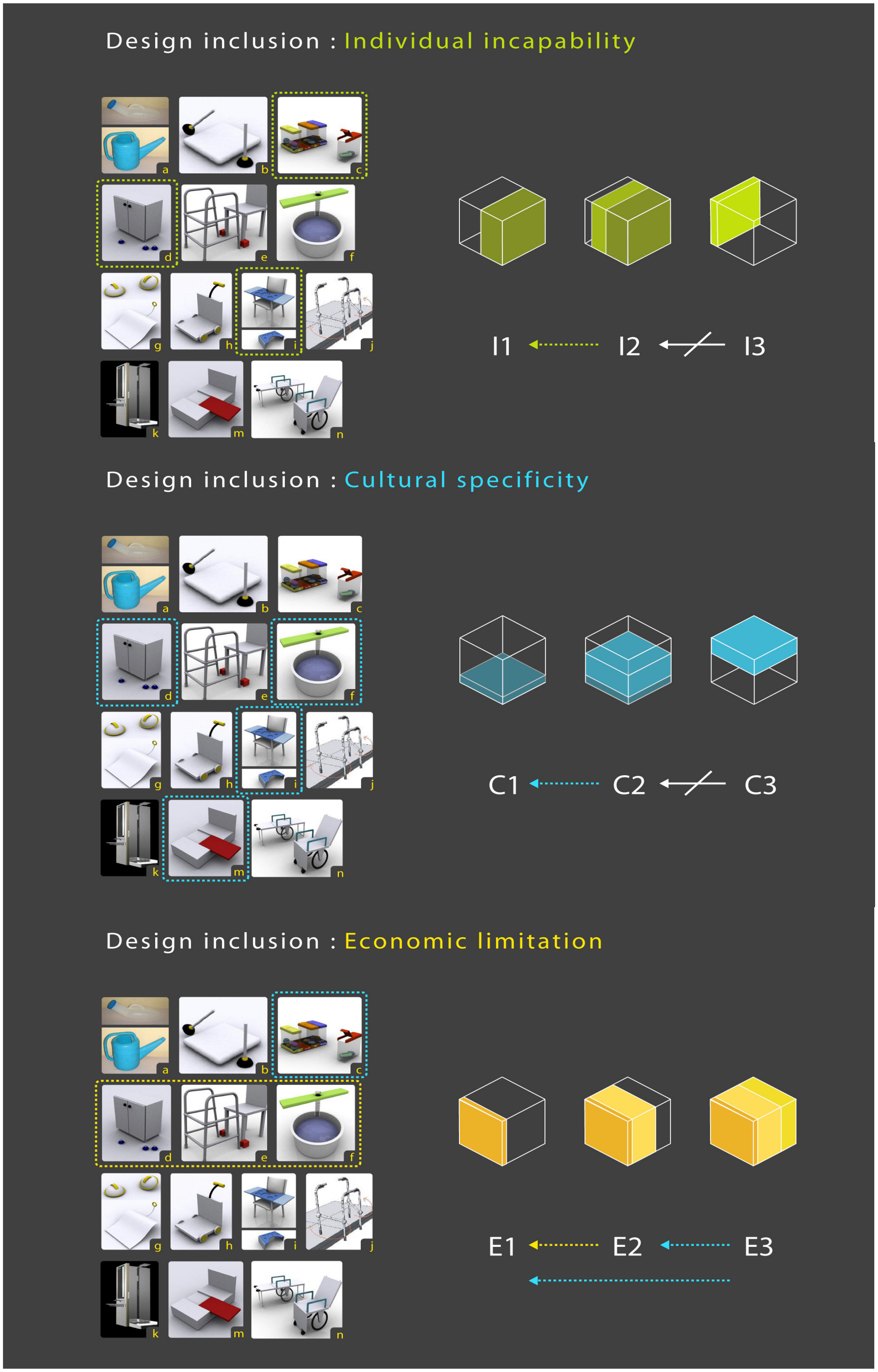


Figure 5 Degree of design inclusion along each inclusive design dimension: individual incapability, cultural specificity and economic limitation

b). For the problems specific to Thailand, in terms of culture, the findings and solutions can be applied to countries with similar cultural characteristics and behaviors, such as sitting and sleeping on the floor. These similar cultures would be in East Asia, namely, Japan and the neighboring countries of Thailand.

c). For the problems specific to Thailand, in terms of limitations in purchasing power and literacy, the findings and solutions can be applied for other developing countries with similar limitations.

Nevertheless, the context in each country varies, so further research should study specific problems locally.

7. Further research

This research, in the first phase, aimed to study the broad problems covering all the elder-care activities. Further research for product development could be more in-depth. Behavioral prototypes can be used as a tool to collect information on each device, involving experts from other fields. A multi-disciplinary teamwork would provide the most useful information in developing elder care products.

The ‘Inclusive I.C.E. Cube’ is only a starting point for inclusive design across capability, cultural and economic diversity. Further work could be done to develop this concept in terms of dimensions and user ranges in order to turn it into a more completed framework and set of design principles.

8. Conclusion

Elder care in Thailand has specific problems rooted in cultural, economic and physical factors. The adoption of methods and devices from abroad has limitations in application, and some even lead to more complex problems. Therefore, problem-solving through design in elder care should start at the root causes with an in-depth understanding of problems and preferences in purchasing or using devices. The design approaches should be compatible with the local lifestyle and economic status. This research proved that the adoption of conventional products from the developed countries present serious difficulties and exclude users with limited capability, specific culture and lower purchasing power. The understanding or the problems and barriers enable the I.C.E. Cube to be developed. The concept of the I.C.E. Cube intended to provide a framework for active design guidance for all range of users with different capability, culture and purchasing power. Lastly, although similar problems in the Thai context can be found in similar cultures and developing countries with economic limitations, but each country has specific needs and requires the study of local problems in order to achieve the best solutions.

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Far Beyond Dualisms in Methodology - An Integrative Design Research Medium "MAPS"[1]

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Abstract

Design research is an academic issue and increasingly a success factor for industrial, organizational and social innovation. Efficient methodical support is crucial. The fierce rejection of 1st generation design methods in the early 1970s resulted in the postmodernist attitude of "no methods", and subsequently in the strong adoption of scientific ways of thinking for design research. The situation regarding methodology has been characterized by unproductive dualisms such as scientific vs. designerly methods, normative vs. descriptive methods, research vs. design. The potential of the early (1st generation) methods is neglected and the practical usefulness of design research is impeded. The suggestion for 2nd generation methods, conceived as discursive instruments, as discussed by Rittel and others has hardly been taken up in design. The development of MAPS is aimed at the support of practice-oriented design, innovation and research processes. The long-term aim is the development of an *integrated knowledge and communication platform for research through design*. MAPS is based upon the idea of a productive reconciliation of the strong dualisms between "scientific" and "designerly" modes of inquiry and supports the emerging concept of *design thinking*. The paper reports on the ongoing research and development process from MAPS1.0 towards MAPS2.0 and beyond.

Keywords

research through design, methodology, MAPS, integrative design research medium

INTRODUCTION

Background and context

Design Research is both an academic issue and increasingly an essential success factor for industrial, organizational and social innovation. Design and innovation in these contexts are characterized by complexity on the problem side and contingency on the solution side. The fierce rejection of 1st generation design methods in the early 1970s resulted in the postmodernist attitude of "no methods", and subsequently, after more than a decade, in the strong adoption of scientific paradigms and methods for

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[1] "MAPS" stands for Matching Analysis Projection Synthesis and is available at http://www.designprocess.de. The title refers to Chow&Jonas (2008).

design research. The potential of the early (1^{st} generation) methods is neglected and the practical usefulness of design research is impeded as a result of the strong scientific bias. Besides, suggestions for 2^{nd} generation methods as discussed by Rittel (1972) and others have hardly been taken up in design. The current methodological dualisms fail to address these issues as a whole. There is no doubt that design and innovation projects today are increasingly knowledge-intensive and research-based. Nevertheless uncritical adoption of scientific methods and ways of thinking is showing strains. Certain sub-problems in design research projects need proper scientific ways of inquiry, but we suggest that the scientific approach alone is not sufficient.

The request for accelerated and systematic innovation suggests a need and an opportunity to adopt design as the generic process model of innovation. The emerging paradigm of "research through design" (Jonas 2007) provides a methodological and epistemological model for bridging the gap and creating the relation between "problems" and "solutions", that means for problem definition (dealing with complexity), solution generation (dealing with contingency) and project formation (dealing with the process that generates new facts and artefacts = forms). It also holds promise to end the dualisms by integrating both. Resolving the dualisms is a must if design research is to proceed to fulfil its potential and to meet its ambitious claims:

"black"	**Or "white"**	**→ And ("the beauty of grey")**
scientific methods	designerly methods	the flexible design process structures both scientific and designerly methods to allow the integration of heterogeneous scientific contributions
"proper" research	research through design	research through design, conceived as mentioned above, is proper and rigorous design-specific research
pre-rationalization	post-rationalization	both modes of reflection are complementary and proceed in a circular relation
descriptive methods	normative methods	both methodological concepts are necessarily complementary in designing
1st order methods	2nd order methods	a 2^{nd} order cybernetic view integrates both perspectives and resolves the apparent contradiction
control	conversation	the character of the process depends entirely on the observers´ interpretation of the situation, conversation seems to be the more effective approach
tool	medium	the character of the instrument depends on the users´ interpretation of the process, medium seems to be a more productive concept
rigourous	undisciplined	rigour in the trans-discipline of design is fairly complex and still barely understood; the hypothesis is that in trans-disciplinary endeavours such as design one has to be rigorously undisciplined in order to be relevant
research	design	essentially, research is a special mode of design, in practice there is a continuous transfer zone between the two, we have to re-discover "the beauty of grey"

Table 1: Overcoming dualisms in design research (Chow&Jonas 2008).

The challenge now is to operationalize these theoretical concepts of design thinking without destroying or suppressing the intuitive qualities of the design process by the rational approach, but to enhance them and to make them more explicit and communicable.

Questions, hypotheses and assumptions

The research questions are (a) theoretical: how to integrate design methods and scientific methods under a designerly paradigm of knowledge creation?, and (b) methodological: how to make them operable in a way which creates added value for designers and design researchers? The project is based upon the following assumptions:

a) Research THROUGH design is the appropriate paradigm of knowledge generation in design and mode-2 science today. (Glanville 1980, Knorr-Cetina 1981, Latour 1991, Nowotny et.al. 2001, Rheinberger 2001, Jonas 2007, Findeli 2008a,b).

b) There is more continuity in methodology than normally assumed. From a 2nd order cybernetic perspective, which accounts for the necessary and inevitable involvement of the designer / researcher in the process, it is possible to integrate the early (1st generation) methods as well as scientific methods into a more continuous and consistent concept of 2nd order design methodology, see fig. 1. Findeli (2006) identifies the same modes, albeit in a different terminology:

• AS: "Premier type : modèle de la théorie minimale",

• ABOUT: "Deuxième type: la théorie comme cadre interprétatif",

• FOR: "Troisième type: le design comme science appliquée",

• THROUGH: "Quatrième type: le design comme théorie située et pratique éclairée".

Observer position Observer looking	Outside the design system 1st order cybernetics	Inside the design system 2nd order cybernetics
outwards	research FOR design	research THROUGH design
inwards	research ABOUT design	research AS (?) design (inaccessible)

Fig. 1: The concepts of research FOR / THROUGH / ABOUT design – as related to the cybernetic concept of observer positions with respect to the design system (where design activities take place, see Glanville 1997).

We hypothesize that in order to operationalize research through design, the instrument, which we name MAPS must provide the following functions and characteristics:

• MAPS is an instrument FOR design (→ normative, improving the process, aiming at pre-rationalization),

• MAPS is based upon assumptions that are results of research ABOUT design (→ descriptive, building on post-rationalization of existing processes / models),

• MAPS is aiming at the support of research THROUGH design (→ conversational, an interplay of different observer positions, pre- and post-rationalization).

• MAPS gives space for research AS design (→ generative, the necessarily inaccessible component of every abductive process). This is the epistemological core.

RESEARCH THROUGH DESIGN – AN EMERGING PARADIGM

Designerly ways of thinking

Findeli (2008a,b) provides a brief epistemological clarification of the much-quoted "designerly way of thinking in design". He contends that it can contribute to research in general by delivering valid and trustworthy knowledge about a part of the world considered as its specific field of knowledge. The scope or field of design research, according to Findeli, is *general human ecology.* It is the stance or epistemological bent of design research, which makes the difference: it is normative, diagnostic, prescriptive and not primarily analytical / descriptive as in the sciences. Design has a *projective* stance, the world is seen as a *project*, not an object of inquiry. And this feature is not a deficit at all (Findeli (2008b):

"Recent developments in human and social sciences have dealt extensively with the issue of objectivity as a possible and desirable horizon in research. The interpretive or hermeneutic turn has shown that objectivity is not a relevant and fruitful criterion for research in those disciplines, and that rigorous inquiry is nevertheless possible without diving into extreme relativism or scepticism. On the other hand, the pragmatist epistemological tradition - where the engagement of the researcher is also required - may also be invoked to propose a robust epistemological framework for design research, not to mention action research (renamed "project-grounded research" in design research) as one of its incarnation in methodological applications.

… definition:

Design research is a systematic search for and acquisition of knowledge related to general human ecology considered from a designerly way of thinking, i.e. project-oriented, perspective."

Elsewhere, this is usually called research through design (RTD).

3-stage models - APS

There is a myriad of design process models, as the collection from Dubberly (2004) testifies. We do not want to provide just another model but to suggest an integration. Beside this messy pluralism – if we take a more general and slightly fuzzy view – we realize that hybrid and integrative models are emerging that acknowledge the "beauty of grey" between "mere design" and "proper research" and argue explicitly for a specific epistemological status of design research. There is a striking triadic pattern showing up: a genuine design-specific structure, albeit still in diverse terminologies, of the research process emerging in various "sciences of the artificial" (disciplines dealing with the teleological / purposive transfer of an existing state into a preferred one), such as design (Jones 1970, Archer 1981, Nelson and Stolterman 2003, Jonas 2007), management (Weick 1969, Simon 1969, 1977), HCI (Fallman 2008).

author	**Phases / macro steps / components of design (research)**		
Jones 1970	divergence	transformation	convergence
Archer 1981	science	design	arts
Simon 1977 / Weick 1969	intelligence	design	choice
Nelson&Stolterman 2003	the true	the ideal	the real
Jonas 2007	Analysis	Projection	Synthesis
Fallman 2008	Design Studies	Design Exploration	Design Practice

Table 2: Triadic concepts / domains of knowing in design research indicating a generic model of the designerly research process (see also Chow 2009).

The so-called APS-approach (Hugentobler, Jonas and Rahe 2004, Jonas 2007) (APS stands for ANALYSIS PROJECTION SYNTHESIS) has been elaborated and developed into an operational tool (Jonas&Chow 2008). The underlying theoretical model consists of the hypercyclic combination of three domains of knowing ("the true", "the ideal", "the real", Nelson&Stolterman 2003) - the macro-level, and 4 steps of the basic learning cycle (research, analysis, synthesis, realization, Kolb 1984) - the micro-level. The claim is that APS represents the generic structure of a design research process in the paradigm of research through design.

APS and further …

Three generic design process models from Simon / Weick (1977 / 1969), Nelson&Stolterman (2003) and Jonas (2007) provide the basis for the further deveolpment of our theory. They are different but compatible and can be synthesized in a productive manner. Jonas´ operational "macro phases" of the design process (Analysis, Projection, Synthesis) are related to Nelson&Stolterman´s epistemological "domains of knowing" (the true, the ideal, the real). Simon&Weick´s generic steps of the management process (Intelligence, Design, Choice) are integrated, because Boland (2004) has demonstrated that it makes sense and provides further insight to consider the 3 macro steps of the design research process (which we call A, P, S from now on) in arbitrary sequence. So it is essential to mention that the 3 macro steps of the design research process are arranged not in a linear but in a circular sequence, allowing any possible punctuation of the process:

1. **intelligence – design – choice (APS): Herbert Simon´s rational man economic theory,**
2. design – choice – intelligence (PSA): the "what have I done?" manager,
3. choice – intelligence – design (SAP): the existential introvert,
4. intelligence – choice – design (ASP): the chronically disappointed manager – "if I had only…",
5. **design – intelligence – choice (PAS): Karl Weick´s sensemaking manager,**
6. choice – design – intelligence (SPA): the existential hero.

According to Boland, from the six possible combinations of punctuations it is most reasonable to put Choice (SYNTHESIS) to the last moment. Therefore the sequence 1 - APS and the sequence 5 - PAS are the only desirable ones.

"NARRATIVE 1. INTELLIGENCE – DESIGN – CHOICE

The sequence of intelligence – design – choice is Simon´s own punctuation in which intelligence recognizes a need for intervention, design makes alternatives available for consideration, and choice selects the best (satisficing) one. This is the classic view of rational man who is intentionally goal seeking and uses intelligence and forethought to guide organizational action. Our literature is full of examples showing that this model does not represent how humans actually behave. Simon "saves" this model for economists by posing that individuals are boundedly rational and do not seek best or optimal solutions as a strong economic model might suggest, but rather search for solutions until one that is "good enough" is found – the boundedly rational person therefore satisfices. This image of a satificing human, as attractive as it may be, has an undesirable consequence that follows from its temporal dynamic. In light of Simon´s own recognition of the importance of problem representation, we see that this punctuation of managing is easily trapped by the common wisdom of those in a problematic situation – its sequence begins with a pre-understanding of the situation that can promote a myopic circularity in which the way we happen to be thinking about *things becomes institutionalized in the representation and definition of the world we face. My intuition is that this way of punctuating management action leads to a finer and finer attention to problem representations that grow increasingly irrelevant to the human condition. Welfare policy, education policy, transportation policy, and most public policy issues seem to fall prey to the traps of this form of punctuation."*

"NARRATIVE 5. DESIGN – INTELLIGENCE – CHOICE

Here, we have design as the shaping of things while engaged with others in the flow of action, and the producing of outcomes that are surprising to even the individual herself. Interaction with others generates equivocal enactment that is then subject to a sensemaking process. During sensemaking, intelligence is applied to order those elements of the raw action in ways that make the situation meaningful, aesthetically pleasing, and morally acceptable. This intelligence is followed by a choice of which meanings and sensemaking structures to carry forward into future enactments. This is a cybernetic system modeled after an evolutionary process, much like Weick´s sensemaking model with its pattern of variation, selection, and retention. Here, goals (if they are ever explicitly considered at all) are only understood retrospectively, and the raw, surprising enactments of design are the primary driving force of organizing. Weick´s many years of research on the sensemaking model of organizing shows how powerful this view of punctuating action is for understanding organizing behaviors both successful and unsuccessful. It is, in a sense, the antidote to the rational man model of the first narrative, grounded in a phenomenological appreciation of human action."

The distinction refers also to Lawson´s (1980) notion of scientists being more "problem-oriented" (analyzing the problem so that the solution can be derived from that) in contrast to designers being more "solution-oriented" working and thinking (generating tentative solutions until the best one emerges).

We can derive archetypical processes from the above considerations. The APS model **p**laces intelligence and goal-driven problem-solving as the driving activities (Simon 1977). Design research departing from a more or less known context, aiming at … solutions. The PAS model **p**laces design as the driving activity (Weick 1969). Design research departing from a highly unclear context, aiming at … innovations. Eliminating the doubles, we arrive at nine archetypical processes:

1	A	P	S	APS a "complete" design research process	Intelligence and goal driven problem-solving as the driving and leading activities in the design research process with / without Synthesis
2	A	P		AP a concept / futures studies process (without synthesis/realization)	
3	A		S	AS a "normal" design process (without proper projection)	
4	P	A	S	PAS a "complete" design innovation process	Design projection as the driving and leading activity in the innovation / exploration / research process with / without Synthesis
5	P	A		PA an exploration process (without synthesis/realization)	
6	P		S	PS a "risky", "speculative" trial&error process (without analytical grounding)	
7	A			A an analytic research process (inquiry into "the true")	disciplinary, domain-specific research or practice
8		P		P a projective futures studies process (inquiry into "the ideal")	
9			S	S a synthetic realization process (inquiry into "the real")	

Table 3: Nine archetypical design and design research processes.

By the way: Based upon these considerations it seems possible to describe the model of RTD as closely related to mode-2 science Nowotny et.al. characterize mode-2 science through primacy of the application context, transdisciplinary working situations, institutional heterogeneity (project-orientation), social accountability and new practices and criteria of quality control. In a mode-2 perspective there is a growing convergence of the design- and the research process; a shift from understanding to changing. We argue that it is the PROJECTION phase which integrates science and design and thus establishes the model of mode-2 science. This has to be elaborated elsewhere in more detail.

	ANALYSIS	PROJECTION	SYNTHESIS
Design			
Design Research (equals mode-2 science)			
Scientific Research (mode-1 science)			

Table 4: PROJECTION links Design & Science and establishes the model of mode-2 science.

CONCEPT OF MAPS

Distinctions of MAPS

MAPS is aimed to dissolve the toolbox' apparent rigidity and its conditioning and to provide a flexible, discursive and productive knowledge-supported medium. In the light of user experience with MAPS1.0 and against the background of deeper research into management processes (Boland 2004) and user-centered design research processes (Chow 2005) we realize the need to make the model more open and flexible. MAPS is designed to assist design researchers to specify / categorize (problem) situations, to match process patterns to the specified situation (and specify the role of design research), to select methods / tools related to the process, and to capture and retrieve design knowledge. Furthermore the new tool will assist the user in analyzing existing projects and processes (post-rationalization) as well as in configurating own processes (pre-rationalization). This contributes to the development of a knowledge base on design research processes. We consider four different functions / conditions of use:

• 'HELP': when experienced design researcher needs to locate quickly references on design research process, methods, tools.

• 'INSTRUCT': when design researcher needs step-by-step instruction on design research process, methods and tools.

• 'PROMOTE': when design researcher needs to explain the value and process of design research to partners and clients quickly.

• 'COLLABORATE': when design researcher needs to work closely with partners and clients.

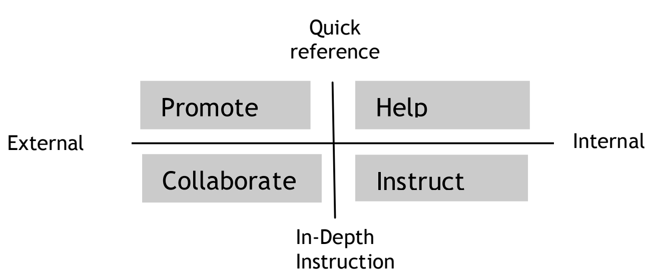

Fig. 2: MAPS provides four different functions.

The wider MAPS system

MAPS is aiming at the support of practice-oriented design, innovation and research processes. The long-term aim is the development of an integrated knowledge and communication platform for research THROUGH design. The outcomes of research through design projects are models in the widest sense: artefacts and new knowledge. MAPS assists problem specification by means of a questionnaire, which collects the main characteristics of the project. It suggests, if necessary, the use of a systemic model of the situation, which evolves during the process. MAPS provides an archive of methods. The methods are tagged according to the generic APS process model. MAPS generates preliminary process proposals, based upon the generic process model and using the outcome of the questionnaire (this is pre-rationalization). The process can be modified according to new and changing insights and requirements at any time, so that MAPS has the function of a communicative / reflective tool during the process. The final process can be documented and stored in a project archive for further evaluation and use (this is post-rationalization). Finally the growing project archive will feed MAPS and will generate new knowledge regarding the appropriate use of methods for the configuration of processes. Prototypical processes for certain situations may emerge, so that transferability of processes will be a longer-term effect of the use of MAPS.

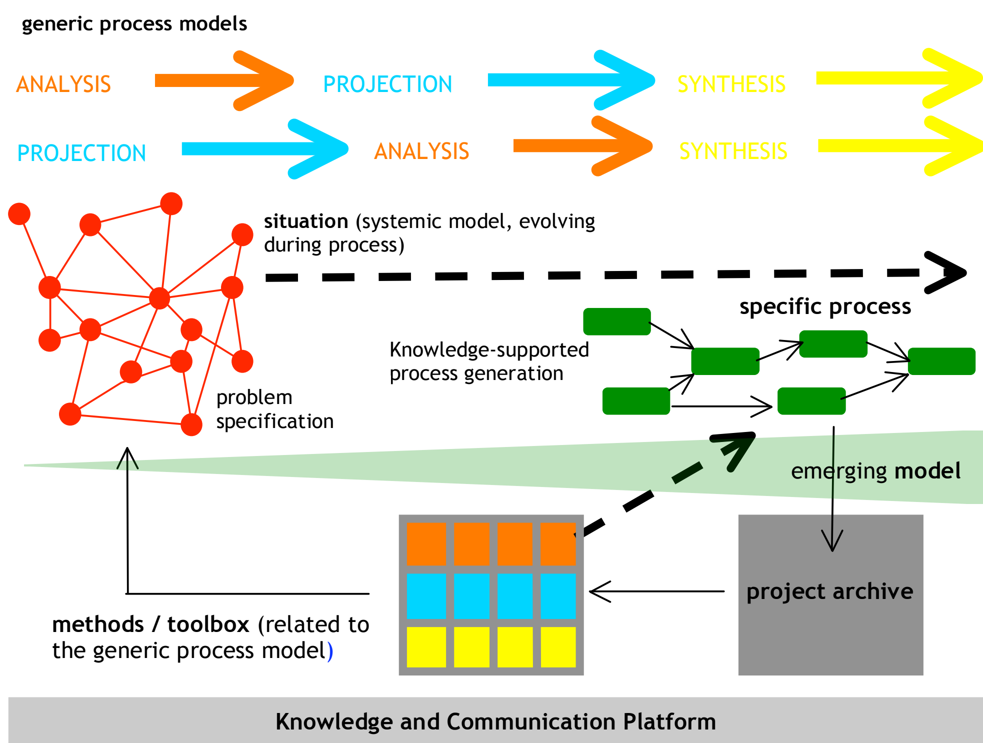

Fig. 3: The wider design concept of MAPS and its use.

OPERATIONALIZATION OF MAPS

Following from these theoretical considerations we have conducted in-depth user-studies in the context of a communication and information technological research center. Users from Business, Engineering, Design Design Research, were included.Following from these interviews, we transferred the four ideal functions as conceived above (Fig. 2) into three demonstrative use-scenarios or working modes for MAPS. They serve as guidelines for the development of the system and the specific user-interfaces:

• "WIZARD-mode" is an assistance tool, mainly for beginners, for knowledge-supported configuration of processes. It is highly normative, using the questionnaire for the specification of process requirements.

• "PLANNER-mode" is a discursive tool / workspace for planning a process timeline for a team of experts, possibly from different disciplines. It is intensively using the methods toolbox and the methods descriptions.

• "REFERENCE-mode" is a reference tool with easy access to the methods database and the project archive and links. Effective user-generated knowledge capture and retrieval features are implemented here

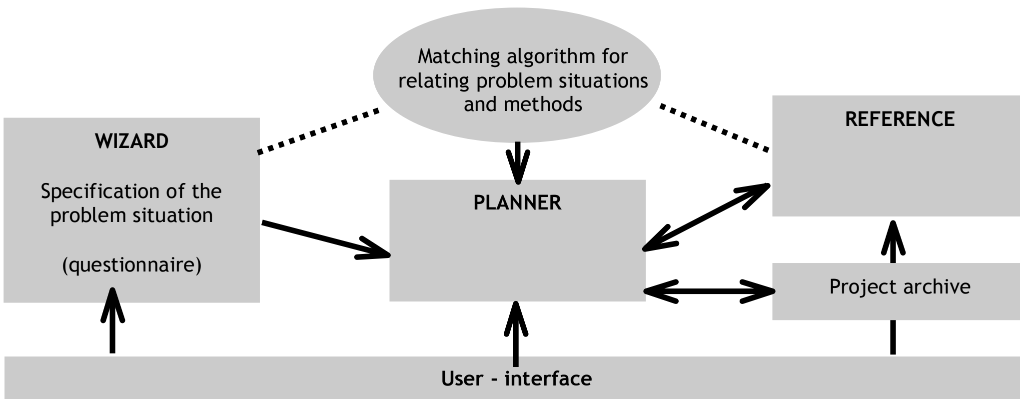

Fig. 4: Main components of MAPS2.0.

The questionnaire in the WIZARD mode is a tool for the user to specify his / her project situation. By answering the questions the user is also selecting tags that characterize the project. At the same time the tags are instruments for method profiling, that means characterizing their usability / usefulness for specific purposes. The set of tags is shared by the questionnaire (problem side) and the methods archive (solution side); they are the connecting elements. MAPS uses tags to match the situation with the suitable methods. That means for example: a problem situation can be designerly / scientific and a method can be designerly / scientific, etc. Matching the profiles of the situation and of the methods available contributes to the intelligent knowledge-supported selection of methods and tools for specific project situations. The matching algorithm for the meaningful relation of problem situations and methods is essential and still in the process of development and refinement ….

The four idealized functions (Fig. 2) are matched with users needs and made usable by three different interaction modes.

Function	**User needs**	**Mode**
Help	Easy handling (Step by Step)	Wizard
	Not so complex. Preselection of Information	Wizard
	Pre-rationalization	Wizard
	Not so interested in process, just need some advice on methods	Reference or Planner
	Favorite methods	Reference
Instruct	Archive	Reference

	Lots of in-depth information	Reference
	Search for particular method	Reference
	Fast & efficient	Reference
Promote	Access to other people's processes	Planner
	Post-rationalization	Planner
	Streamlining processes	Planner or Reference
Collaborate	Show process plan to client	Wizard or Planner
	Fix process	Planner
	Access to own history	Planner
	Reuse processes & methods	Planner or Reference

Table 5: User-centered functions and interactions of MAPS.

WIZARD is the mode for non-experts, who seek recommendation regarding the configuration of their design research process. See Fig. 5.

Julia (Design Think Tank) is a young designer who has just joined a design consultancy for a month. Her first project is to assist a senior designer to develop mobile communication for teenagers. She is very practice-oriented, creative and used to work intuitively. In her design education she has not learned to reflect and communicate her design process. But now she has to make explicit her methods and process. She is under time pressure for this short-term project and she needs to get information quickly and is looking for easy-to-understand cookbook descriptions of process and methods. Julia starts using WIZARD to get quick and plausible results. She also browses through REFERENCE and gets interested in the archived experience reports and ratings from colleagues and thinks about reusing existing templates, etc.

PLANNER is for those who have much experience in planning and carrying out projects. Users can enter PLANNER either through first using WIZARD or directly. See Fig. 6.

Barbara (Product Development) is a very pragmatic project leader with an engineering background. She leads a multi-professional team and needs to co-ordinate and to organize the group and information flow. She needs to plan in advance in details for every single project. Consensus among project members is highly important; therefore transparent and explicit communication is essential for successful teamwork. She needs clear overview of the project: what is happening when, with whom and where. Her projects are longer term with definite milestones. Moreover she is interested in new methods that improve efficiency and effectiveness. Barbara enters PLANNER, retrieves a successful project from the archive and modifies it according to the requirements of the actual project. From time to time she browses in REFERENCE in order to check out the newest methods and updates that might be useful for her team. Sometimes she also adds new methods that she finds useful to share with colleagues.

REFERENCE is for all to get information about methods. The user can search for the database of methods in various ways. Furthermore, (s)he can evaluate and comment existing methods and add own methods. See Fig. 7.

Herbert (Research Consultant) has a scientific background and is a very analytical worker. From his long consulting experience he has in-depth theoretical and practical knowledge about processes and methods. He needs and prefers scientific references, links, published case studies and literature for his work. He needs information and sound knowledge. He likes to keep record of his own projects to show clients. Furthermore, he is permanently looking for new knowledge and he is constantly building his professional network. So Herbert is a frequent user of REFERENCE where he comments and rates existing methods, looks for interesting new methods and projects and frequently adds new methods.

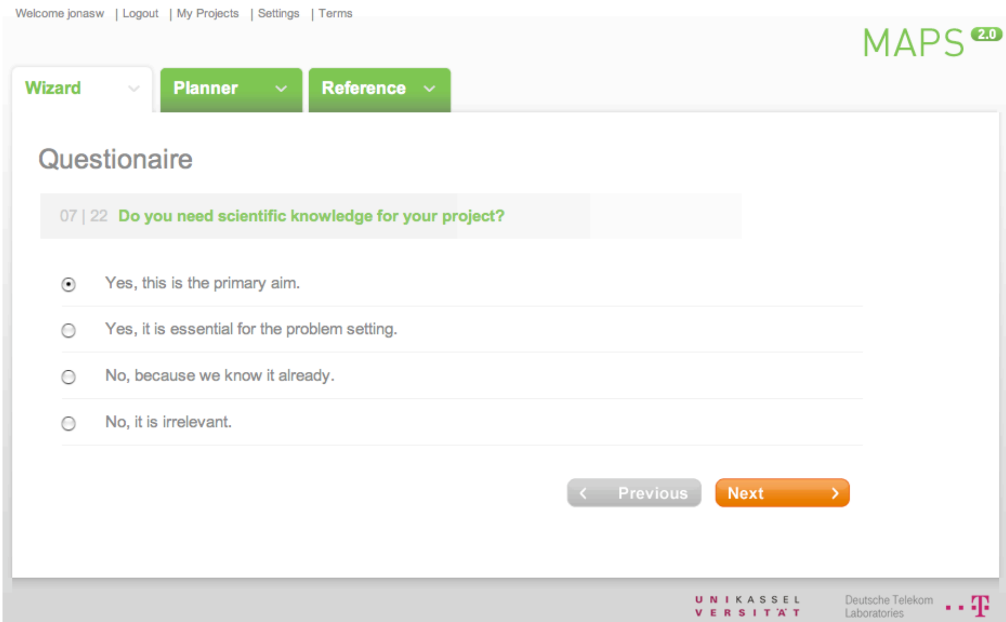

Fig. 5: Knowledge supported process configuration in the WIZARD mode.

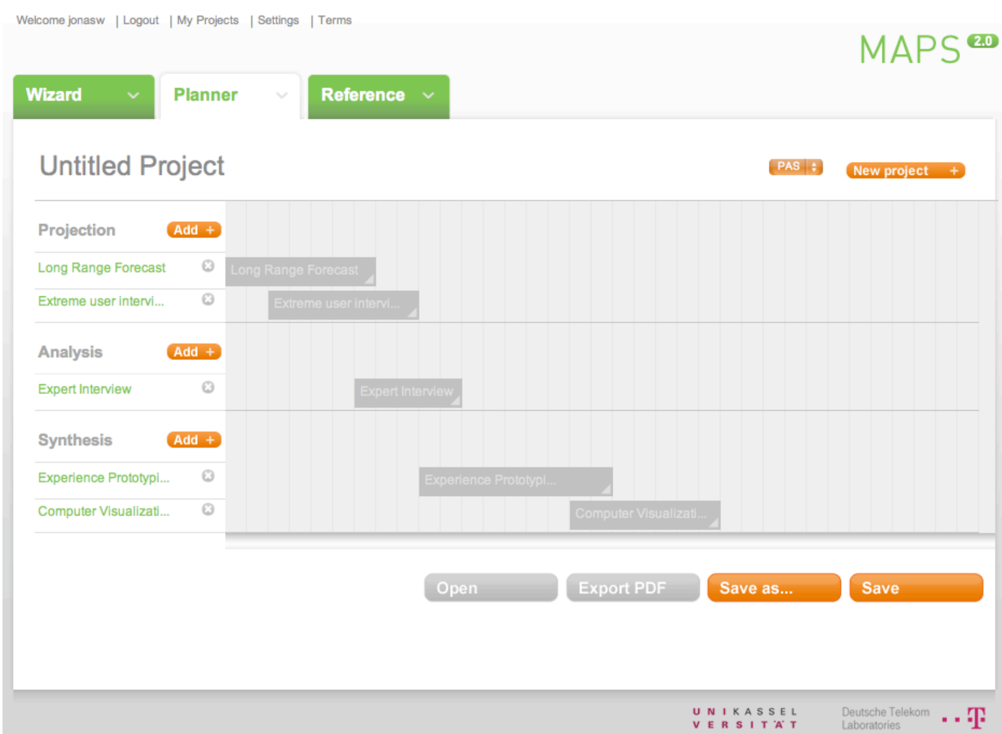

Fig. 6: Configurating a design research project in the PLANNER mode.

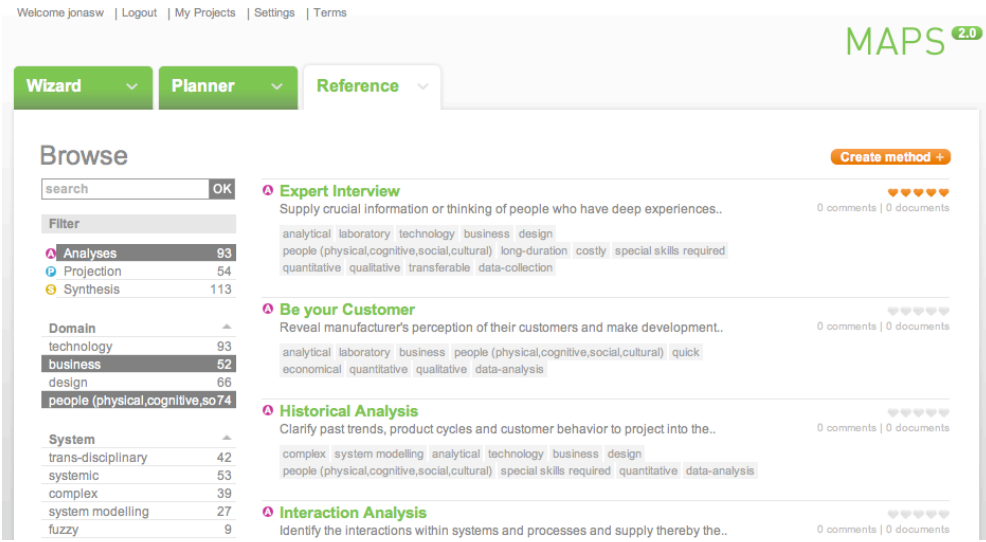

Fig. 7: Method description in the REFERENCE mode.

CONCLUSIONS

It is not difficult to find descriptions and representations of processes for designing, problem solving, and innovative product development. Evbuomwan et. al. (1996) and Dubberly (2004) provide a comprehensive collection of philosophies and process models. However, most of these representations, although informed by practical experiences, can hardly be considered systematic or rigorous. And even the more thoughtful representations come short in a few critical aspects, since they overlook the problematic situation, i.e. the relevant contextual factors of the project, or they conflate process models with methods and tools, or they fail to distinguish the epistemological domains of knowing (the true, the ideal, the real), or they are focussed on specific application areas such as software, HCI, architecture, etc. Table 6 provides an overview.

Our ambitious claim may be supported by the observation that there is self-similarity in the project. The entire ongoing development process of MAPS can be described so far as A – P – S – A – P – A – S … with open end: A: Analysing existing process models and tools – P: Projecting a tool for design research (theoretical concept) – S: Synthesising the first version of MAPS (toolbox and MAPS1.0) – A: Analysing user experience with MAPS1.0 – P: Projecting the improved version of MAPS – A: Analysing user needs for the new version – S: Synthesising the improved version MAPS2.0 – …

The rather rigid toolbox structure of MAPS1.0 has been made much more open and flexible in MAPS2.0. Three different modes are available by means of a user-friendly interface. Further improvements are required for each of the three modes:

• WIZARD: Filtering algorithm for matching problem situations and methods needs refinement. MAPS-users have to contribute.

• PLANNER: Connecting interfaces to project planning software might be helpful.?

• REFERENCE: User collaboration is required for the evaluation of the existing methods, for the thorough examination of the tagging logic, and the introduction of new methods

We are looking forward to MAPS3.0…

	MAPS2.0	**ID Chicago approach**	**MePSS**	**Z-Punkt CF toolbox**	**IDEO method cards**
Reference	http://www.designprocess.de	http://www.id.iit.edu/130/	http://www.mepss.nl/index.php?p=intro	http://www.zukunft-im-mittelstand.de/z_punkt.php?kat=1	http://www.ideo.com/work/item/method-cards/
Application focus	Support Design + Research Through Design (RTD)	Support human-centered design and design research	Support Product Service Systems (PSS) development	Support Corporate Foresight (CF) processes	Inspire human-centered design and research processes
Problem situation / purpose	Situation may be specified in detail (questionnaire)	Human-center-ed design and design research situations	PSS development in general	One out of four different CF purposes has to be chosen	Design situations in general
Theory	3-step macro- and 4-step micro process (Kolb-type), 12-step hypercyclic	4-step process (Kolb-type)	5-step process and 6 decision nodes	4-step process (Kolb-type)	4 suits according to activity modes: Ask, Watch, Learn, Try
Methods	200 methods	100+ methods	23 tools, detailed des-cription of the working steps	21 methods, detailed description of tools	51 methods, brief illustrated descriptions
Method selection / process configu-ration	According to the situation as specified in the questionnaire, or underlying 12-step struc-ture , or free	Selection of methods for each of the 4 steps	Configuration according to a fixed scheme	Predefined proposal, user can choose among 1-3 methods for each of the 4 steps	Completely free, supported by the 4 suits
Normativity regarding whole process	Normative, descriptive, or anything in between	Mainly normative	Mainly normative	Mainly normative	Non-normative
Comment	Theoretically the most robust and practically the most general. Usability still to be improved	The classic	Excellent for PSS development	Excellent for CF purposes	Nice and playful tool for inspiration

Table 6: Comparison of exemplary methodical tools.

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In Touch with Representation: Iconic, Indexical and Symbolic Signification in Tangible User Interfaces

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Abstract

In this paper, we discuss the value of semiotics to inquire tangible user interfaces (TUI) in human-computer interaction (HCI). Drawing on Peirce's three types of representation – icon, index, and symbol (Peirce, Houser, & Kloesel, 1998) – we analyze signification processes in the design of tangible UIs. As a case study, we draw on several prototypical interfaces and analyze their semiotic structure. We focus specifically on three different significations for a similar application on a mobile phone: Displaying a new event on a mobile phone (e.g. an unread text message or a missed incoming call). The aim is to establish a basis in semiotics for TUIs that can inform the mapping between physical and virtual parameters. Taking semiotics as basis can help to enhance interface design as the interface 'specifies the optimal set of signs for the interaction between two entities' (Nadin, 1988, p. 273).

Keywords

tangible user interfaces, semiotics, representation, interface design, design research.

Tangible UIs is an emerging research field as the value of haptic perception in HCI is getting more and more into the focus of research and development endeavours. At the same time, easy handling and low-cost availability of prototyping tools for physical interaction (e.g. the Processing environment or the Arduino board (Cuartielles, Banzi, Mellis, & Igoe)) opened up new opportunities for interaction design. Today, it is possible to design prototypes for new digital products rapidly, making the interaction concept explicit and developing it further in fast iterations. Therefore, the production cycle for tangible UIs became shorter, and prototypes in the status of 'perpetual beta' are increasingly popular in interaction design. This practice can be described as *thinking through prototyping,* as the design of the actual prototype plays a major role in the whole research process.

Therefore, it appears crucial to provide a theoretical foundation for the interactive processes that are enabled through these interfaces. We propose that combining the *efficient practice of tangible interaction* with the *analytical potential of communication theory* might provide a basis for findings beyond a purely practice-based approach in HCI. Therefore, we argue that it is worthwhile to investigate the underlying *semiotic principles* of tangible UIs – principles that are derived from the study of signs in communication processes and applied to interactive communication between humans and computers. Physical representations of the virtual can be designed in various ways for TUIs, and semiotics can provide a valuable guide to find the right signification for a given purpose, including parameters like function, context, user, and interaction.

Background

In this section, we discuss relevant findings in *semiotics* and *tangible interaction design*, in order to provide a foundation for the semiotic analysis and contextualization of the three tangible UIs presented in this paper.

Icon, Index and Symbol in Semiotics

Charles Sanders Peirce introduced three basic semiotic categories that describe the relation between Object, Representamen, and Interpretant (Peirce, Houser, & Kloesel, 1998). The *icon* 'is a sign fit to be used as such because it possesses the quality signified.' [p. 307] Peirce gives the example of a geometrical figure drawn on a piece of paper that resembles a triangle. The *index*, the second category of signs, is a sign that is 'in real reaction with the object denoted' [p. 307]. His example is a weathercock that is physically connected with the wind, and, being a sign, is an index of the wind. The third category, the *symbol*, is defined as a sign that 'determines the interpretant sign' [p. 307]. Peirce's example is language itself, as it has a fundamental symbolic relation between letter, word and meaning. These categories had a deep impact on describing all processes of signification, especially when it comes to visual and iconic representation as in visual rhetoric or semiotics.

If we understand all design production as rhetorical action, as Richard Buchanan states (Buchanan, 1985), we can also apply these semiotic categories to interface and interaction in HCI. If we want to understand the communicative purpose of an interface and its semiotic structure, we can refer to *icon, index,* and *symbol* as basic categories. Hence, it is now aimed to understand the relation between the semiotic representation, the communicative function and the tangible UI. Mihai Nadin applied Peirce's semiotic paradigm to interface design in the late 1980s with a fundamental conclusion for interface design as such: 'Since the technology upon and for which we build interface changes very rapidly, pan-logical semiotic principles, in their breadth and depth, provide a foundation for improved interface design' (Nadin, 1988, p. 283). In his article, he investigated Command-Line Interfaces as well as GUIs. In this paper we argue that the basic assumptions and semiotic categories can also be applied to tangible UIs.

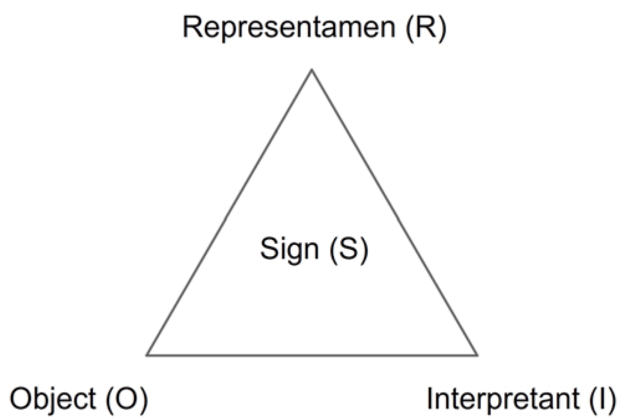

Figure 1, Peirce's definition of Sign.

Iconic, Indexical, and Symbolic Representations in Interface Design

Gui Bonsiepe defined the interface as a device turning 'Vorhandenheit' into 'Zuhandenheit', drawing on Heidegger's terminology. Therefore, he stressed the tool character of the interface as such and shed light on the aspect that an interface is more a relation between user, tool, and artefact than a simple input and output device. Nadin also enhanced the definition of the interface by defining every point of contact between user and computer system as part of the interface. As a result, there are many interfaces between the whole computer corporation and the market with users and potential users (Nadin, 1988, p. 274). We follow this broad definition of the interface when looking at tangible UIs. Furthermore, we stress aspects of time and physical space of interaction that draw on concepts of embodiment as being a specific quality of tangible interaction. Ishii and Ullmer, in 1997, proposed this style of interaction that couples 'bits and atoms' (Ishii & Ullmer, 1997).

Regarding the semiotic categories for interface design, the question is how object, representation and interpretant relate to each other in order to form a sign in the communication process between the entities. It is crucial to understand that the interpretant is not equal to a single user, but rather it characterizes the process of interpretation in which various users can be involved. All these significations (iconic, indexical, symbolic) are actualized through the interpretant and its human agency. Without this process of actualization there *is no* sign. Therefore, the interaction between object, representamen and interpretant in human-computer-interaction puts the signification into place.

The question is how iconic, indexical, and symbolic signification is used in interface design and in which forms they occur. Nadin gives the example of a virtual calculator that can be represented in all three forms – from an iconic representation of a physical calculator to a symbolic representation of the mathematical operations of calculating. In tangible UIs, the physical dimension comes into play and expands the realm of signification. The relation between object, representamen, and interpretant changes as there is no physical object being represented, but rather a function or action that is represented by the interface. This representation is actualized through the process of usage.

Signification in Tangible UIs

Iconic representations can be found in mappings based on *resemblance.* The icon resembles its representation in a certain way, although it can be an abstraction like we learned it from Peirce's example of the geometrical figure. When we look at Graphical User Interfaces (GUIs), we encounter some common examples of iconic representation, like e.g. the trash bin for the function of 'deleting files'. For TUIs, it is much harder to find examples as we are facing physical representations of virtual concepts.

In the LucidTouch project, Wigdor et al. (Wigdor, Forlines, Baudisch, Barnwell, & Shen, 2007) introduced a 'pseudo-transparent' device that displayed the user's fingers, interacting at the back of the device, on its display. The fingers on the device's back are filmed by a camera, and then shown on the display, as for enabling them to be used in the interaction with the GUI. The interaction with the device is, as the Wigdor et al. demonstrated, intuitively understandable, flexible in terms of its applications, yet limited to 'fingers represented by fingers'. The signs on screen resemble the fingers that touch the back of the device, and therefore, we can call it an iconic representation. In this example, we see a hybrid interface being a GUI with graphical display, and at the same time a tangible interface, because of its rich integration of the fingers into the virtual space (on the screen).

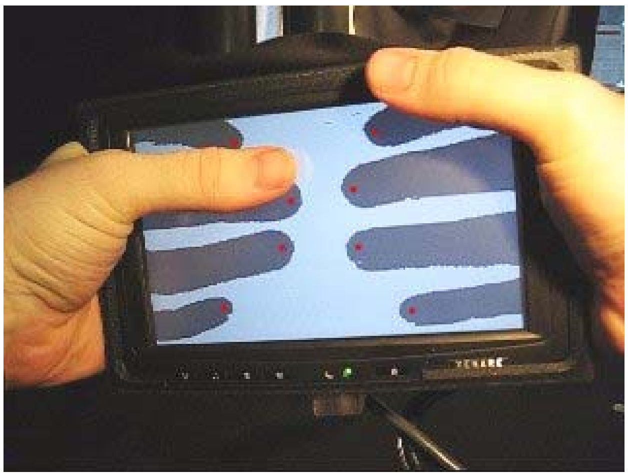

Fig. 2: The LucidTouch device.

Indexical representations can be observed in devices that draw on a *causal relationship* between digital entity and physical counterpart. In the FeelSpace project (Nagel, Carl, Kringe, Märtin, & König, 2005), Nagel et al. augmented users' perception with 'orientation information, obtained by a magnetic compass, via vibrotactile stimulation around the waist'. Here, the vibrotactile stimulation indicated the direction of north.

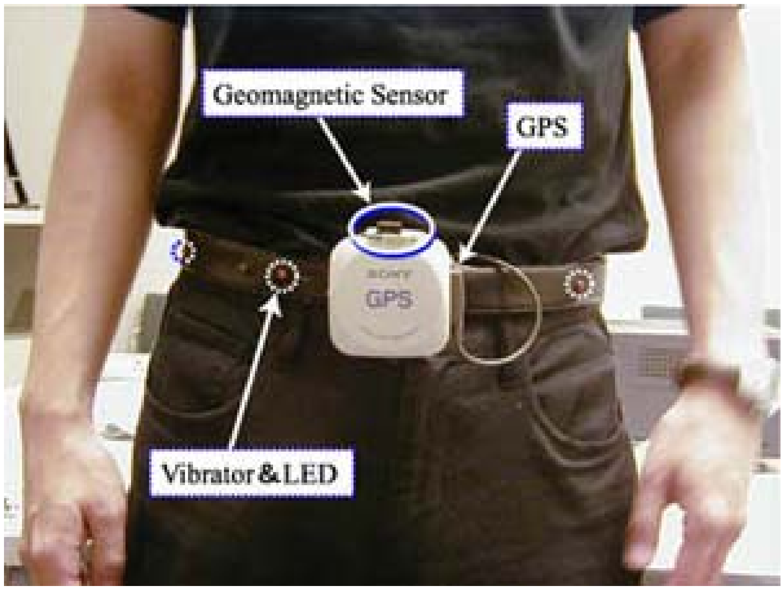

Fig. 3: The FeelSpace belt.

The actual digital data (zeroes and ones, respectively magnetic measurements data) is not represented in an iconic way here. Rather, it is interpreted, brought into connection with the belt's orientation, and then *linked* to a vibration into the direction of north. Therefore, we find an inherent link between the information and its representation within the TUI, an indexical representation. This kind of interpretation and reduction to a simple physical signal can be found more often in tangible interfaces. As the output channels are in many examples primarily used to provide a physical cue about the digital contents to the user, the representation is indexical. The model therefore is to have an output signal to the user that s/he can perceive in a haptic manner

Symbolic representations can be of use in many encoded physical representations. The *Marble Answering Machine* by Durrell Bishop (1992) is an example for such a type of representation. Here, a marble represents a message left on an answering machine. The user can interact with this object: Putting the marble into a hollow plays back the message. In this example, we find a *symbolic representation* of the digital content – a left message – that is translated into a tangible object, a marble. This mapping is not inherently obvious, as the data entity 'message' does not relate directly to the concept of 'marble'. In this symbolic representation, two semantic fields are connected that were separated before: a voice message that is related to the functionality and logic of an answering machine and to the usage of phones in general – and the marble, that is associated with child play.

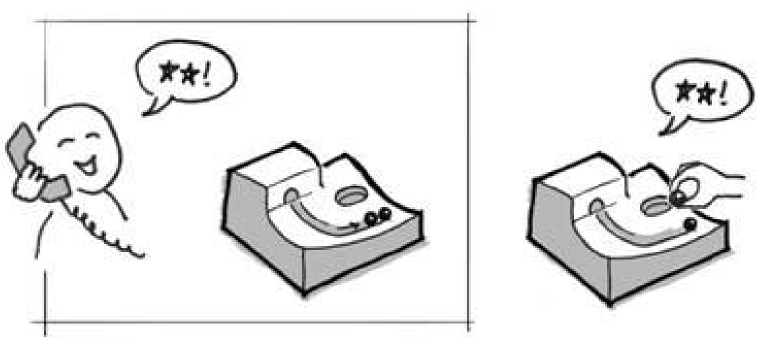

Fig. 4: The marble answering machine

Connecting these two fields adds a new semantic to both. The small, tangible children's toy gets an added functionality by representing a virtual voice message. The interaction with the marble still resembles the one of the children's toy: dropping it into a hollow, making rows of marbles, quite handy and easy. Therefore, this signification adds on the one hand a tangible interaction mode to a virtual message; on the other hand it applies the emotional value of a playful interaction to an answering machine. It should be noted that there is also an indexical component in this representation: The number of marbles 'waiting' on the device represents the number of messages waiting inside. In general, one finds often examples of a combination of different types of representations. As in the example of the answering machine, there are different layers of signification that form together the semiotic structure of the interface.

For now, we discussed examples for all three kinds of representation following Peirce's model. Therefore, we focused on the relation between a function and its semiotic translation within the interface. We discovered a higher degree of complexity in the semiotic structure of the three examples: an iconic and 'direct' representation of the user's fingers on the display; a tangible output signal representing certain information about directions; and a symbolic representation of missed calls adding a new layer of semantics to an answering machine.

In the following, we will draw on a case study of tangible UIs on mobile phones. We compare three different mappings for the same application: Displaying a new event on a mobile phone.

Case Study: Three Examples of Representation

We will now analyze from a semiotic point of view three research projects that we conducted in the past years: The *Dynamic Knobs* project (Fig. 5a), which employed an *indexical* representation, a project named *Weight Shifting Mobiles* (Fig. 5b), which also followed an *indexical* approach, and the *Ambient Life* project (Fig. 5c), which drew on *symbolic* representation.

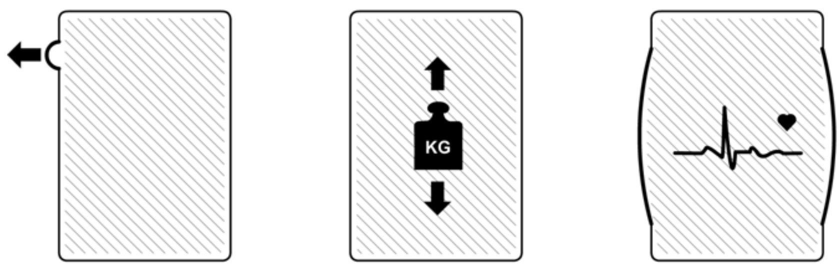

Fig. 5a-5c: Three prototypes, utilizing different means of user notification.

Dynamic Knobs: Indexical Representation

In common UIs of mobile phones, an event (e.g. new text message, missed call) is indicated on the display (GUI) as well as through a signal (vibration, ring tone). In the Dynamic Knobs project (Hemmert, Joost, Knörig, & Wettach, 2008), we utilized a physical representation of the mobile phone's internal events on its physical surface. A new event would result in a knob dynamically extending out of the phone's casing. Hence, the physical device itself changes its shape according to a change of status. The user can perceive an event in a tangible way by touching the physical shape of the device. The knob, a small entity sticking out of the rectangular shape of the phone's device, expands itself triggered by the internal event.

Fig. 6: The Dynamic Knobs prototype.

The principle is implemented through a servo motor in the phone's casing (Fig. 6), which moves a button out of the phone's case. On its surface, a pressure sensor is placed in order to measure the force exerted on it by a finger. The servo is strong enough to withstand most pressure a finger can exert, and the pressure sensor can measure weights between 10g and 10kg.

As soon as a call has been missed, the knob is extended out of the phone's casing. Therefore, we drew upon an indexical relation between an event (a missed call) and its representation (the physical knob). We argue that there is a physical relation between the sign 'protruding knob' pointing to the missed call (the event). Through interaction of the user by e.g. pressing the knob to listen to a voicemail, the sign is constituted. This interaction between tangible UI and user sheds light on the role of the interpretant. Through his or her interaction the process of signification is completed and the signs relates to its semantics.

This interface allows for direct interaction with the underlying virtual entities. In this particular example, the *being-there* of the message is particularly important, as its representation physically stands out of the phone's casing. Physical pressure can be applied to the – otherwise virtual – text message, like we discussed in the example of the marble answering machine. In further implementations, the length of a voice mail message was mapped to the length of the extended knob, so that the message could be 'squeezed' out of the phone while holding it next to one's ear. In this signification we find again a strong physical relation between sign and event when mapping the length of message with the extension of the knob. An indexical mapping with a physical representation allowed for convenient interaction with the digital content as the user had a direct hint how to interact with the interface.

User reactions

We conducted an informal user study with 6 users (2f, 4m, Ø32.2 yrs.), presenting them the prototype and asking them for their impressions. When confronted with this system and explained the concept of physical representation, they understood the pop-out knob as a *logical* representation of the digital entities. The approach was facing issues, however, when *more* than one event should be displayed, also *more knobs* would be required, as would other types of physical display for other types of virtual contents. Users emphasized that the principle proposed was *easily understandable*, yet *limited in its extendibility*. Nevertheless, the indexical representation was understood by most participants intuitively as being a reference to physical interfaces. Therefore, the signification seemed to be appropriate for the purpose.

Weight-Shifting Mobiles: Indexical Representation

In the second project, Weight-Shifting Mobiles (Hemmert, Hamann, Löwe, Wohlauf, & Joost, 2009), a moving weight was explored as a means of display in mobile phones. In one application, a new text message is displayed through the phone's centre of gravity being moved to the top of the screen. The message's placement inside the phone is physically *simulated*.

Fig. 7: Weight Shifting Mobiles Prototype

The proposed prototype employs a weight on a servo motor, which is affixed on the inside of a box. This weight-actuated box is then mounted underneath a mobile phone, which serves as the screen and button means for the 'weight actuated mobile'.

Interacting with a mobile device that employs an actuated centre of weight involves fine sensitivity for how the device *feels* in the hand. Its kinaesthetic behaviour changes with a moving centre of weight, and so, often, the information is perceived only in an ambient way, a circumstance that fitted the system's character of a non-visual information display. The event, e.g. a text message on the mobile phone, is signified in an indexical manner as it relates to a physical weight and location. A virtual event is therefore mapped to physical space and gravity. Interacting with the message, e.g. accessing it or browsing through a list of messages is assigned with physical parameters that are related to the interaction. This indexical mapping suggests a tactile sensing of navigation as well as a physical space and gravity of the mobile phone's informational space.

User reactions

A user test with 12 users (5f, 7m, Ø25.2 yrs.) was conducted. Users were engaged in a study regarding the accuracy at which they were able to estimate the weight's position, and also in a semi-structured interview that assessed their experiences. They appreciated the subtleness of the approach – they would be displayed additional information non-visually, yet perceivable while interacting. The idea of *information with weight as a sign of presence* in the device was considered intuitive, and was easily integrated with the users' interactions. However, users asked for *more realism* of the same interaction, e.g. to move the weight around in the phone by tilting it, instead of through the usage of buttons.

Ambient Life: Symbolic Representation

In the Ambient Life project (Hemmert, 2008a), a mobile phone is augmented with a permanent tactile heartbeat. Other iterations of the system (Hemmert, 2008b) included a 'breath'-like deformation of the phone's casing, following the same 'life-like' principle. In case of a new text message, the phone's heartbeat would then switch from the normal 'calm' heartbeat to an 'excited' pattern. This draws on the assumption that humans are inherently well-trained in the perception of life. It uses a *metaphorical signification*.

Fig. 8: Ambient Life Prototype

In the prototypes, the breathing is simulated through a servo motor that moves similar to a lung in a corpus. The heartbeat, as a second application, is simulated through a regular vibration motor, which is common to many current mobile phones on the market. The prototype of a mobile phone proposed in the 'Ambient Life' project informed the user about its state through instinctive cues. Interacting with it may, at first sight, be compared to interacting with a living being like a small animal. The metaphor would be a 'hamster in the pocket', as it simulates the mobile phone to be a living being, especially with an occasional need of attention. However, it is controlled through buttons and menus – not, as a real 'hamster' would – empathically, through touch and voice. It is, besides the pulse, purely technical. Therefore, the signification is symbolic as it maps two separated semantic fields – the one of living beings and its bodily functions and the one of virtual events on a mobile phone. The concept behind is to draw upon human ability to sense living being in an ambient way, like subtle breathing or heartbeat, and using it to inform about the status of a technical device. This mapping reminds of the children's toy 'Tamagotchi' from the 1990s were the user had to take care of a (non-functional) device like it would be a living being. This triggers a higher emotional involvement as it links to personal relationships in the real world. This prototype of 'Ambient Life' was, being a research prototype, not meant to explore new features of mobile phones for market use, but rather should trigger discourse on the question about our relationship to mobile devices today.

User Reactions

In a study, users (3f, 4m, Ø 27.1 yrs.) were handed the device and asked to carry it for two days. The phone randomly switched from 'calm' mode to 'excited' mode randomly several times per hour between 9:00 and 19:00. Users were instructed to 'take care' of the device, calming it down through a button press whenever it switched to 'excited' mode. The reactions to the heartbeat-augmented phone were mixed: In general, all users introduced to the phone fell into one of two groups: They would either perceive the device as 'cute', or perceive it as 'disgusting' – interestingly, none of the users was emotionally untouched by the device (which might have led to a perception of 'just a rhythmic vibration pattern'). The usage of the instinctive cue of the heartbeat allowed for a metaphorical *projection* of the phone into an *emotionally rich* context: living beings that need to be taken care of.

Along with that projection, it emerged that users *assumed more* than the functionalities that were actually implemented. For example, they assumed that the phone would be 'hungry', 'lonely', or 'in the need to be spoken to and caressed' – they attributed pet-like behavioural components (in this case: basic needs and emotion) to the phone.

Discussion

Analyzing different tangible UIs we formed the hypothesis that an iconic representation is hard to find. This is true due to the fact that there is always a semiotic translation between actions and physical representation within the interface. Therefore, an iconic representation based on resemblance is not likely to be implemented in TUIs. This category might be better applicable to GUIs – but this is a tentative finding that has to be investigated further.

In the first example, Dynamic Knobs, a functional event in mobile communication was represented by a physical sign in an indexical representation. Pressing the knob to trigger a function can be defined as an indexical representation, too. The second example, Weight-Shifting Mobiles, shows a physical representation of an action, in a dynamic way. The action of scrolling or navigating in space is represented via a similar movement that involves physical weight and movement. In a way, this representation is also partly symbolic as it attaches a symbolic weight to an operation in digital space. The third example, Ambient Life, is highly symbolic, as it refers to the metaphor of (artificial) life.

All these mappings draw on prior knowledge about conventions of interface design. One of these conventions is representing functions via specified elements like knobs or keys on a device. The indexical mapping applies an inherent logic connection between function and representation as we learned from Peirce’s example of the weathercock. This connection can be logically derived when interacting with a device. Therefore, in the example of Weight-Shifting Mobiles, this mapping is likely to be understood by the users through experiencing the interface. The symbolic mapping, in spite of this, is the most abstract one, where the representation is highly abstract.

Conclusion

In physical interaction design, the mapping between the physical and the virtual needs to be chosen with care – the pointed out semiotic translations can provide a valuable basis for this choice. We see from the discussion above that interface- and interaction design requires knowledge about the semiotic action that comes with it. Therefore, it is crucial to understand the kind of representation that is chosen to represent functionality. We suggest using the three semiotic categories, icon, index, and symbol, in order to describe the communicative function of the mappings that are made. We discussed several examples from HCI that involved different kinds of mappings for different interaction purposes. Further work has to be done on measuring user acceptance for these mappings according to the context of use. Furthermore, the applicability of these categories to interaction design has to be validated through alternative examples from interaction design. For such endeavours, we suggest to consider the aspects of flexibility, inherent logic, emotional richness as well as the necessary prerequisite knowledge.

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Rethinking System Diagrams: from Arranging Components to Organizing Action, Thought, and Possibility

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Abstract

The use of system diagrams has encouraged information designers to tacitly consider the holistic context. However, because the traditional understanding about the nature of systems has been highly focused on the arrangement of components within a static model, users' experience is considered little. The goal of this research is to provide a theoretical framework to broaden designers' conception of the system diagram and enable them to design system diagrams that would prove most effective for different situations, needs, and design problems. Therefore, the key of system diagrams is to understand the relationship of how the system is organized, according to the intent of the designer, the purpose of the user action, and the function of the group. In order to further investigate this notion of a system diagram, we present four kinds of system diagrams where relationships emerge, depending on the following organizing principles: 1) law that holds together individual components, 2) rule that guides decision making, 3) function that supports users' action possibility, 4) condition that facilitates participation in cultural ideals. In addition, we examine numerous system diagrams that have been created in the Domestic Mail Manual Transformation Project by the Carnegie Mellon School of Design and the United States Postal Service. This is a design case study that not only illustrates the role of system diagrams throughout the design process but also identifies four cases of system diagrams according to different goals: structure diagram, pathway diagram, affordance diagram, and vision diagram.

Keywords

System diagram; information visualization; interaction design; design principle; case study

The role of information design has become increasingly important in our society, as people desire to regain their sense of control within an environment of information overload and growing idea complexity. However, many information design products take the approach of limiting people's choice of action rather than supporting decision making with open possibilities for action. For example, when there is an unexpected delay in a bus service, it is not easy to identify the problem and find another bus route if the users are only provided with scattered information. Without having a clear understanding of how the bus service system works holistically, users may not be able to take alternative actions if there is any breakdown in the sequential information initially given to them.

Among numerous approaches to resolve this problem, the use of system diagrams is the only one that allows information designers to tacitly consider the holistic context. There is a need for not only understanding the system itself, but also a need for studying system diagram as means of effectively communicating the system, which is abstract in nature. While the use of system diagram is still a key component in communicating and understanding the holistic structure of an information system, designers often have difficulty in discussing systems as an aspect of their work, even in contemporary discussions of design. Because the traditional understanding about the nature of systems has been highly focused on the arrangement of components within a static model, often the user's experience ends up fragmented and degraded.

The goal of this research is to provide a theoretical framework to broaden designers' conception of system diagrams and enable them to design system diagrams that would prove most effective for different situations, need, and design problems. In this paper, we will study the nature of the system diagram by presenting four kinds of system diagrams, analyzing different examples of system diagrams, and discussing how each mode of thinking is utilized in different needs and goals in the design process.

Organizing Principles of System Diagram

Encyclopedia of Science, Technology, and Ethics defines a system as "a set of distinctive relationships among a group of components that interact with one another and their environment through the exchange of energy, matter, and/or information" (Strijbos & Mitcham, 2005, p.1880). Although system thinking is regarded as dating back to the 1950s, it has been always prevalent in human history. But the big change today, states Richard Buchanan (2001b), is that the focus is no longer on material systems but on the aspect of the human who experiences the system. He further points out that:

> One of the most significant developments of system thinking is the recognition that human beings can never see or experience a system, yet we know that our lives are strongly influenced by systems and environments of our own making and by those that nature provides. By definition, a system is the totality of all that is contained, has been contained, and may yet be contained within it. We can never see or experience this totality. We can only experience our personal pathway through a system. (Buchanan, 2001b, p.12).

Then the question is—how can we possibly design a system diagram, if a system is the wholeness of the totality, and human beings can't experience the whole? In fact, the role of a system diagram is not a mere representation of particular phenomenon or fact. According to Charles S. Peirce, "diagram not only represents the related correlates, but also, and much more definitely represents the relations between them, as so many objects of the Icon" (Peirce, 1906, p.316). In this respect, system diagrams are about relationship.

Here we should not simplify a relationship as mere connectivity between numerous components, but rather take it as an idea or a thought that integrates different parts into a whole, that is, the organizing principle of the system. According to Buchanan, human beings can't see or experience the totality of the system and, therefore "in our effort to navigate the systems and environments that affect our lives, we create symbols or representations that attempt to express the idea or thought that is the organizing principle" (Buchanan, 2001b, p.12).

As the focus of system has shifted from things to human beings, a system diagram should be regarded as a visualization of the organizing principle of the system, which alters system into a *place* that opens up users' action possibilities and supports effective use of the system. In turn, the key of system diagram is more than to *represent* relationship among things. The key is to *understand* the relationship of how the system is organized, according to the intent of designer, the purpose of user action, and the function of group. In order to further investigate this notion of system diagram, we present four kinds of system diagrams where relationships emerge depending on the following organizing principles (figure 1): 1) law that holds together individual components, 2) rule that guides decision making, 3) function that supports users' action possibility, 4) condition that facilitates participation in cultural ideals. (Buchanan, 2008)

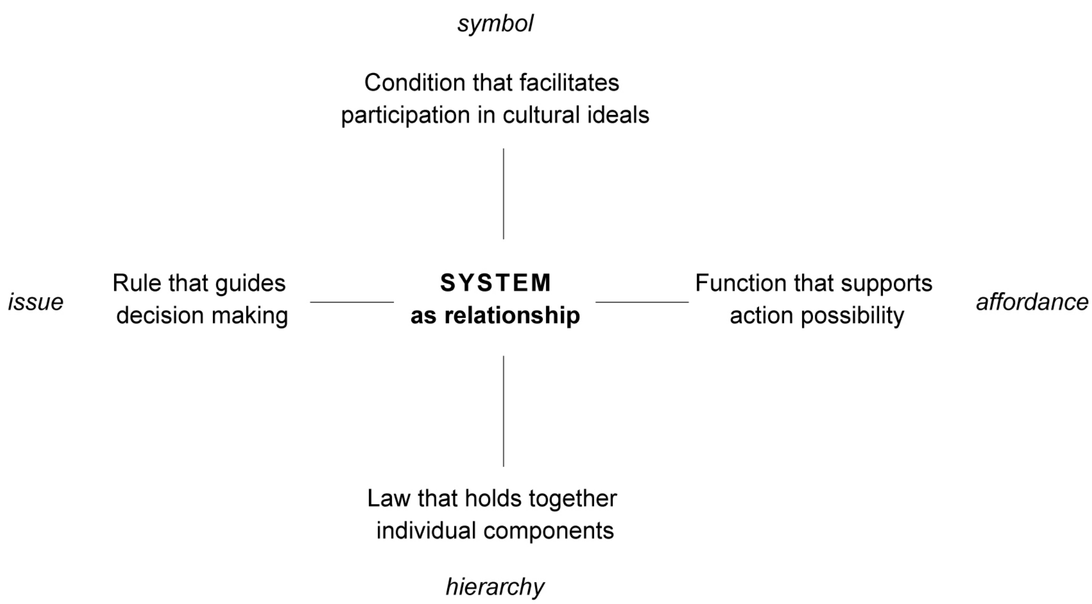

Figure 1. Organizing principles of system diagrams

System as law that holds together individual components

First of all, Herbert Simon's discussion on system gives insight to understanding system as an aggregation of individual components. Simon explains a complex system as "one made up of a large number of parts that have many interactions" (Simon, 1969, p183). As he seeks to find the essential quality of what is this interaction that constitutes the architecture of complex systems, ranging from artificial/natural adaptive systems, social systems to symbolic systems, he finds that the complex system is composed of subsystems and the subsystems are again made of their own subsystems. He sees this hierarchy to be the distinctive relationship among the parts that organize them into a system. As he states that "hierarchic systems have some common properties independent of their specific content. Hierarchy is one of the central schemes that the architect of complexity uses" (Simon, 1969, p184), hierarchy can be explained as a kind of law that serves as objective force that is universally applicable.

Network diagram is one of the representative system diagram that starts from this principle of hierarchical relationship among individual elements. Figure 2 is an example of social network analysis. Similar to a molecule made of electrons, individual people in the network diagram below would be mere elements without the hierarchical relationship visualized by the lines, the distances among people, and the overall positions of people. The repeated hierarchy of who gives order to whom and who belongs to whose command becomes the core organizing principle that holds those individuals together into a system and serves the purpose of analysis.

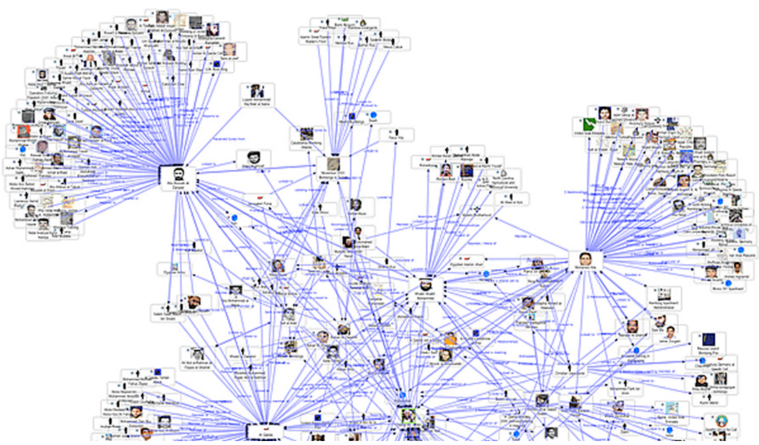

Figure 2. Network (http://www.fmsasg.com/) [1]

The system diagrams in figure 3 share the same element of the celestial bodies from the Solar system. However, the hierarchical law that serves as organizing principle is different in these two diagrams, which yield two different forms. The diagram on the left focuses on the hierarchy of size rather than exact representation of the distance. In comparison, the diagram on the right based on the hierarchy of distance omits the irrelevant hierarchy of size.

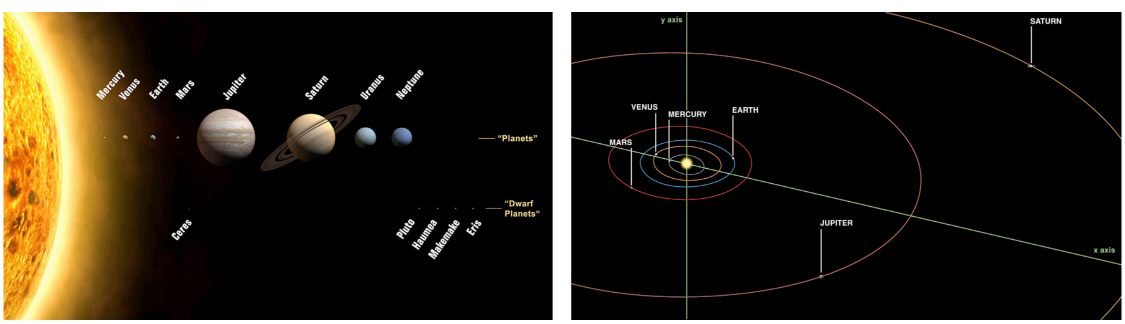

Figure 3. Solar system (http://en.wikipedia.org [2] and http://nasaimage.org [3])

System as rule that guides decision making

The next approach is based on the understanding of system as a set of rules that guide an agent's decision making. In contrast to the first approach that focuses on hierarchy among individual components, the emphasis of this approach is put on the role of the agent in the system, in particular, choices that individual agents can make. This is closely related to the discussion of information system by Kunz and Rittel when they define a system as "constructs of rules and procedures which are meant to serve the desired end" (Kunz & Rittel, 1984, p.57). It is important to note that they bring rules and procedures to their discussion of system. Instead of regarding a system as a piece of hardware that consists of individual components, they are instead interested in the human aspect of system, the agency that operates the system. In this respect, what organizes the second kind of system is rules that are arbitrarily chosen and changeable, not universal laws or truth.

In addition to this concept of agency, it is also important to discuss system as "an argumentative process" that is based on "a model of problem solving by cooperatives." This is articulated in Kunz and Rittel's discussion of an Issue-Based Information System (1970) where *issues* are identified as elements of system along with other elements, such as topics, positions, argument, etc. According to the authors, issues are "brought up and disputed because different positions are assumed" (Kunz & Rittel, 1970, p.2). Therefore, this kind of system leads individuals to continuously make decisions on the issues that are encountered by their reasoning process so that they reach the decision considered the most reasonable among all possible opinions.

One of the most common examples is a flowchart (figure 4). A flowchart is a diagrammatic representation of step-by-step procedures, and each step is connected to the next based on the cascade of issues that arrives at a ultimate solution to a problem. In this respect, flowcharts have been used as a method for problem solving, because they break down the whole process into manageable steps, where issues become focal points that determine the sequence of individual decision-making. Figure 5 is another example of system diagrams that visualizes the lifecycle of EMI Music products and operations. What makes this distinct from other kinds is the use of related environmental issues as color-coded arrows in order to organize key environmental areas, such as manufacturing facilities or music publishing suppliers.

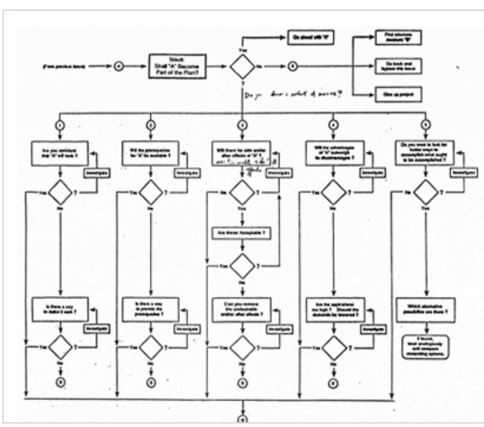

Figure 4. Flowchart [4]

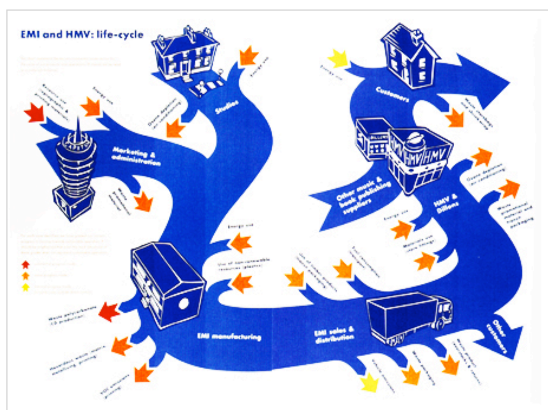

Figure 5. Music product life-cycle [5]

System as function that supports action possibility

The third view is to understand a system as an organic group. This view emphasizes a whole rather than parts, where the characteristic of the whole is lost if mechanically cut into parts. James J. Gibson proposes that human visual perception is not merely a channel but a system that requires all the parts to work together, with explanation that "vision is a whole perceptual system, not a channel of sense. One sees the environment not with the eyes but with the eyes-in-the-head-on-the-body-resting-on-the-ground" (Gibson, 1979, p.205). He further explains that a system has organs, compared to a sense with mere receptors. For Gibson, function is the key relationship that makes an organ a necessary part of the whole, as he states that "the perceptual capacities of the organism do not lie in discrete anatomical parts of the body but lie in systems with nested *functions*" (Gibson, 1979, p.205).

System and relationship in this third approach are especially meaningful within the context of experience design. Experience is our interaction with environment, and environment can be interpreted as a kind of system that supports our action possibility. However, it is not the case that any surrounding can serve as environment for an organism. Following Gibson, the environment and the animal are inseparable because the animal modifies the environment and the environement shapes the action of the animal. Therefore the environment *affords* the animal, in the sense that the environment as the system provides the function of good or bad. Based on this relationship of function, Gibson presents his theory of *affordance*, which can be explained as a necessary relationship of the ever-changing interaction between a living anmial and the environment.

An example of system diagram from this approach could be an airport sign system (figure 6). We may not easily recognize individual signs as affordance until our situation calls for the need to understand the function of each sign and how they work together in holistic relationship, in order to achieve our goal using this sign system. When the action-takers find out the relationship, they realize how the signs and maps in the environment work together just as navigating within a huge system diagram. This is the moment when meaningless pieces of signs are related to other signs together, and a surrounding is altered to an environment that provides systematic supports for action possibilities that are open to their different needs and goals.

Figure 6. Cologne-Bonn airport signage system [6] and map [7]

System as condition that facilitates participation in cultural ideals

The fourth kind of principle comes from the transcendent ideas that gives a unity to individual parts. In this approach to system diagrams, individual elements are still a recognizable, yet harmonious interaction among disparate parts of system and become an integrated whole to serve "a higher ethical, spiritual, cultural or aesthetic vision" (Buchanan, 2001a, p.82). In contrast to the three approaches described above, the distinctiveness of this approach is the emphasis on this transcendent whole. The fourth approach regards system as a condition that facilitates participation in these ideals, such as culture, truth, vision, or beauty, depending on the context and the purpose of system diagrams.

At this point, Kenji Ekuan's discussion of the aesthetics of the Japanese lunchbox (1998) can be useful to articulate this further. For Ekuan, the Japanese lunchbox is not merely a physical assortment of different kinds of food. All the ingredients are artistically arranged so that the visual layout pleases the eyes of the person who takes off the lid. However, the real beauty of lunchbox does not come from the skillful arrangement of elements, but from the harmonious integration of all distinct elements. Although individual ingredients are still recognized in this system, what is more important here is the appreciation of the cultural ideal that gives a unity to parts that otherwise remain separate. In this respect, the Japanese lunchbox serves as a symbol that embodies the cultural and spiritual ideal of Japanese culture. Its form and structure become the expression of the ideas of beauty as function or unification in diversity that is deeply embedded in Japanese culture.

Figure 7 is an example that illustrates this approach – a Tokyo subway map designed by Richard Wurman for the *Tokyo Access* guide (1984). In this map, what is first noticed is the symbol of yin yang along with the Imperial Palace marked as a red circle. When he created this subway map to emphasize the connections of two lines with reference to a familiar landmark, he deliberately altered the form of actual subway lines (left) to the yin yang symbol (right) so as to make it easier to understand and remember. In this example, the use of symbol is effective not merely because it simplifies the form of lines into an easily recognizable symbol. What is more important is that it symbolizes an idea of Japanese culture in its form, which organizes individual functional components (subway stations) into a unified whole (Japanese culture). In this repect, this can be an example of system diagrams that serves an intended function as well as expresses an idea of culture through its form that transcends individual human experiences.

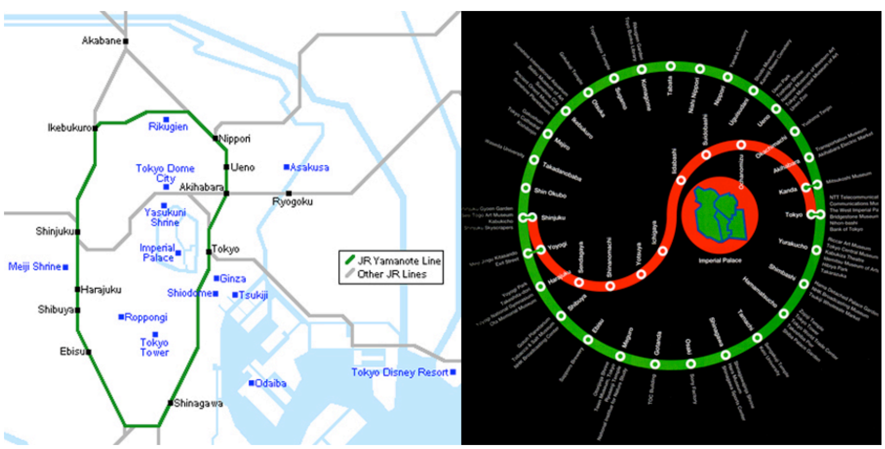

Figure 7. Tokyo subway map [8] and Tokyo transportation system [9]

Case Study: The USPS Domestic Mail Manual Transformation Project

So far we have investigated different kinds of relationships that are found in various system diagram examples. Understanding the relationships of individual components is the key to identify the organizing principle of a system. Then, is it possible to identify these relationships in the context of a design process? If so, what is the primary focus of each relationship in the activity of designing? When designing, system diagrams can be used in various stages of the process in order to serve different purposes of designers using system diagrams. System diagrams can serve as a roadmap at the very beginning of the design process or function as a means of communication with internal stakeholders or with clients during the process. They can also become a final product to inform customers. Although we may point out the distinct characteristic of system diagram examples in different phases of the design process, they can be distinguished one from another depending on the context and the purpose. This also changes the relationship as well as affects its formal representation.

From now on, we will examine how different kinds of relationships emerge in various system diagrams that have been created in a specific design research project. The Domestic Mail Manual (DMM) Transformation Project[1]was an interaction design project that moved beyond the traditional information design approach towards redesign. Similarly to the Australian Tax System design project (Preston, 2004; Body, 2008), the DMM Transformation project focused on designing the information system with a long-term goal of encouraging organizational change in the United States of Postal Service.

The DMM is a 1000-plus-page manual that contains all the mailing standards in the US. It serves as the operational core of a federal agency that employs 800,000 postal workers and supports an industry of more than nine million people. However, this manual did not provide employees and customers the tools to understand mailing options and guidance for making informed decisions because of the complexity, difficulty of use, and inaccessibility of the structure. Therefore, designing the information architecture became the most important concern, especially because the scope of the project did not include changing the actual wording of regulations. Since there was a big discrepancy between the existing topic-based structure and the way users make decisions, "understanding the relationships of the information contained in the DMM was the key to creating a structure that properly reflected the connections and dependencies within the document." (CMU and the USPS, 2005)

For this reason, human-centered design approach became the fundamental principle that guided multiple goals according to different design stages. During the restructuring of the architecture, numerous system diagrams were created to serve various goals. In what follows, we will illustrate four cases of system diagrams according to different goals, to show how the four kinds of relationships we discussed in the previous section are used in an actual design project.

Structure Diagram

One of the fundamental goals of this project was to design a new system architecture that improves efficiency of use. There was also a need to devise a resilient system that could evolve over time. In the initial stage of the project, designers continuously analyzed, tested, and restructured the contents with different versions while working closely with content experts at the USPS to ensure that the details of the structure were

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[1] The DMM Transformation Project (2001-2005) was a research project in the Carnegie Mellon School of Design that was funded by the US Postal Service from 2001 to 2005. (Richard Buchanan, project director; Angela Meyer, project manager)

accurate. Different system diagrams were generated in this process to analyze existing structure (figure 8) and to represent changing architectures. Therefore, we needed a system diagram that focuses on simple and universal hierarchy that would serve as a basic reference point for the ongoing conversation.

After the redesign of the architecture, the team collaborated in fitting the actual content into the new structure. We introduced Adobe Framemaker application because of our concern of how to support the sustainable management of a document with such a complex cross-reference. As time goes by, there would inevitably be a need to change the document as the regulations in the content would be updated. Our solution was to create a working system for the ongoing editing and publication, including software, content, code, and maintenance guidelines, that allows the USPS to continue to develop the DMM. Figure 9 is a diagram of the publishing workflow of the DMM, which was prepared as part of the maintenance guideline. The major relationship depends on the analytical representation of how computer files are co-referenced. When compared to figure 10, which focuses on the architectural analysis, the content does not differ much but the represented relationship does since the need and purpose change. Figure 10 focuses on shape-class-topic hierarchy, whereas figure 9 focuses more on the hierarchy of regulation numbers.

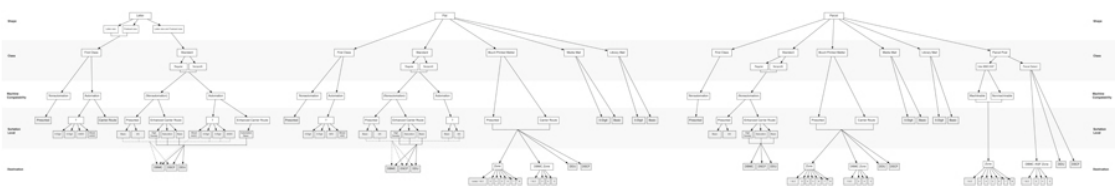
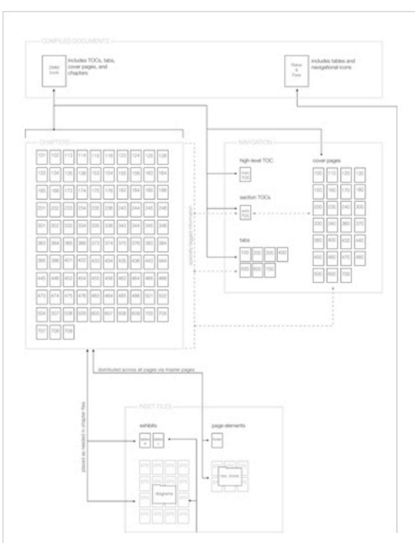


Figure 8. Rate structure analysis



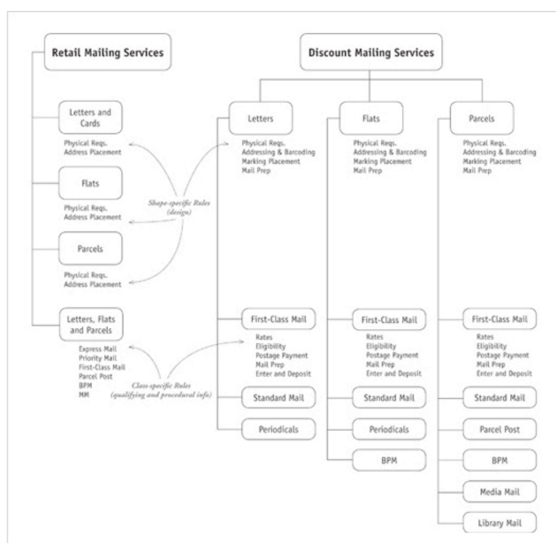


Figure 9. Framemaker file structure

Figure 10. Architectural analysis

Pathway Diagram

Another important goal of the project was "to develop user pathways to help customers find the information that they need in the DMM" (CMU and the USPS, 2005). In order to achieve this goal to guide users to make informed decision, figure 11 was built based on the idea of intuitive user pathways. Here, individual pathways are structured following the logic of decision-making based on cascade of questions that a user would logically ask when trying to decide *whether* and *how* to use the postal service, for instance, "the *issue* of shape" answering the question, "what are you mailing?"

In figure 11, what stands out the most is the connections made by lines with multiple cross-sections that lead to a certain destination, just like subway maps. Selection of this particular form was appropriate not only to emphasize the aspect of pathways but also to serve the intended function of this particular system diagram in the following two ways. First, pathway diagram makes procedure notion apparent so that the connections between modules are recognized as navigable pathways. When transitioning from the phase of redesigning the new information architecture to the phase of fitting the content into the new structure and its detailed adjustment, we needed a new system diagram different from the ones developed in the previous phase. This led us to create a new system diagram for this phase that could promote shared understanding of the team upon the new structure proposed. Second, this diagram was used to manage process and tasks. When we were deconstructing the existing structure of the DMM to fit the content into the new one, this diagram was used to visualize and check the progress as we finished each modules.

This relationship becomes clear when comparing figure 11 to one of the previous iterations for the same purpose (figure 12). In fact, there were some advantages in figure 12 in that the amount of each module and the regulation numbers could be more visible. However, that was not the primary relationship that figure 12 needed to visualize because the idea of navigable pathways that guide decision making process was not apparent. Furthermore, representing each module as book shapes seems to emphasize the materiality of documents rather than the connections between the modules. In a sense, the organizing principle in the figure 12 is closer to static hierarchical organization for structure diagrams.

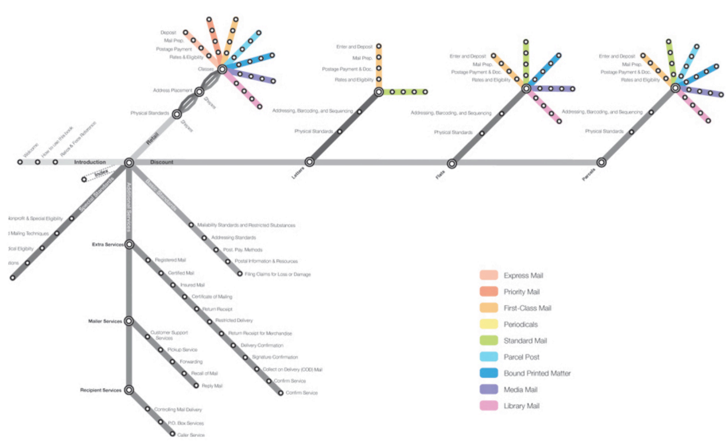


Figure 11. Pathway diagram

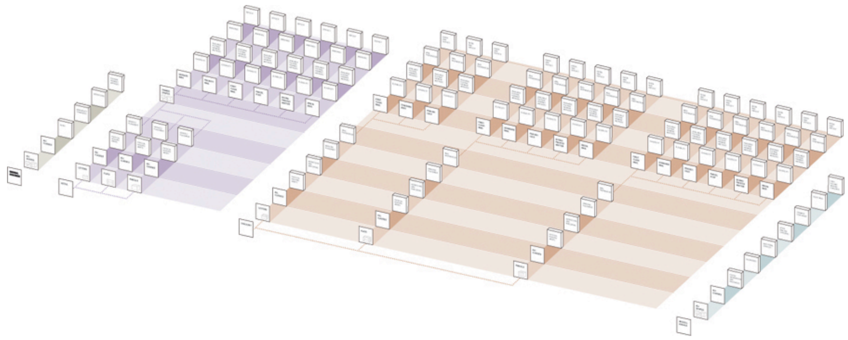


Figure 12. Proposed architecture

Affordance Diagram

Another goal of this project was to create a document that is intuitively meaningful to the user, focusing on an information system that presents the standards from a practical user perspective, that serves pragmatic needs, and is concrete. After we completed the restructuring of the architecture and inserted the content, we realized the need to prepare introductory material for the users. This introductory material was more than just a preface or a table of contents in that the purpose was not just to help the user find certain information. First, as the old DMM has been transformed to the new DMM, there was a need to offer a quick and easy explanation that helped users to understand the difference, and to let them know how to use the new DMM. Second, this introduction material also needed to serve as a promotional piece that encouraged USPS employees to embrace the new document and to educate themsleves.

Figure 13 is the core system diagram that illustrates the document structure of the new DMM. Here, *affordance* is the key organizing principle of this diagram based on the user-centered approach that accommodates users' needs as well as the creation of satisfying user experience by providing intuitive access and a seamless transition. This is articulated in the DMM process book as the following: "A good document architecture does more than just provide categories and arrangements for content. It is designed to create *affordances* for good user experience and is closely informed by users' real needs and expectations" (CMU and the USPS, 2005).

Figure 13 is an example where this relationship of affordance is reflected in various ways. First, it is found in the way the new DMM is physically represented in this diagram. In contrast to other shematic system diagrams, this one imitates the physical aspect of the new DMM, such as the color-coded divider tabs for each section or the binder for the entire volume (figure 14). The idea of a modular approach is also reflected in a similar way to best meet user's needs by modifyng the document. Second, the use of perspective implicitly reinforces this relationship of affordance, in particular by presenting the shape of the new DMM in the moment when opened for use, reflecting users' point of view. In order to use the new DMM, the first step is to assemble the whole documents into a binder for personalzation. This system diagram affords the user's action possibilities for how to assemble this document, not by directly instructing but by indirectly providing one of the major entry points for navigation of the documents. This organizing principle becomes evident when comparing figure 14 to another iteration. Figure 15 may be a more realistic representation of the volumes to some degree, because it shows the hierarchy of thickness of each module. However, this detailed description is not important in the context of user action.

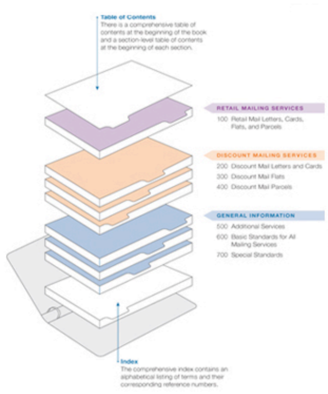


Fig 13. Oganization diagram Figure 14. New DMM's color-coded divider tabs

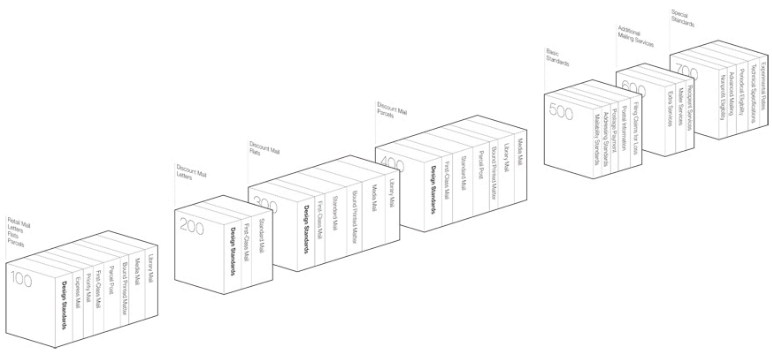


Figure 15. Module system

Vision Diagram

There were specific reasons in our project to encourage the shared vision. First of all, this was an academic project where students were in the continuous process of learning, and the role of the faculty was to stimulate the spirit of inquiry throughout the evolution of the product to create an environment where changing team members can adjust to unfamiliar design problems. The work itself was also complex and fragmented because there were multiple components being developed by different members, and the interweaving of task items required a holistic approach. A clear vision was needed in this process to allow the project to evolve as a whole.

The DMM process book (2005) provides the vision statement as: "the project will design a Domestic Mail Manual that speaks directly to users and tries to meet their needs in the clearest and most efficient ways." This vision of human-centered design remained as the fundamental value and culture in practice that drove the development of process, incorporated diverse people within the USPS system, and facilitated participation in the culture of change. In other words, human-centerdness was not only about the interaction between user and the document. Rather, it was about the culture of the organization that includes internal users, postal employees, and even those responsible for establishing and enforcing regulations. Therefore we needed to share it with the client as well as team members. Moreover, not only was this vision of human-centeredness an ambiguous idea but also was a novel concept at that time, even to the designers who joined the team. For this reason, system diagrams played a critical role in embodying this abstract idea in a visible form to promote its acceptance.

Figure 16 and 17 are examples of system diagrams created for this purpose. Both were made in the early phase of the project and were posted on the wall as roadmaps to maintain our vision. With rich use of symbols which effectively show the perspective and action of users, these diagrams tell the story of mailing as a whole. In comparison, figure 18, which served as the inspirational figure of the project throughout the process, was developed in a later phase when the need to share vision with the client arose. After proposing the initial architecture, we needed to prove that the new shape-base structure would be usable by providing the clients with the first glimpse of what the new DMM would be. The comprehensive nature of figure 18 helped to bring their attention to the high-level organizing principle of "user-intuitive shape" without unnecessary details. At the same time, this diagram sucessfully ensured the client that every piece of information has a logical place within the system, by focusing on the relationship of holistic integrity.

Figure 16. Shape-based framework

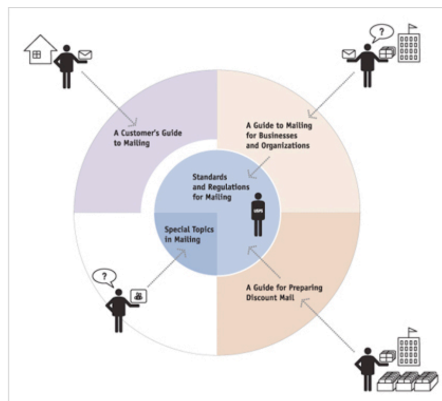


Figure 17. User segmentation and access

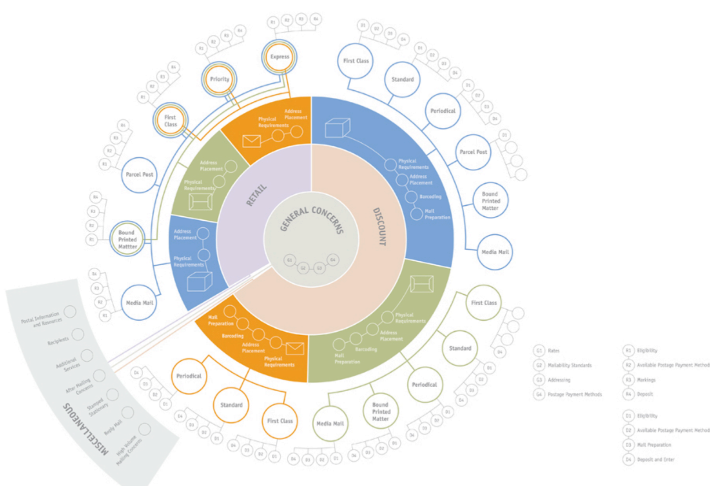


Figure 18. Architectural overview

Conclusion

We have identified four modes of thinking to differentiate relationships with the intention of clarifying the organizing principle of system diagrams. But the purpose of this distinction is by no means to argue which one of the relationship described above is better than the other. All are valuable for advancing the discussion of system diagrams in design and related disciplines. Better understanding of the essence of system diagram will also lead to a shifting perspective from regarding it as a mere data-rich statistical graphic to conceiving it as a place for invention or discovery, depending on various situations.

The situation of use for system diagrams is shifting. The emergence of complex information system, human-centered design, and participatory culture point to a further situational change for how system diagrams will be used, like our case study example. Users are also in need to understand the organizing principle of the complex information system in order to take action. As the problem of design becomes more complex, designers are also facing increased need to work in collaboration with experts from other fields, to bring in clients or users to participate in the design process, and to mediate these different stakeholders' collaborative work. There is a growing need for a system diagram that can work as a reliable reference tool and a shared structure to support group work in such a situation where multiple stakeholders are engaged.

What is needed in this situation is high-level thinking that will help designers foster different modes of thought to utilize designers' reasoning, while at the same time serve as a reference point that guides the direction for designers' reflective arguments. This research will contribute to design education and practice by broadening designers' understanding of the nature of systems, classifying system diagrams used in the design process according to its purpose, and by exploring its potential use for supporting users' action and shared group vision.

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Image Credit

[1] The FMS Advanced Systems Group

[2] The International Astronomical Union / Martin Kornmesser

[3] NASA / courtesy of nasaimages.org

[4] Horst Rittel (1987) The reasoning of designers

[5] Tor Pettersen & Partners

[6] Toan Vu-Hu

[7] Cologne Bonn Airport

[8] http://japan-guide.com/

[9] Richard Saul Wurman

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Conceptualizations of the Materiality of Digital Artifacts and their Implications for Sustainable Interaction Design

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Abstract

In this essay, we report on our survey of the design and HCI literature and other sources we have conducted in order to create an inventory of notions of digital materials past, present and future. We provide some thoughtful speculations and implications for design of digital artifacts with focus on emerging materials based on this survey. Our inventory includes state-of-art technologies and art and design projects covering the topics of organic user interfaces, smart materials, transitive materials, and so forth, as well as theoretical perspectives on materials in interaction design (Blevis, 2007; Löwgren and Stolterman, 2004). We construct design implications to include specific application scenarios of new material and interface technologies based on speculations for each theme of material perception that we uncover in our survey. These include (i) reducing the use of disposable materials—*how to reduce material consumption as personal lifestyles,* (ii) creating mechanisms of innovative, appropriate interaction—*how to reduce energy consumption by means of the use of digital artifacts constructed with new display technologies,* (iii) fostering ownership of sharable resources—*how to promote the feeling of ownership or security in sharing public resources,* (iv) updating things through the use of new materials—*how to renew old objects by adding new technologies instead of replacing them with new ones,* and (v) using materiality for engagement and expression—*how to promote peoples' attachment to artifacts by means of preserving sentiments and histories in the qualities of materials as a critical motivation for sustainable behaviour.* We provide specific examples that reflect on how such themes can foster sustainable design practice with new material and interface technologies by expanding the perception and understanding of the materiality of digital artifacts.

Keywords

design; material; materiality; digital artifacts; sustainable interaction.

As digital technology continues its rapid pace of development and pervades everyday life more and more, it exhibits increasing material effects both in terms of an augmented selection of materials in design practice and material consumption in use. Previous theoretical perspectives in the area of HCI and interaction design have suggested ways to promote sustainable interaction design along a number of dimensions, notably by emphasizing the need to promote renewal and reuse over the invention and disposal of digital artifacts with focus on the material effects of software technology (Blevis, 2007). Very recently, there has been a shift in focus from design for mitigating unsustainable behaviors that lead to climate change to design for adaptation to the likely effects of climate change (Blevis & Blevis, 2010). Sustainability concerns are part of the origins of our interest in digital materiality—nonetheless, our present writing concerns digital materiality directly in all contexts, including a world where resources have become more precious. We introduce the term *resource-conserving interaction design* to stand for both possibilities—a focus on sustainable behaviors and a focus on adapting to changing global conditions.

We are confronting new challenges and opportunities in interaction design especially with the introduction and advancement of new material and interface technologies such as tangible/organic user interfaces (Holman and Vertegaal, 2008), computational composite (Vallgårda and Redstrom, 2007), and transitive materials (Coelho et al., 2009). These new technologies blur the boundaries between hardware and software elements of digital artifacts, transforming the notion of materiality in interaction design. These new technologies require new conceptualization of materiality both in terms of how to use new materials in shaping an interactive object and how to predict its material effects in use. Specifically, as materials of traditional design have significance in determining the range of function, durability or cost of a product (Ashby & Johnson, 2002; Doordan, 2003), new material and interface technologies can also transform the way we design and use digital artifacts with new product ecosystems. For example, the invention of electronic papers might transform the user experience of reading books with new device interfaces as well as the process of purchasing books by eliminating the distribution of physical materials. Another possible example is programmable fashion—forms of clothing that can be updated for style by software means. The scenario of programmable fashion poses a question of how the fashion industry can adapt as the capability of updating styles of clothing becomes available by means of software programming. What is needed is a more developed conceptualization of what we mean by materiality in the context of digital technology. Such a conceptualization can support a better understanding of design potential of new material and interface technologies and appropriate strategies in design practices. Operating under an hypothesis that these technologies could contribute to supporting and promoting sustainable behaviors by transforming the way we use and value digital artifacts, our goal is to explore diverse dimensions of materiality in the context of resource-conserving interaction design.

Based on this background motivation, the present study first introduces a theoretical foundation regarding materials of digital artifacts to understand how materials of interaction design are increasingly different from those of traditional product design. Next, we provide a survey of recent trends of material and interface technologies from art and design projects, based on which the conceptual dimensions of materiality are explored in terms of perception and use of digital artifacts. Finally, we delineate design implications and possible research opportunities in relation to the explored dimensions of materiality of digital artifacts.

Materials of Digital Artifacts

Material is an essential element of design. Specifically, material selection—based on the understanding of physical properties of a variety of materials—is critical in forming aesthetic and functional qualities of an object in design practice (Lefteri, 2007). Moreover, unique symbolic meanings of a certain material based on its social or economic values—as in jewellery or garments—are also something designers need to consider beyond functional qualities of a design. Through the lens of materials, design can be considered as a process of creating meaning with proper materials and applying them to appropriate contexts based on exploratory practice with them. How to choose the right tools and methods to manipulate materials has always been a major issue of design practice. Moreover, materials are not just a given to be incorporated in the designer's calculation, but are a part of design problems (Doordan, 2003). Invention of a new material sometimes brings design innovations and changes our experiences with objects, as seen in many examples such as plastics in modern design (Monem, 2008). Likewise, the advent of new materials in the modern era often poses a new design problem—both in terms of operationalizing new manufacturing process for them (Vallgårda, 2009) and envisioning their social and cultural impact in use—rather than providing a simple solution for what design opportunity is considered.

Recently, designers of digital artifacts are facing a particular challenge regarding design material due to its complex composition of physical and digital qualities. Especially with respect to the software aspect of interaction design materials, Löwgren and Stolterman (2004) described digital technology as *material without qualities,* indicating its unlimited yet undefined design potentials—both aesthetic and functional qualities that designers could realize with digital technology. In other words, the design of digital artifacts is largely open, leaving designers with significant power to shape a future and also with corresponding responsibility. Especially, with advancement of tangible and physical computing interfaces, digital technology may be more seamlessly weaved into physical materials, and thus digital devices may be designed in many forms for a variety of purposes in everyday life beyond work-related tasks in office environments. Initiated by the notion of tangible bits (Ishii and Ullmer, 1997), there have been many studies exploring new applications of physical computing interfaces from product to architecture—as in studies of computational composite (Vallgårda, 2007) and transitive materials (Coelho et al., 2009), to name a few. Starting from the approaches for technical implementation, now the focus of research on tangible and physical computing has moved to design potential of new forms and interactive behaviors of computational objects. For example, Holman and Vertegaal (2008), in the context of human-computer interaction research, envisioned new, organic forms of computer devices by emphasizing three developments in computer technology, namely (i) advances in touch input technologies, (ii) flexible displays, and (iii) Kinetic Organic Interfaces. Brownell (2006), from the perspective of industrial design, highlighted transformational and interface aspects of design materials with enhanced functionality. Likewise, as computational technology is more physically materialized, it holds the potential not only to change forms of computer devices, but also to transform the way we interact with static objects and environments into computational activities. In our present writing, such physicality and forms of digital technology are considered to be main issues of new design materials of digital artifacts. Specifically we question how the development of tangible and physical interface technology can influence on the relationships between people and objects. In particular, we focus on the nature of material impact in use of digital materials that change the way in which people value enduring relationships with objects constructed in part from digital materials.

Materiality of Digital Artifacts

The increasing physicality of computational technology has brought challenges of complex design materials. They call for expanding conceptual dimensions of materiality of digital artifacts in order to predict how digital artifacts designed with new materials can transform user experience as well as social and material ecology. For example, these new materials can provide users with rich sensory experiences (Djajadiningrat, 2004), leading to more attachment to an object and achieving ensoulment or heirloom status of an object (Blevis and Stolterman, 2007). Specifically in terms of sustainability of digital artifacts, Blevis (2007) describes a designerly ethos to promote renewal and reuse over the invention and disposal of digital artifacts as a matter of promoting sustainable or resource-concerning behaviors with focus on the material effects of software technology. This notion has been advanced by investigating critical design qualities of digital artifacts that are loved and ensouled, and thus consequently contribute to sustainable relationship with users (Odom, Pierce, Blevis and Stolterman, 2009). While these approaches are analytical based on design theories and philosophy of material objects, there are also exploratory approaches for new design methods and processes with digital technology by considering social and material impact of design. For example, Bonanni, Parkes, and Ishii (2008) suggest the notion of *future craft* with examples of new design process and examples to more conscientiously include users in the design process through personalized digital materialization. Moreover, by tracking and visualizing material flows in manufacturing and distributing process, digital enhancement of material objects can promote more active sustainable behaviors in producing and purchasing industrial goods (Sterling, 2005; Bonanni et al., 2010).

Broadly speaking, new design materials or manufacturing processes associated with materials can transform the way we design, use, and relate to material objects. In this vein, the conceptualization of materiality of digital artifacts could serve as a lens to strategize design with digital technology considering its material effects in use. We categorized five themes that are related to material effects of digital technology—*disposability, energy consumption, sharability, reconfigurability, and expressive engagement*—by speculating on specific examples from art and design projects.

Disposability: reducing the use of disposable materials

Disposability is one of the most frequently discussed material effects of digital devices. As software technology quickly develops, disposability of digital artifacts is increasing; no matter how durable a device might be, it is easily discarded if its software is out-dated in terms of processing speed or data storage capacity (Blevis, 2007). Interaction designers tend to less care about outside (i.e. shapes, materials) than inside (i.e. software, contents) in designing digital artifacts (Critical Friends of Technology, 2003).

Moreover, digital device tends to be considered as an instance of similar types of other devices—as easily replicable as software programs. For example, BIC phone, a disposable mobile phone was introduced in 2008 with a pre-charged battery and a SIM (Subscriber Identity Module) card so that people can immediately use it by purchasing without a phone contract (Figure 1). This unit actually costs cheaper and is more easily replaceable than most contract-based phones. However, the convenience of prompt availability entails increasing disposability of hardware materials. The company had to deal with this issue by coming up with a recycling program where people can ship the phone back to them when they finished with it. Commodification of digital devices, in many cases, fosters disposability of materials by facilitating manufacturing and disposal process. As material consumption and disposal is closely related to lifestyle issues—specifically how people either embrace social concerns or act with conformity—a conscientious design strategy considering recycling materials need to be considered in close relation to social and cultural as well as economic values of digital artifacts.

While recycling is one strategy for increasing disposability, another possible design opportunity is to deeply appreciate material qualities and craft authentic values of a device. Magnhild Disington, a Norwegian fabric designer, offers an interesting perspective on the design of digital artifacts through her project of furry objects (Figure 2). Applying natural materials like wood, leather and fur to portable electronic devices, she designed unique character and sensory experiences, which can create a greater emotional value within the physical product. This approach questions whether the use of authentic materials in design of digital artifacts can be a solution for reducing disposability of digital devices by endowing them with unique values that cannot be replicated by similar other devices as in fashion design (Svendsen, 2006). Although this may not be the solution for increasing disposability of digital artifacts, it does expand design possibilities in terms of diversified material selection of digital artifacts toward sustainability.

Figure 1 BIC phone © BIC
(Retrieved from www.bic-phone.fr)

Figure 2 Furry Objects © 2009 Magnhild Disington
(Retrieved from http://www.magnhilddisington.com)

Energy consumption: creating mechanisms of innovative, appropriate interaction

More and more, digital devices emphasize the non-physical materials over the physical ones—the physical form factor of devices like the iPhone and iPad reduce the physical materials to their simplicity, for example. Notwithstanding, many visions of digital technology—represented by the notion of calm technology and ubiquitous computing environment (Weiser & Brown, 1995)—require more energy consumption for continuous data sensing and capturing, prompt access, and ambient displays.

Considering, for example, the iPhone compared to an older bar type Nokia phone, much more interactivity depends on the use of the display in a manner, which consumes more power than the traditional phone (Figure 3). At the same time, versatile features and access to abundant information enabled by iPhone prompts more use of it in varying contexts compared to simple features of making phone calls or sending texts of older phones. Of course, these advanced information applications has made our life more convenient. However, in some sense, this technology or business oriented development—as opposite to value-sensitive design approach (Friedman, 1996)—has created additional human needs, resulting in more energy consumption.

Figure 3 Bar-Type Phone with Small Screen vs. iPhone with Touch Screen

There have been many studies to use 'visualization' of energy consumption as a part of user experience to persuade user behaviors to reduce energy consumption in daily life as enumerated in (Pierce, Odom, and Blevis, 2008; Pierce and Roedl, 2008). However, more fundamentally, research on more energy-efficient display technology is in demand with increasing display-centered digital artifacts such as e-papers or OLED (Organic Light Emitting Diode) lighting applications. With the development of organic user interfaces (Holman and Vertegaal, 2008), it is a promising design direction to develop alternative solutions for information display by exploring symbiotic use of natural material properties and their computational enhancement. There are some projects exploring energy-generating interactions that use physical engagement as source of power. For example, Villar and Hodges (2010) developed an interaction-powered rotary input device that sources its power from the physical effort required to operate it. When turned, its circuit provides a temporary power source for an embedded device, and doubles as a sensor that provides information about the direction and rate of input. Such design exploration with new forms and mechanisms of interaction can provide alternative solutions to current display-oriented digital devices by diversifying design opportunities of digital devices.

Sharability: fostering ownership of sharable resources

The development of network technology has enabled ubiquitous data access through online data storage or applications such as google documents, dropboxes, and Cloud computing. Cloud computing is Internet-based computing, whereby shared resources, software and information are provided to computers and other devices on-demand.

In spite of this convenience of data access, some people are uncomfortable working with online documents, without the comfort of knowing that the data resides on their own devices. This sentiment of ownership of actually "having" or "keeping" a digital material in the same manner as physical one may be one of the important issues in relation to feelings of privacy or security as well. In this vein, the vision of Cloud computing provides interesting design questions on how ubiquitous access to data can transform the conceptualization of ownership of a digital device by separating its software contents and physical interfaces.

This vision may help reduce material consumption by enabling public sharing of physical interfaces and display to access personal data. On the other hand, advanced networking technology like Cloud computing might actually foster more instances of physical interface that could be easily acquired and thrown away. In any case, the vision of the new network technology can influence how people own or share physical devices, and design can contribute to shaping a sustainable model to access ubiquitous data considering the aspects of privacy and security as well as sharability of material resources.

Figure 4 Ubiquitous Data Access

Reconfigurability: updating things through the use of new materials

As digital devices often work in connection with other devices, interaction designers now need to consider ecological aspects of a digital device (i.e., compatibility with other devices, upgradability to newer versions) beyond its own functional and aesthetic qualities. From an ecological perspective, it is critical to support reconfiguration of individual digital devices so that they can flexibly adapt to each individuals as a whole system.

However, in many cases, it is still not easy to customize or update physical and hardware aspects of a digital device compared to its software upgrade. This often leads people to have multiple devices with redundant features because subtle differences in physical forms and hardware aspects of each device—i.e., different screen sizes of a desktop computer, a laptop, or a smart phone—exhibit varying contextual affordances in use although technical features of these devices are basically similar with each other (Wortham, 2010). Moreover, digital devices easily become old-fashioned by losing their technical compatibility (not working in connection) or aesthetic commonality (not looking up-to-date) with other newer devices (Jung, et al., 2008). From the perspective of sustainability, it is a waste of resources that properly functioning digital artifacts are increasingly disposed or just left not used.

New design approaches for supporting flexible reconfiguration need to be considered, especially in terms of physical and hardware aspects of digital devices. Advanced material and interface technologies can provide new design solutions, for example, by modularizing software/hardware parts that can be assembled for different purposes of use, by adding new features to an old device for functional enhancement, or by transforming shapes of an artifact for aesthetic refreshment. For example, modu Ltd. introduces a mobile ecosystem where people can choose a new phone as often as they like, constantly taking different forms, functions and designs in a way to satisfy changing user needs, preferences and styles (modu Ltd., 2008). Another interesting example is the concept of transforming fashion by Hussein Chalayan that experiments potential of new technologies applied to fashion design either for functional or aesthetic purposes (Figure 5). In the Flat Futures project, Miquel Mora explored application scenarios of digital paper (Figure 6). With the concept of *objects wearing technology* in forms of interactive, dynamic digital paper, he envisions new ways to add or modify technical features with materials that are easy to handle.

Likewise, the advanced physical computational technology can envision new design scenarios of “programming hardware like software”, by transforming physical forms flexibly according to different contexts or purposes of use. With this potential, designers can more actively materialize ecological aspects of digital devices by blurring lines between objects.

Figure 5 Transforming Fashion © 2007 Hussein Chalayan
(Retrieved from http://www.husseinchalayan.com)

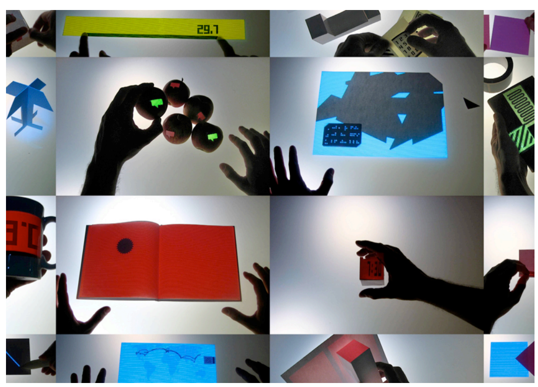

Figure 6 Flat Futures: Exploring Digital Paper © 2007 Miquel Mora
(Retrieved from http://www.flatfutures.com)

Expressive engagement: using materiality for user engagement and expression

Touch screen interfaces, blurring the boundary between interface and information, have brought many benefits in terms of simple and intuitive interaction from direct manipulation as well as portability by merging physical and digital elements of a device. However, aesthetic qualities of form or tactile feeling have been relatively less considered in the design of digital artifacts, although people are very sensitive at perceiving subtle differences of such qualities.

Tactile properties of an object, affording rich sensory experiences and bodily engagement, can serve as an essential motivation for users to interact with and to feel attachment to an object. Upon the increasing priority of efficiency or functionality of digital devices, interaction designers need to more seriously consider how the corresponding trend of simple and minimal design will influence the relationship between user and device and what qualities of interaction will be lost or gained from such design beside function-oriented simplicity. For example, the concept of e-paper devices has many benefits to reduce the amount of paper consumption, but sensibility of physical books is still left as critical design challenges to overcome for popular use of digital paper.

With increasing design potential of physical computational technology, tactile/sensory qualities can be further explored in a way to build intimate and affective relationship between user and object. Physical properties of materials—how they invite user engagement or how they reflect the history of use (Figure 7)—can provide meaningful insights to interaction design, especially to explore diverse form properties of computational materials. Such design exploration with new computational materials can eventually contribute to increasing the feeling of attachment to an object by empowering users to more actively expressing their emotional conditions or personal identities through of an interactive object (Ahde, 2007; Webb, 2005).

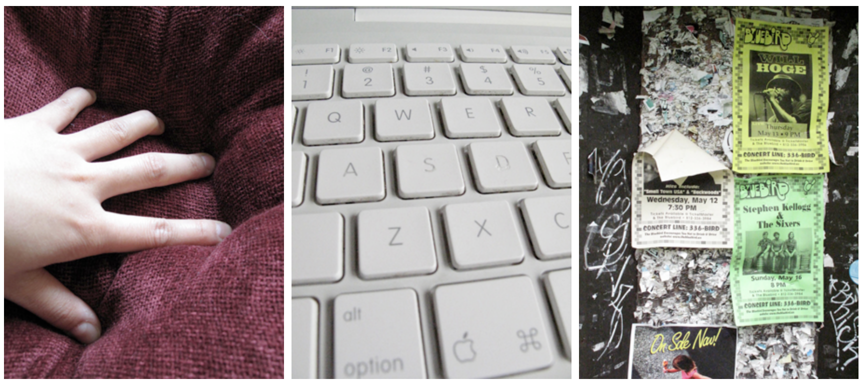

Figure 7 Physical Materials Inviting User Engagement or Reflecting History of Use (from left to right: soft cushion, worn keyboard letters, and message board)

Implications for Sustainable Interaction Design

As briefly introduced above, the materiality of digital artifacts is becoming more complicated due to its dynamic computational properties. As if traditional product design underlines the understanding of physical qualities of materials, the conceptual dimensions of material effects of digital technology could help designers calculate functional and aesthetic qualities of a digital artifact as empirical design knowledge. Considering interaction design material as a composition of both technical artifacts and social systems, we attempted to strategize design with new digital materials—particularly physical computational materials—speculating on their material effects in sustainable use of digital artifacts. In particular, our interests include, but are not limited to, questions on how tangible or physical computing interfaces would transform the relationship between user and digital artifacts from longitudinal and socio-ecological perspectives, how they could achieve or would lose certain design qualities compared to the interaction with non-digital artifacts, and how designers could strategize design with physically enhanced computational technology to promote sustainable interaction.

Based on the review of specific examples and design scenarios, we have described five themes of material effects of digital artifacts—*disposability, energy consumption, sharability, reconfigurability,* and *expressive engagement.* These themes are not mutually exclusive but closely related to each other. Each of the themes suggests a corresponding design implications and research directions in the service of sustainable interaction design and resource-conserving interaction design—specifically (i) reducing the use of disposable materials: *how to reduce material consumption as personal lifestyles,* (ii) creating mechanisms of innovative, appropriate interaction: *how to reduce energy consumption by means of the use of digital artifacts constructed with new display technologies,* (iii) fostering ownership of sharable resources: *how to promote the feeling of ownership or security in sharing public resources,* (iv) updating things through the use of new materials: *how to renew old objects by adding new technologies instead of replacing them with new ones,* and (v) using materiality for engagement and expression: *how to promote peoples' attachment to artifacts by means of preserving sentiments and histories in the qualities of materials as a critical motivation for sustainable behavior.*

The themes and implications in this essay are to explore design and research opportunities regarding sustainable interaction design with digital materials by questioning and speculating on the material effects of computational technology, instead of offering prescriptive solutions for sustainable interaction design. Further investigation for each theme needs to be followed for practical application of the implications described above.

Conclusion

In this essay, we introduced a theoretical foundation regarding materials of digital artifacts by comparing them to materials in traditional product design. Our survey of recent material and interface technologies described specific art and design examples in order to conceptualize the emerging material qualities of digital artifacts in terms of their material effects in use. As an overall observation based on this survey, we found that there is a need for interaction design and HCI research to pay more attention to the ongoing rapid and dynamic development of new physical materials. It is clear that these new materials bring potentials for new forms of interaction design where the physical is merged and blended with the digital.

The qualities of digital materials—including *disposability, energy consumption, sharability, reconfigurability, and experiential qualities (expressive engagement)*—suggest that there exist corresponding design implications for sustainable interaction. Application of these implications to interaction design practice requires more research from different disciplines, but the lens of materials helped us have a broader view of how to design with digital technology considering its material effects in terms of sustainable interaction. We argue that the future of sustainable interaction design is partly to be found in the exploration and examination of new materials with the aim to find new approaches suitable for resource-conserving interaction design.

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Motion Design for Nonverbal Communication with a Humanoid Robot

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Abstract

In the near future, humanoid robots will act as the partners of human beings in daily life. Among numerous human-like competencies, motion of humanoid robots is critical for providing humans with richer interactions with such robots. Motion plays an essential role in complementing spoken communication. Moreover, the motions of humanoid robots generate nonverbal communication in various contexts. Through this nonverbal communication, humans can interact with robots not only directly but also indirectly or even unconsciously, as if the robot were simply part of the environment.

Before the developments of humanoid robots, embodied conversational agents (ECAs) were introduced as virtual embodied representations of humans that communicated multi-modally with humans and there has been a great deal of research on ECA behavior. ECAs and humanoid robots share many features in terms of how they communicate with humans. Nevertheless, simply adapting knowledge gathered from current ECA studies to a humanoid robot study is insufficient for the following reasons: 1. ECA studies lack knowledge focused on nonverbal communication, which has become more important in the physical world; 2. ECA studies have focused on developing agent-centered intelligence rather than a user-centered experience; 3. ECA studies have developed logics to generate motions automatically rather than to provide designers with the practical knowledge necessary to design desirable motions.

Motivated by these three arguments, we seek to pioneer a new field of motion design between robot engineering and design discipline. To bring this motion study into design discipline, we focused on human-centered experience through nonverbal communication with a humanoid robot. This paper aims to outline sharable user experience in order to help designer create desirable motions for humanoid robots in various speechless contexts.

Keywords

motion design; nonverbal communication; humanoid robot; sharable user experience

Recently, personal computers, digital gadgets and even home appliances are being designed to speak to the user. Product designers consider more anthropomorphic approaches in order to design our daily goods in an intuitive and interesting way, which is closely related to the trend of robotizing. The boundary between robots and products is blurring. Still, robots are superior to other products in one area: motion. The movable body parts of robots can provide higher pleasure beyond usability or intuitiveness. The humanoid body may be the best strategy to resonate human experience. There have been plenty of gesture studies on virtual characters, or embodied conversational agent (ECAs), however, not many of these studies have attempted to infuse ‘soul’ into such entities in terms of user-centered experience. Therefore, it is necessary to establish such design knowledge to support designers who wish to create desirable experiences that users will want to have, enjoy and share. The following chapter will identify the trends and limitations of previous studies on motion-based interaction with humanoids in order to verify the necessity of a user-centered perspective in motion design.

Review of related work

ECAs can be regarded as the ancestors of humanoid robots, as they have similar body features for human-like communication. Research on ECA behavior has influenced the behavior of robots. The most typical approach focuses on the relationship between verbal language and behavior. Cassel et al. (2001), for example, developed the 'BEAT: Behavior Expression Animation Toolkit' system to generate ECA behavior by extracting linguistic structures of text. For more natural synthesis of motions, Kipp et al. (2007) analyzed a number of gestures from human actors and applied them to the ECA. It is basically possible to transfer the behavioral algorithms from ECA research to humanoid robots. Kushida et al. (2005) tested the knowledge-link between those two lines of research and noted the additional benefits of a physical humanoid robot. Kidd and Breazeal (2004) explained the superiority of a physical robot in terms of providing better absorption, interest, credibility and dependency than ECAs.

Despite all of these connections between ECAs and humanoid robots, simply adapting knowledge from current ECA studies to a humanoid robot study is insufficient. First, ECA studies deal with the virtual world, not the physical world. Second, ECA studies have a tendency to develop agent-centered intelligence rather than a human-centered experience. Third, ECA studies have developed logics to generate motions rather than to provide designers with practical knowledge to design desirable motions. Regarding the first argument, some of the studies mentioned above have tested the possibility of knowledge-transfer from ECAs to physical robots; others have tried to emphasize the superiority of real-world-based interaction compared to virtual interaction. However, those benefits of the physical robot cannot be achieved unless we consider that physical robots share space in humans' daily lives. Humanoid robots cannot be hidden even when they have to remain 'nonverbal' for a large period of time. Therefore, nonverbal communication should be properly managed in terms of motion design to avoid damaging the entire human-robot interaction (HRI) experience. With regard to the second argument, developed algorithms and markup languages have dealt with generating automatic behaviors according to ECA speech. Many of these approaches have focused on developing the communicability of the ECA in an artificial intelligence (A.I.) sense. However, we also need to approach the quality of the experience from a user-centered perspective. Considering the third argument, previous studies have developed the better algorithms that cause an agent to perform motions for proper interactions with humans. Many of these studies created systematic logics by conducting literature studies, taking observations, performing experiments or even capturing humans' motions. Nevertheless, their final outputs, markup languages or the agents themselves seem to be complicated for direct use by the motion designers. We anticipate that the user-centered approach could provide designery insights to overcome all three of these limitations.

Nonverbal communication *gestalt* through humanoid motion

As reviewed in the section on related work, nonverbal communication is also critical for the overall HRI experience, and thus practical knowledge for the design of humanoid motion needs to be established. This chapter provides a baseline from which to apply the user-centered perspective to nonverbal communication with humanoid robots.

Human body and nonverbal communication

Relative to verbal communication, nonverbal communication has a closer relationship to the human body. Every language transfers messages on a certain level. Humans have developed verbal language as a social protocol for clearer and more effective communication. On the other hand, within our daily lives there is a higher proportion of time in which we remain nonverbal. Though we can stop speaking, we cannot stop communicating because the body is always in motion (Goffman, 1963).

Nonverbal communication generally means 'nonverbal and non-vocal communication' in which the mouth is not used to generate linguistic words or sounds. Semiotics for nonverbal communication assumes that the human body can function as the *signifiant,* the medium of communication, and studies how the human body performs symbolic functions or may even unconsciously influence other humans (Poyatos, 1976). Gestures, body language, kinetics, signals, gaze, tactile communication and proxemics are related to nonverbal communication (Kim et al., 1998).

Successful communication requires a consensus between both parties of the communication. According to Argyle (1975), nonverbal communication can easily be one-sided; nevertheless, as Goffman observed, we never stop communicating because our bodies never stop moving. Considering the intention of the sender, the perception of the receiver and the influence on the receiver, there can be 6 patterns of nonverbal communication, as shown in Table 1.

	Intention of sender	Perception of receiver	Influence on the receiver
1	O	O	O
2	O	X	X
3	O	X	O
4	X	O	O
5	X	X	X
6	X	X	O

Table 1 Patterns of nonverbal communication

The first case is the most ideal nonverbal communication, in which the sender and receiver share intended and perceived meanings. On the other hand, the second and fifth cases are not truly communication, because communication assumes interaction. However, the third and sixth cases are different from the first, second and fifth cases. Although the receiver does not fully understand the sender, the motion of the sender influences the receiver, regardless of the sender's intention. In brief, nonverbal communication may occur at various levels of concentration and communicator interaction. Nonverbal human motion may sometimes communicate only a small piece of information, such as 'I am alive,' or may even communicate nothing at all. Some motion can be reinterpreted from the receiver's perspective. In that sense, nonverbal communication is similar to art, which communicates sharable messages where reinterpretation according to the different experiences of the audience is partly expected.

Nonverbal communication Gestalt

Motion design for a humanoid robot is different from teaching motions to a human. Designers have to design all motion details for the robot, because even unconscious motions, which express the minimum lifelikeness, are not intrinsic behaviors for robots. To design such motions for a humanoid robot, we need to understand the concept of interaction gestalt. As Lim et al. (2007) explained, "interaction takes on a *gestalt,* a composition of qualities that creates a unified concept, configuration or pattern which is greater than the sum of its parts." In the same sense, Moore (1922) stated, "not simply the whole, but its constituent parts could not survive that destruction of other parts." In such an organic whole the constituent parts have a relation of mutual causal dependence on one another. This study agrees with these ideas of Moore and Lim. First, we separate motion design attributes from the type of nonverbal communication used. However, this approach is not an analytic approach which would issue a formal definition giving art necessary and sufficient conditions or an algorithm for classifying and evaluating its works. Dewey (1934, p. 155) said that such “formal definitions leave us cold.” Therefore, we argue that a set of motion design attributes, the elements of interaction, can be projected as a unified gestalt, by projecting them into a type of nonverbal communication. This study intends to concretely identify the relationship between motion design attributes and nonverbal communication in order to outline sharable experiences to design desirable motions for humanoid robots. We acknowledge the fact that experience is never the same from one individual to another and unique reinterpretation occurs in each instance of communication. Indeed, it would be advantageous for the motion design activity to be wide-open to a varied audience, similar to the way the arts communicate.

Motion design attributes for humanoid robots

A humanoid robot can be defined by its ability to communicate in a human-like manner, rather than its superficial resemblance to humans. Of course, the communicational ability of a robot determines its appearance, and thus robots have come to have similar morphological elements to humans to some degree. Though there is no clear boundary defining humanoid robots, any robots with the proper body elements and motion ability for human-like communication can be considered as humanoids. Because of their human resemblance, the motion design for humanoid robots needs to be carefully considered so users do not develop detrimentally false expectations of the robot’s capabilities (Duffy, 2003).

Dance is gaining in importance as a means of conveying body knowledge: it is perceived as an art form in itself and is becoming the subject of research. Dance study seeks to establish knowledge of how to interpret and produce body motions to sublimate dance as an archive, medium and interface between art and science, which is similar to the purpose of this study. The renowned researcher Rudolf Laban (1988) identified principles of human body movements and systematized the four attributes of movement: weight, time, flux and space. Based on these 4 attributes, we held a workshop to establish sub-attributes. Doctoral students, who had experience in HRI design projects from the industrial design department, participated in the workshop. First, participants brainstormed all of the adjectives that represent motion design attributes for humanoid robots. Next, they watched the 3D animation movie ‘Robots (FOX, 2005),’ which contains a set of well-refined imaginative ideas about how humanoid robots move, to supplement the initial brainstorming. Then, we printed those adjectives on sticky memos for use in a grouping session. Similar attributes were combined and opposite attributes were paired to become sub-attributes of weight, time, flux and space. Finally, we established eight sub-attributes: speed and scale for weight, rhythm and repetition for time, smoothness and accurateness for flux and direction and proximity for space. See the following for descriptions and Figure 1.

A. Weight: indicates the energy of motion. For a humanoid robot, more energy can mean more information or dominance, which is more easily perceived. Weight is proportional to both the speed and scale of motion.

- ***A-1. Speed (slow-to-quick)***: indicates how quickly the humanoid’s body parts move from one point to another. There is a continuous spectrum from slow to quick, which is always a relative concept. However, slow motion is perceptively distinguished from a stopped motion. (Example: Slow beat motion ↔ quick beat motion ↔ trembling motion)
- ***A-2. Scale (small-to-large)***: indicates how wide or long the humanoid’s body parts move from one point to another. There is a continuous spectrum from small to

large, which is always a relative concept. But, a small motion is perceptively distinguished from a stopped motion. (Example: timid hurrah ↔ powerful hurrah)

B. Time: indicates the degree of regularity or tension during a period of time. For a humanoid robot, this attribute can be related to character and emotions. There are two sub-attributes, rhythm and repetition.

B-1. Rhythm (Static-to-Rhythmic): indicates the level of cadence. There is a continuous spectrum from static to rhythmic. Static motion seems to be drier and more function-based than rhythmic motion. On the other hand, rhythmic motion can be perceived as more artistic, as in dance. (Example: greeting by simple nodding ↔ greeting in a Hip-hop style)

B-2. Repetition (Non-repetitive vs. Repetitive): indicates if there is any pattern of motion. Some motions can be performed only one time (non-repetitive), such as tracking something or by direct manipulation from an outside force, while another motion can be repeated as pre-programmed. (Example: continuously facing a moving object vs. rotating the head several times for stretching)

C. Flux: indicates the degree of tension in a stream of motion. For humanoid robots, this attribute can determine how lifelike they appear. There are two sub-attributes, smoothness and accuracy.

C-1. Smoothness (Stiff-to-Smooth): indicates how naturally the trajectory of the motion curves. This is a relative concept within a continuous spectrum from stiff to smooth. In general, static motion is more machine-like and less human-like than smooth motion. (Example: popping dance ↔ waving dance)

C-2. Accuracy (Approximate-to-Accurate): indicates how precise or sophisticated the motion is. This is a relative concept within a continuous spectrum from approximate to accurate. The need for accurateness depends on the level of information. (Example: directing north ↔ pointing at a specific object)

D. Space: indicates the orientation and distance of the motion in a physical space. For the humanoid robot, this attribute can be related to dominance and character. There are two sub-attributes, direction and proximity.

D-1. Direction (Inward-vs-Outward): indicates the directional characteristic of a motion. It can move inward or outward. In general, inward motion is easily perceived as passive or unconscious while outward motion is perceived as active and coming from a dominant character. (Example: shrinking motion vs. blooming motion)

D-2. Proximity (Far-to-Close (vs-touch)): indicates the distance at which the motion is perceived. This is a relative concept within the continuous spectrum from far to close. However, a close motion is distinguished from a touching motion. A distant motion is more difficult to perceive than a closer motion. A short distance between social entities can mean a closer relationship; therefore a touching motion may be the best approach for that purpose. (Example: waving hands from a long distance ↔ waving hands at a close distance vs. shaking hands)

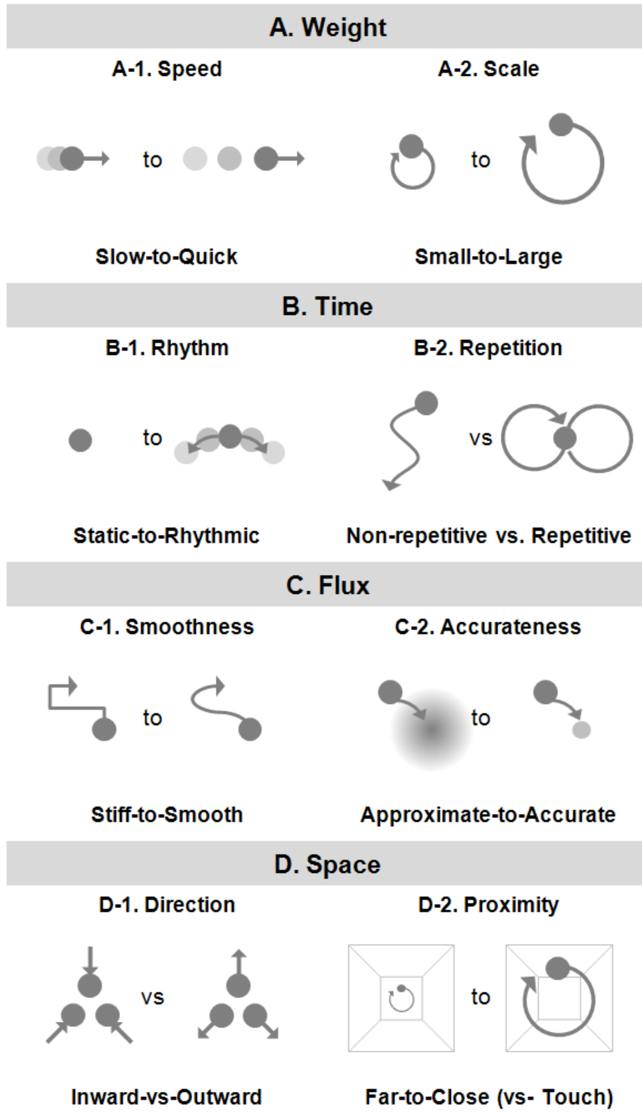

Figure 1 Motion design attributes for the humanoid robot

The established set of motion design attributes are not meant to be deconstructive; rather, we intend to provide them as general set of communication gestalt for humanoid robots. Of course, as these are general attributes, they can be used for other types of robot as well. However, we distinguish the social-oriented characteristics of a humanoid robot within a relationship using the following four types of nonverbal communication.

4 types of Nonverbal Communication Design for the Humanoid Robot

As we saw in Table 1, there are six kinds of nonverbal communication. However, design can deal with only four of them because the second and fifth cases were the result of miscommunication, which is never the designed aim. This chapter explains the four remaining types of nonverbal communication in the context of motion design for a humanoid robot. By considering the intention of the robot and the perception of the human audience, we can imagine the contextual conditions and name the situations as direct, diluted, bridged and ambient nonverbal communication. See the following descriptions and Figure 2 and 3.

1. ***Direct Nonverbal Communication***: This form of communication assumes that both parties of the communication consciously concentrate on one another. Therefore, this is often limited to one-on-one communication. By performing body motions, a humanoid robot can send a message (relatively clearer than the other types of nonverbal communication) to the human audience, which the human tries to understand and respond to, based on what he or she understood. Direct nonverbal communication can be more easily understood within verbal communication. For example, the robot can use symbolic gestures such as sign language, express emotions or even participate in physical contact, such as shaking hands.
2. ***Diluted Nonverbal Communication***: This form of communication assumes a special situation where a humanoid robot tries to send messages to an audience of multiple humans. Unlike in direct nonverbal communication, the human audience does not have to concentrate on the robot but is unconsciously influenced by its motion. Therefore, the audience is usually distracted and the communication is typically not accompanied by eye contact. For example, the humanoid can make motions intended for advertisement at a shopping mall or a dancing motion for performance on a stage.
3. ***Bridged Nonverbal Communication***: This form of communication assumes the opposite condition of diluted nonverbal communication. A humanoid robot unconsciously responds to environmental changes or people around it. When the robot performs responsive motions, eye contact or joint attention may occur, which the human audience can possibly perceive as interest or curiosity on the part of the robot (Duncan et al., 1977). Therefore, motion that is designed for bridged nonverbal communication implies a readiness for the next form of communication, so it provides more opportunities to initiate or sustain direct communications with the human audience. For example, a humanoid robot can look around as if searching for something interesting, turn its body toward some sound or nod in response to what humans say to it.
4. ***Ambient Nonverbal Communication***: This form of communication is the weakest of the four types of communication. Both parties remain unconscious of the communication, but sense their coexistence. The humanoid robot naturally expresses its lifelikeness through motion so that the human unconsciously perceives it as alive. If the robot stops its motion people might consider it as a burden, which can be bothersome. Ambient nonverbal communication is a sort of bridged nonverbal communication that helps people believe they can start to interact with the robot anytime they wish. For example, the robot can perform a breathing motion, a neck stretching motion, a thinking motion or act sleepy.

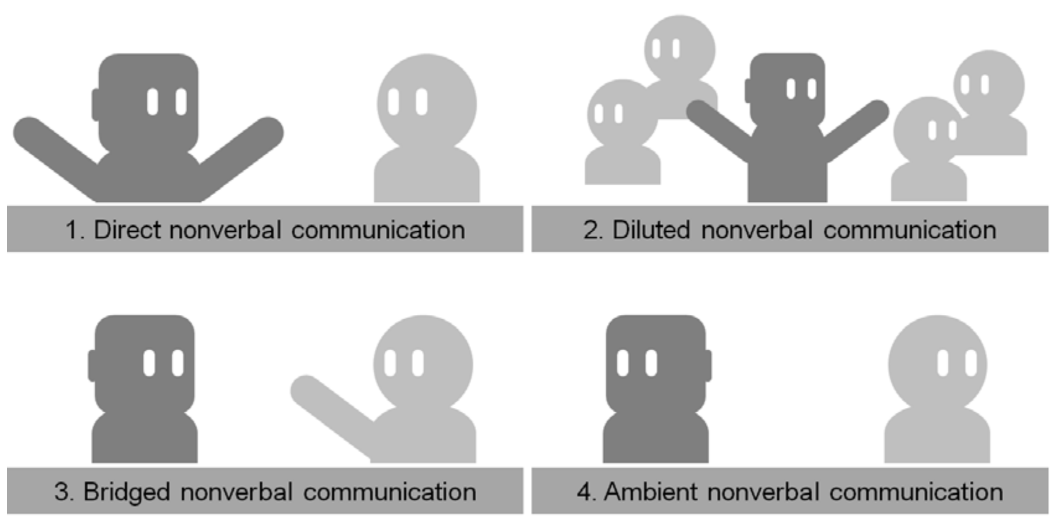

Figure 2 Four types of nonverbal communications with a humanoid robot

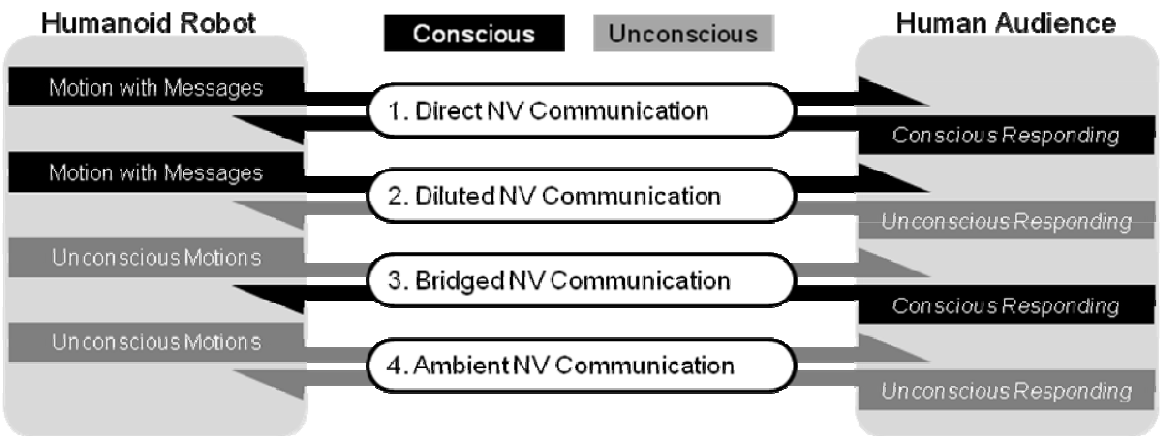

Figure 3 Responding patterns of human audiences for the four types of nonverbal communications with a humanoid robot

Survey to identify sharable user experience

In order to identify the relationship between the motion design attributes and types of nonverbal communication, we conducted a simple survey. The hypothesis was that some of the motion design attributes have significant tendencies in relation to a specific type of nonverbal communication. For example, most people might agree that the speed for ambient nonverbal communication needs to be slow. This is not for judging the validity of motion design, but for outlining sharable user experiences to design desirable motions for humanoid robots in various speechless contexts.

Survey Method

17 masters or doctoral students, 8 males and 9 females from the industrial design department of KAIST, participated in the survey. The survey was composed of four sessions. The first session was an introduction in which participants were acquainted with the purpose of the survey and signed a letter of consent. The second and third sessions were learning sessions. Participants were provided with handouts that explained the concept of nonverbal communication for the second session and motion design attributes for the third session (the content was the same as previous chapters). They carefully read the content so that during the last session they could define the relationship between the two concepts. Participants were provided with a 4x8 matrix (4 types of nonverbal communication x 8 design attributes) on a sheet of paper (Table 2). Each cross section had three possible choices. Two options indicated extreme opposite ends of each design attribute, for example Slow-to-Quick for the speed attribute. If the participants thought that the best speed for ‘Ambient nonverbal communication’ was slow, they circled the word ‘Slow’ on the paper. If the participants had no preference for either option, they could choose the remaining answer, ‘No inclination.’ Participants could refer to the handouts used in the second and third sessions.

Results & Findings

A Chi-square test was used to determine the distribution of the results. If the significant level is lower than $p<0.05$, it can be said that there is a tendency in the responses. If there is no tendency in the responses, it means there is no tendency toward one design attribute. But the tendency of an answer can be different from the tendency of a motion design attribute because ‘No inclination’ was among the three choices. Also, if the answers for an attribute lean toward 'No inclination,' then there is no tendency for that design attribute. In the results, 15 of the 32 cross sections were $p<0.05$ (Table 3). Three of those 15 cross sections had a tendency toward 'No inclination,' and therefore the remaining 12 cross sections contained the information we wished to identify. There were four more cross sections that we needed to look into even though they were not statistically significant. For 'direct-smoothness,' 'bridged-smooth,' 'ambient-accurateness' and 'ambient-direction,' participants showed no tendency for a specific choice. For example, no one selected 'stiff' for the 'direct-smoothness' relationship (Table 2). This can be interpreted to mean that 'not stiff' would be preferential for the motion design in direct nonverbal communication. The remaining cross sections did not show a strong tendency (Table 2). The participants shared their opinions about motion design for each type of nonverbal communication as follows.

1. Direct nonverbal communication needs to be designed with accurate, close motions and without stiff motions.
2. Diluted nonverbal communication needs to be designed with quick, large, repetitive, outward and far motions.
3. Bridged nonverbal communication needs to be designed with approximate motions and without stiff motions.
4. Ambient nonverbal communication needs to be designed with slow, small, repetitive, smooth motions and without accurate, outward motions.

Motion Design Attributes \ 4 Types of Nonverbal Communications		1. Direct NV Communication	2. Diluted NV Communication	3. Bridged NV Communication	4. Ambient NV Communication
A. Weight	A-1. Speed Slow-to-Quick	0. No inclination 12 1. Slow 1 2. Quick 4	0. No inclination 4 1. Slow 2 2. Quick 11	0. No inclination 6 1. Slow 9 2. Quick 2	0. No inclination 2 1. Slow 15 2. Quick 0
	A-2. Scale Small-to-Large	0. No inclination 6 1. Small 2 2. Large 9	0. No inclination 1 1. Small 0 2. Large 16	0. No inclination 3 1. Small 10 2. Large 4	0. No inclination 4 1. Small 12 2. Large 1
B. Time	B-1. Rhythm Static-to-Rhythmic	0. No inclination 7 1. Static 2 2. Rhythmic 8	0. No inclination 5 1. Static 2 2. Rhythmic 10	0. No inclination 3 1. Static 8 2. Rhythmic 6	0. No inclination 3 1. Static 10 2. Rhythmic 4
	B-2. Repetition Non-repetitive vs. Repetitive	0. No inclination 9 1. Non-repetitive 7 2.Repetitive 1	0. No inclination 4 1. Non-repetitive 0 2.Repetitive 13	0. No inclination 8 1. Non-repetitive 3 2.Repetitive 6	0. No inclination 6 1. Non-repetitive 1 2.Repetitive 10
C. Flux	C-1. Smoothness Stiff-to-Smooth	0. No inclination 7 1. Stiff 0 2. Smooth 10	0. No inclination 10 1. Stiff 6 2. Smooth 1	0. No inclination 8 1. Stiff 0 2. Smooth 9	0. No inclination 3 1. Stiff 0 2. Smooth 14
	C-2. Accurateness Approximate-to-Accurate	0. No inclination 3 1. Approximate 1 2. Accurate 13	0. No inclination 4 1. Approximate 6 2. Accurate 7	0. No inclination 4 1. Approximate 11 2. Accurate 2	0. No inclination 5 1. Approximate 12 2. Accurate 0
D. Space	D-1. Direction Inward-to-Outward	0. No inclination 5 1. Inward 2 2. Outward 10	0. No inclination 1 1. Inward 1 2. Outward 15	0. No inclination 4 1. Inward 10 2. Outward 3	0. No inclination 7 1. Inward 10 2. Outward 0
	D-2. Proximity Far-to-Close	0. No inclination 3 1. Far 1 2. Close 13	0. No inclination 3 1. Far 14 2. Close 0	0. No inclination 6 1. Far 5 2. Close 6	0. No inclination 8 1. Far 7 2. Close 2

Design attributes has strong tendency | There is a tendency of answer to 'No inclination' | There is a choice that was never selected

Table 2 Frequency and tendency of the answers

	Direct_Speed	Direct_Scale	Direct_Rhythm	Direct_Repetition	Direct_Smoothness	Direct_Accurateness	Direct_Direction	Direct_Proximity
Chi-Square(a,b)	11.412	4.353	3.647	6.118	0.529	14.588	5.765	14.588
df	2	2	2	2	1	2	2	2
Asymp. Sig.	0.003	0.113	0.161	0.047	0.467	0.001	0.056	0.001

	Diluted_Speed	Diluted_Scale	Diluted_Rhythm	Diluted_Repetition	Diluted_Smoothness	Diluted_Accurateness	Diluted_Direction	Diluted_Proximity
Chi-Square(a,b)	7.882	13.235	5.765	4.765	7.176	0.824	23.059	7.118
df	2	1	2	1	2	2	2	1
Asymp. Sig.	0.019	0.000	0.056	0.029	0.028	0.662	0.000	0.008

	Preparatory_Speed	Preparatory_Scale	Preparatory_Rhythm	Preparatory_Repetition	Preparatory_Smoothness	Preparatory_Accuratenes	Preparatory_Direction	Preparatory_Proximity
Chi-Square(a,b)	4.353	5.059	2.235	2.235	0.059	7.882	5.059	0.118
df	2	2	2	2	1	2	2	2
Asymp. Sig.	0.113	0.080	0.327	0.327	0.808	0.019	0.080	0.943

	Ambient_Speed	Ambient_Scale	Ambient_Rhythm	Ambient_Repetition	Ambient_Smoothness	Ambient_Accurateness	Ambient_Direction	Ambient_Proximity
Chi-Square(a,b)	9.941	11.412	5.059	7.176	7.118	2.882	0.529	3.647
df	1	2	2	2	1	1	1	2
Asymp. Sig.	0.002	0.003	0.080	0.028	0.008	0.090	0.467	0.161

Table 3 Chi-square test results

In the same way that we might appreciate and analyze works of art, we applied our own interpretation to the results. For direct nonverbal communication, accurate motion would be appropriate to express clear messages and close motion would make it easier to communicate without interference. This form of communication in particular should not have stiff motion, because the motion is observed at a close distance and thus the stiffness might detract from the communication. For diluted nonverbal communication, the robot is generally far from the human audience. Therefore, quick, large and outward motion, in other words, high-energy scattering motion, is advantageous to catch the attention of people in distracted contexts such as public spaces or wide-open areas. Moreover, a repetitive motion pattern is necessary because a scattered audience can hardly comprehend the intention of the robot in one instant when catching sight of it by chance. For bridged nonverbal communication, approximate motion would be more natural when presenting the robot as responding unconsciously. But the motion should not be stiff, because stiffness is exactly opposite to natural lifelikeness. In ambient nonverbal communication, the robot's motion should remain calm and minimized; therefore, low-energy motions (slow and small motions) would be proper. Additionally, smooth and repetitive motion suits the expression of life-likeness as an unconscious state. In that sense, accurate and outward motion is not appropriate.

In spite of the participants' choices, the statistical analysis and our own interpretation, all of which culminated in recommendations for motion design attributes for different types of nonverbal communication, it is not our intention to constrain designers to following these recommendations. Rather, this study suggests that the designer needs to refer to what people have agreed regarding nonverbal communication and about how memories can be shared, because both sharing information and the reinterpretation of meaning are important to shape a general user-experience.

Conclusion and future works

Knowledge of how to design motions for robots is increasing in importance. Humanoid robots are especially interesting and thus their motions need to be delicately designed to maintain their resemblance to humans. We reviewed related HRI studies about motion, and concluded that we lack knowledge in three areas: 1. nonverbal motion design, which is critical for HRI experiences with a physical humanoid robot; 2. motion design from a user-centered point of view; 3. practicality to help designers create motions for humanoid robots. To overcome these limitations, we turned to user-centered design approach. Based on the relationship between design attributes and nonverbal communication experiences, we suggest the concept of nonverbal communication gestalt to design a general user experience for interaction with a humanoid robot. To test our concept, a survey with 17 participants was conducted and it was found that participants shared a considerable amount of design preferences for desirable nonverbal communication with humanoid robots. Nevertheless, we do not seek to impose the relationships extracted here as a design guideline, instead preferring to leave open the possibility for reinterpretation, which is the spirit of art and design. As the HRI field grows, additional contributions to the study of robot design are required to bring robot technology into people's daily lives. This study aims to make synergetic knowledge about motion for robot engineering and design available so that people can have more desirable HRI experiences soon.

In this paper, we have introduced a concept user-centered motion design for humanoid robots. However, a real robot platform needs to be implemented for experimental verification of the concepts outlined in this paper. We plan to conduct a motion design case study with real humanoid robots so that we can identify deeper insights and inspirations.

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Design naturally, dealing with complexity of forms in nature & applying it in product design

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Abstract

The aesthetic NORMs have formed some presupposes in designers' **minds** which don't let their eyes see the reality of forms in NATURE before their abstracting mind see. They usually reduce complex forms to their basic geometries and proportions, in order to find orders in their complexity and to harmonize them with their design paradigms. We believe that this common vision to the nature, deprive us from perceiving its reality. This paper proposes a new vision to the nature and thereby present nature's approach to the form issue, and some of its manifestations. These findings which are presented under the title of DESIGN NATURALLY would guide designers, one step closer to the complex reality of forms in nature to get inspired by. Our point here is that this approach takes us far beyond the law-bound principles of the geometry and traditional design aesthetics and would create a new aesthetic language to the world of products based on the real complex world.

Keywords

Abstraction; growth story; forces; complexity; natural forms; design naturally.

Human's perception from the world is obedient to his mind (Nasr, 1996) and his mind is obedient to platonic forms and metric proportions (Alexander, 1964, Arnheim, 1979; Rotzler, 1977); these prevent us from seeing the complexity of world and understand it in the way it is (Rampell, 2003; warthall, 2005). Being obedient to these kinds of presupposes have had obvious effects on different aspects of human life and has manifested in the world of design in format of geometric forms and abstraction. Regarding to the changing meaning of the beauty and growing need for renewing the aesthetic language (Akner-koler, 2007), this study is aimed to propose a new vision to the forms in nature. This vision is based on ignoring the traditional aesthetic language and presupposes in order to create new theory of form and go beyond the law-bound principles of geometry.

Phenomenology is a compatible conceptual framework to explain the approach of this paper. Phenomenology is about studying phenomenon based on direct and pure experience and observance from the world and by ignoring presupposes (Verneaux &wahl, 2009). Just as phenomenology question presupposes to study the reality of things, we questioned the aesthetic norms and conventions in order to get closer to the reality of forms in nature.

Therefore, by taking a phenomenological approach, it is tried to break down presupposes and re-observe the forms in nature. This kind of visions opens designers' eyes to the ignored qualities such as complexity, irregularity, asymmetry, etc. These qualities could be applied as tools of renewing the aesthetic language and to find freedom from conventions in field of design (Bois & Krauss, 1997).

Quantitative approach

Rationalism and humanism of renaissance enabled a scientific revolution, which let scholars look at the world in a different light and by reason & knowledge. In the 16th and 17th centuries, in contrast with medieval centuries, knowledge was strongly based on rational calculus, mathematics and quantitative measurements (Bertelsen, 2004; Nasr, 1996).
Galileo, in his famous phrase under the title of "*IL Saggiatore"* likened the nature to a math book with geometric shapes as its letters. He believed that this book could be merely understood by human's rational mind (Nasr, 1996). Descartes' mathematical definitions of time, place and substance, has had the deepest affects on the essence of the modern science structures. His reductionism went to extreme until he defined nature as a physical moving reality which is merely understandable via geometry and quantitative measurements. Scientific revolution reached its zenith by Newton. He in his essay called *Principia* certainly declared the beginning of the quantitative and mathematical approach to the nature (Frangmyre *et al.*, 1990).

By the efforts of some individuals such as Christian Wolff[1], mathematical and quantitative methods were gradually developed in other fields of SCIENCE too (Frangmyre *et al.*, 1990). In fact scientists were strongly motivated to impose order on all domains of nature via quantizing and reducing its complexity. *L'esprit Geometrique* (geometric sprit) is the French expression for this extensive approach which were shadowing on all European scientific activities of 18th century and also affected many aspects of the western culture up to 20th century (Nasr, 1996).

Geometric Spirit

Industrial revolution in 19th century and modern technology stimulated the penetration of quantitative attitude to different layers of human life (Nasr, 1997), such as DESIGN. By the beginning of the 20th century, the approaches of the modern art movements such as cubism, purism, futurism and constructivism were to turn to SCIENCE for concepts and models (Akner-Koler, 2007; Heskett, 1993). These attitudes were based on the Influence of Idealist philosophical traditions, and the search for Platonic ideal forms. Therefore the quantitative approach of SCIENCE appeared toward abstraction and in particular, geometric forms in modern world of art and design (Heskett, 1993).
Art historian Alfred Barr categorized modern art into two main movements: *geometric abstract art* and *non-geometric abstract art*. This emphasis on geometric abstraction shows how a big role geometric abstraction played in modern art movements (Akner- koler, 2007).
Although post-modern criticized the modernistic approach to define universal principles, genotypes and the search for "pure form" (Rampell, 2003), the major manifestations of the post modernistic styles were again toward abstraction and geometric forms.

1 German philosopher, (1679-1754)

Today, the aesthetic contributions of these movements have become the dominant aesthetic norms (Habermas, 1998) and they still dictate the conditions for beauty, at least for design and architecture (Akner-Koler, 2007).

The point here is that this tradition has also affected designers' visions to the FORMS IN NATURE. From a phenomenological point of view, it can be said that the aesthetic NORMs have formed some presupposes in designers' minds, which made them unable of seeing the reality of forms in nature before their abstracting mind perceive it. In fact, Designers usually reduce complex forms to their basic geometries and proportions, in order to find order in their complexity and to harmonize them with their design paradigms. The function of presupposes in human's mind is similar to the function of a red filter, which make a special wave length visible only (Gleick, 1988). In fact the filtering minds EXPECT to see geometric forms and patterns in nature and so reduce complex quality of forms to extract simple geometric patterns and proportions.

Deprivation from reality

Regarding to George Berkeley[2], the quantitative approach to the nature, abstracts its reality and presents the aspect, which is in our mind (Nasr, 1996).
Martin Heidegger explains that human usually escape from complexities and irregularities of universe. Reducing the infinite universe to understandable structures and models is equal with limiting it to our limited language also, taking this simplified model of reality as the reality itself, would surely deprive us from perceiving the reality of universe and would waste away its real values (Warthall, 2005).
In fact use of geometry entails a reductionism that excludes and "washes away" contact with the real world (Akner-Koler, 2007). Therefore, it can be concluded that abstracting natural forms in order to simplify their complexity, prevents us to perceive their reality. In other words geometric approach to the forms in nature deprive designers from seeing and perceiving many aesthetical values of natural forms.

Nature Inspired Forms

Deliberating forms in nature in order to receive inspiration from them is not a recent issue. The point is the way human represents his observations. We can categorize the human inspirations based on different degrees of abstraction. The more designers abstract natural form, the less the original properties such as asymmetry, irregularity, chaos and complexity would last. In this regard to 3 groups of Geometric, Geo-organic and Organic could be referred.

2 Irish philosopher, (1658-1753)

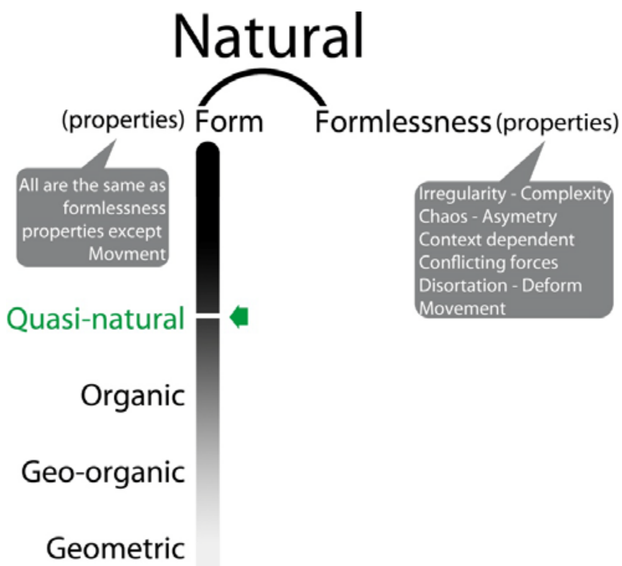

Figure 1 Different level of human inspirations from forms in nature regarding to the degrees of abstraction

Geometric

Golden section ratio and many of geometric patterns which are inspired by the nature are the result of geometric approach.

Geometric-organic Forms

This group refers to strong traditions in art and design, which merge geometric structural analysis with organic principles of growth and tension (Akner-Koler, 2007). By these traditions, Vladimir Tatlin and Mikhail Matiushin have been involved in studies of the efficiency and energy-conserving qualities of the anatomy of animals, which today might be called “bionic” approach (Tillberg, 2003). Many designers, engineers and biologists have endeavored in this field and have studied functional aspects integrated with morphological aspects of nature in order to receive inspiration (Trotto & Cianfanelli, 2006).

Bionic approach emphasizes on functional aspects and puts a great effort on harmonizing inspirations with design paradigms. Therefore, it always reduces natural forms to a general abstraction in format of products. Designers usually change natural forms in order to meet their design needs and so naturally they wash away many original qualities of natural forms in this process.

Organic Forms

As Waddington states:

"… We come then to conceive of organic form as something which is produced by the interaction of numerous forces which are balanced against one another in a near-equilibrium

> *that has the character not of a precisely definable pattern but rather of a slightly fluid one, a rhythm..."* (Wyte, 1968).

He also adds that: regarding the influence of man's intellectualizing, pattern-making habit of simplification, it is expectable that human's work of art would be a diluted version of the reality which has lost its unresolved complexity. Nevertheless, the problem starts when we equalize organic forms with natural forms; in fact we equalize a model or an aspect of reality with the reality itself which Heidegger showed that will deprive us from reality. It has become a kind of aesthetic norm that the result of studying natural forms to design things would be curved and smooth surfaces and circular shapes. But we have to consider that organic approach refers to just a level of abstracted natural forms with more attitudes to curves and fluid forms (figure 1).

In relation to these three types of approaches, we propose **QUASI_NATURAL** forms as the forms resulted by taking the approach of this paper to design. In figure 1 it is shown that this type of forms stand above the organic group of forms and closer to natural forms. It means that these forms have more properties in common with original properties of natural forms; it is because of less abstraction and more realistic approach to the natural forms (figure 1).

The Theory of Form

The approach of this study to the form issue is as follow.

- The first principle of this Theory is ignoring the traditional geometric-quantitative approaches to the nature. Therefore, the mind would ignore presupposes and traditional expectations for finding orders and patterns. Following this, the nature would not be limited merely to fluidic or curved forms or merely geometric and linear ones, but all types of forms would be considered and with their original properties. In other words it is tried to look at the nature as the way it is.
- Each of natural phenomena is considered as a designed one. It means that all details are important and has direct effect on final shape. Therefore, considering all details of forms as intentional created parts is another important principle.
- Although our observations have been based on non-abstraction approach, it should be mentioned that abstraction is unavoidable. Here we have just tried to apply less degree of abstraction in order to get closer to the reality.
- We do believe on the analyzing capacity of geometric reasoning and geometric forms, therefore geometric reasoning would be applied for analyzing the action of the forces (As it is explained in the following); but would not have apparent manifestation in Quasi-natural forms.
- Taking this kind of approach to the nature, complexity is the first quality appears to us. It is not tried to understand complexities of forms by finding and extracting patterns or orders in them. Instead it is tried to generate a clear and tangible definition about the logic of complexity. A definition which helps designers to think about the complexity as complexity.
- Gestalt was explained as "An arrangement of parts which appears and functions as a whole that is more than the sum of its parts" (Monö, 1997). The position of this study to

the gestalt is based on the interaction of all elements of form (Line, Volume, Color, etc.). Our studies showed that all elements of forms in nature affect each other bilaterally and the unity of final whole is the result of their interaction. All elements are exposed to the forces from each other and this is how the final unified shape appears.

- The involvement of this approach with different aspects of form theory is shown in figure 2. Visual aesthetics and emotional aspects are the most involved areas. In other words this approach would mostly affect these two areas in the sphere of form theory.

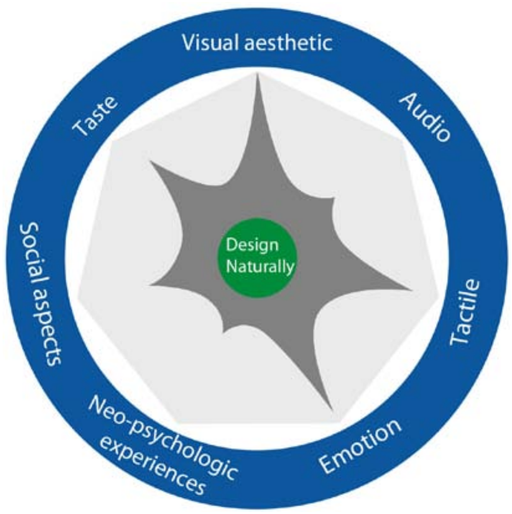

Figure 2 Different issues concern with form theory & involvement degrees of Design Naturally approach with each of them.

Objectives & hypothesis

This paper aims to

1. Study the reality of forms in nature, which is manifested towards complexity, by avoiding reductionism.
2. Present nature's approach to the form issue and its manifestations as applicable tools for designer.

Our hypothesis is that this approach would take us beyond the law-bound principles of geometry and would create a new aesthetical language to the world of products based on the real complex world.

Method

Case study

A case study was performed to study specific target group of natural phenomenon in order to find out nature's real complex approach to the form issue. The geometric reductionism, aesthetical norms, interests and presupposes were avoided and it was tried to see the forms in the way they really are. Thus we encountered with COMPLEXITY of forms and their relating characteristics such as, unpredictability, irregularity, asymmetry, etc. Apparently it was understood that nature's approach to the form is DIFFERENT from designers one. In fact, when we observe forms in nature we can follow some principles that are embedded in their design and it seems that they are not the same as the principles that designers use in shaping the artificial forms. These principles are those which produce visual complexity of natural forms. The target group was consisted of several types of birds and reptiles and few types of plants. The reasons for choosing such a target group was firstly due to the sake of birds' and reptiles' great variety in form and secondly due to the accessibility of plants for virtual study. We focused on principles behind the formation of forms in nature and the ways we defined them for designers.

The study started by observation and realistic drawings. In first phase, 10 types of birds, 6 types of reptiles and 12 types of plants were observed. The materials for observation were pictures, movies and also virtual observations. Some of the pictures were selected from the internet and books and others were taken by digital cameras.

The visual characteristics of each sample were carefully studied. Then detailed explaining notes and drawings from each of them were made (Figure 3). By this phase we could recognize some almost constant characteristics, which seemed to be common in all observed samples.

Figure 3 Drawings from birds

In Parallel with observations, a library search regarding the scientific aspects of form generation processes in nature was performed to find out the reasons behinds the visual qualities. It was also tried to obtain a general explanation for defining the observed characteristics.

The aim was to find out about the possibility of considering the observed visual characteristics, as constant principles, which nature applies to create forms. For this aim, there was a need for studying many samples. Statistical operations performed to determine the sample size of each of the target groups. High percent of common characteristics in first observations showed that studying 20 types of each of the birds, reptiles and plants would be enough to obtain decisive results about the final principles.

Results

The results are categorized in two parts.

1. Form Follows NATURAL Interaction of Forces: An explanation about how COMPLEXITY appears in natural forms.
2. Manifestations of this explanation in natural forms.

Form Follows NATURAL Interaction of Forces (FNIF).

This is our perception from how complex forms appear in NATURE. This sentence can simply and generally explain some complex qualities of forms in nature such as asymmetry and unpredictability. We believe that taking this approach to product design would cause these qualities to appear in products too.

The word "Force" refers to both Directional and surrounding energies. Directional forces refer to the energies acting upon the movement of the inner & spacial axis of form and its elemental parts. These forces increase the complexity and asymmetry in forms by affecting the surface from beneath and above and with different angles and intensities. The pressure or the tension of the force is absorbed by the positive element and then projected outward through the form and into space (Akner-Koler, 2007, 19). For instance they may cause curves, bends, concavity, convexity and wrinkles.

As a complement to directional forces, surrounding force is defined. Each element of forms in nature is surrounded by a type of energy which can affect the form of its adjacent elements. To some extent, it is comparable with invisible magnetic field of the magnet, which affects the iron filings around it or the layers of the energy surrounding every living thing (Figure 4).

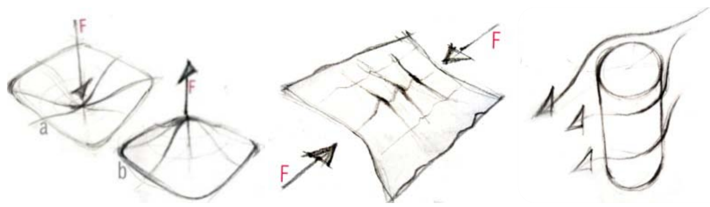

Figure 4 On the left: Directional forces cause concavity & convexity, in the middle: Directional forces cause wrinkles, on the right: Surrounding forces of the cylinder affect its adjacent axial forces.

Interaction of the forces refers to their bilateral relationship and its effects that shape the form. The quality of the interaction of the forces is defined by the word "Natural" which is the key word here. Longman dictionary has defined this word as "concerning, existing or happening ordinarily in the world (nature), especially not caused, made or controlled by people".

In conclusion, FNIF is pointing to "What ordinarily happens by bilateral relationship of directional & surrounding energies affecting axis & constituting parts of form". For example, crumpled piece of paper is the natural result of interaction of the forces applied by fingers to it. Also in figure 5 two forces contract a cylinder by asymmetrically pressing against the two base surfaces of it. It can be seen that two common traits of natural forms, chaos and asymmetry, has naturally appeared in this form via natural interaction of forces.

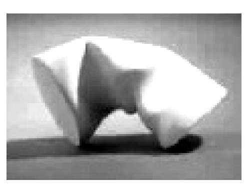

Figure 5 Complexity, the result of natural interaction of the forces

Manifestations-Design Naturally Principles (DNP)

FNIF has variety of manifestations in nature. Here they are categorized into 5 groups of line, plane, volume, color and texture. Each group explains how nature applies that specific element of forms regarding to FNIF dictum. These principles are like toolkit which can guide designers to apply elements of forms as nature do. Here they are presented under the title of DESIGN NATURALLY Principles.

The following principles are all based on one fact: Adjacent elements naturally affect each other and this bilateral effectiveness causes some changes in their forms. These changes which are mostly towards complexity, appears as the results of natural interaction of the forces.

Line

Line changes by form. These changes mostly appear in weight of line (thickness), its direction and sometimes, its color. The reason behind these changes is the forces from the context (plane) and other adjacent elements which affect the line through its path (Figure 6). Here two more common situations are presented.

Figure 6 Changing weight of the black line, regarding to its context

First is about the changes of line when it moves on different surfaces (e.g. concave or convex surfaces). When the line passes the concavity or convexity, naturally, the directional forces which have affected these surfaces and have made them curved, would affect the line too. So, naturally the line would become thick or thin (Figure 7) or temporarily get out of its direction.

Figure 7 Line on convexity naturally becomes thicker (b).

Second situation, is about the changes of line when it becomes adjacent with other elements through its path. For instance in figure 8. It can be seen how the surrounding forces of the bump on a tree have changed the direction of its adjacent lines. The form of the deviation depends on the form of the element, its size, the quality of lines and their distance from each other.

Figure 8 Surrounding forces of the bump on a tree have changed the direction of its adjacent lines.

Line changes the form. Regarding to the bilateral relationship of elements in nature, in some situations it can be seen that line affects its context and other adjacent elements too. For example in figure 9 the slight depression and change of color around the mid rib and each of the veins as lines, on the leaf, as their context (plane) are visible.

Figure 9 Line changes its context

It can be concluded that line changes freely by form and on the other side can change the form too. This dynamic and changing quality of line is what exists in nature but not in man-made products (Figure 10).

Figure 10 An unchanged quality of line when it passes a convex surface of a cylinder

Plane

Plane changes by its constituting parts. Plane prepares a field in which other elements can be defined. According to the bilateral relationship between the adjacent elements, we can say that plane is exposed to the directional and surrounding forces of the elements concluded. So the final shape of the plane depends on the result of natural interaction between all these parts.

Cutting, removing or adding an element, creating unevenness, or applying any other kind of change on a plane, is in fact equal with implementing a type of force to it (Figure 11).

Figure 11 It can be liken to effects of a drop on water.

Natural interaction of these forces would have some manifestations which depending on the forces' properties, would differ. An eye of a bird on her face can be a good example for this. In figure 12, some wrinkles and slight bump around the eye of bird on its face can be seen. These are caused by the directional and surrounding forces of the eye as an added element, on the face as its context.

Figure 12 The complexity of the white area

Regarding to the scope, angle and the strength of the acting forces, other manifestations such as depression or a bump, change in color or texture, wrinkle or even a dent are also expectable (Figure 13).

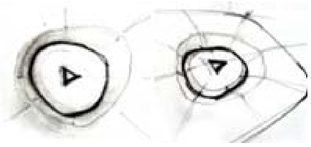

Figure 13 An added play button and its effects on a surface

As mentioned before, plane in nature freely changes by the forces acting upon it. The contour line of the planes also forms by the interaction of these forces. Figure 14 shows how surrounding forces of the inner elements have formed a complex and unpredictable contour line. This is why we rarely encounter with pure geometries of planes in nature.

Figure 14 Unpredictable contour line

Edges are specifically identified. Edges mostly form under the pressure or tension of the concentrated forces. Therefore according to FNIF dictum, it can be seen that in natural forms, these areas are almost always identified by some visual traits such as Wrinkles, constriction, change in thickness or the color and texture (Figure 15).

Figure 15 Change of color, texture and thickness on the edges of duck's bill.

Above-mentioned principles also apply to the "points" as scaled planes.

Volume

As volumes form by combination of the planes, all of the principles about the planes apply to volumes too.

- Volume changes by its constituting parts.
- Volumes don’t appear in their basic forms.

- Edges are specifically identified (Figure 15).

Joint areas are almost always identified by some visual traits. Joint areas in nature can usually refer to where one volume comes out of the other. Growing out a volume from the other one in fact means implementing force from inside, until the volume finds its way to get out. Interaction of pushing and opposite forces would naturally cause some changes to appear in joint area and in both volumes. Figure 16 shows how the petiole has grown out from its stem. Soft tonality of colors and constriction of parts which express contradiction of forces and also transformation of one volume to another can be seen in figure 16.

Figure 16 When a volume comes out from another one

Generally, when two volumes join together, it means that two or more opposite forces are interacting. Change in color, wrinkles, constriction, or a kind of puff are symptoms of this interaction. The changes in joint of volumes would differ due to the direction of axial movements, size and strength of the forces of the meeting volumes.

Texture

In nature texture changes by form and emphasizes on the quality of form. Texture is one of the characteristics of surface. It has a dynamic nature and should change by the changes of the surface. The directional and surrounding forces, which act upon the plane (surface), naturally affect its texture too. Therefore, for example the quality of texture of the concave surface surely differs from the same texture on convex one and also from the texture on the edges and joints (Figure 17). Designers mostly don't consider this point in their designs. Figure 18, is a picture of a product which presents texture that has covered a curved surface. As it can be seen, there is no meaningful relation between the texture and the curved surface beneath it. All elements of the texture are constant, no matter how the surface changes.

In conclusion it can be said that in nature texture changes freely due to the changes of its context. Therefore, it would find a dynamic characteristic which emphasize on the quality of form.

Figure 17 Dynamic texture in nature - All elements of the texture change by convexity and concavity of surface and also at the edges.

Figure 18 Texture in products

Color

Color changes by form and emphasize on the quality of form. Figure 19 shows the thorn of a rose. As the thorn gradually becomes sharp-pointed at the end, its color also changes softly from dark red to light yellow at its sharp end. This tonality emphasizes on the form of the thorn (sharpness) and is one of the other manifestations of the complexity in nature. Color has a dynamic nature and should change by the changes of the surface. Due to FNIF, the acting forces upon the surface naturally affect its color too. For instance, concave, convex, edges and joints are places which pressure and tension of the forces naturally cause changes in colors (Figure 20). We can also trace this phenomenon in some of our every day products, (Figure 21). Though designers mostly don’t consider this matter (Figure 22).

Figure 19 Thorns of rose bush

Figure 20 Mushrooms, Color changes on concavity

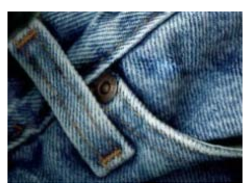

Figure 21 Blue jeans - Abrasion of the edges are the result of natural interaction of forces. Great relationship between form and color

Figure 22 A watch by Ross Lovegrove Plane color, No matter how the form changes

Above-mentioned principles are in fact the manifestations of complexity of forms in nature. Unpredictable contourlines, tonality of colors, dynamic textures, changing quality of lines, non-geometric planes and volumes, asymetrical compositions and so on, are all those visual items, which make nature complex in front of our eyes. FNIF dictum is an explanation which generally help us to understand these complexties and analayze them by the interaction of the forces. Besides, as you know, almost all of the above–mentioned principles are those items which have been ignored previously by designers because of their common geometric approaches to the nature BUT have values to be applied in product design.

Our point here is that Applying Design naturally principles would provide designres a vast realm of creativity and freedom in field of forms. It would grant a dynamic identity and new aesthetical values to all elements of forms, meaningful relationship between them and more sense of integrity to the whole complex.

To design naturally, first we have to think naturally!

As a complement to DNP we need to know about the process which by nature has applied DNP. This process is known as GROWTH. By the 'Growth Process' in nature we are referring to the process in which different parts of a phenomenon gradually appear till it attain to puberty. This is during the growth process which directional and surrounding forces work and so the above-mentioned manifestations appear (by the natural interaction of the forces).

In order to design naturally (apply the design naturally principles), we need to be able to think naturally. Transferring the concept of growth may help designers to do this.

Our studies are still in progress in order to generate a method based on the natural growth, to enable designers to:

- Think about the form-giving process as a growth process of natural phenomenon
- Analyze the acting forces and their natural interactions through the form-giving process
- Apply the DNP regarding to analysis of natural interaction of forces

Conclusion

After all it can be concluded that by looking through the complexity of forms in nature and by forgetting the geometric approaches, we would be able to get closer to the reality of forms to learn more and deeper from nature. Thus we would be able to go far beyond the law-bound principles of the geometry and traditional design aesthetics and create a new aesthetical language to the world of products based on the real complex world.

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Catching Wasps and Baking Dinosaurs: Experiences from Co-designing with Children

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Abstract

User-centred product development and design can be carried out with differing degrees of user participation: for users, with users, and by users. A project characterized by a co-design approach, i.e. design 'with' rather than 'for' or 'by' users, was carried out during the spring of 2009. The co-design teams consisted of children (a total of 45, between 10 and 11 years old) and 10 product developers/designers (teachers and students from an industrial design engineering university programme). The overall theme for the co-design exercise was food, eating and health, a theme which the children had researched as co-researchers during the autumn of 2008. The design project followed a structured design process, including problem identification, idea generation, concept development, etc., supported by typical methods and tools such as various brainstorming techniques, formulation of evaluation criteria and concept screening. Working in teams of 3-4 children and one developer/designer, various problems were identified and solutions proposed. The problems included for example "healthy sweets", "keeping wasps away from the lemonade glass", and "how to make washing up more fun". The results from the process consisted of for example a healthy sweets advertising campaign, several "wasp traps", and a new type of dishwasher based on the principle of a record player. However, the results also encompassed experiences from co-designing with users. Some of these experiences were considered the consequence of the fact that the children were indeed children, and are thus considered relevant only for other projects involving children as co-designers. Maintaining focus and concentration, for example, was a key issue. Other experiences are considered more generic, i.e. issues which would emerge as important topics in any co-design process. Communicating an understanding of the product development process and the time required for the solution to develop from idea to prototype were regarded as such generic topics.

Keywords

co-design; participatory design; design with children

User-centred product development and design can be carried out with differing degrees of user participation. One way of categorizing these degrees is in terms of 'for users', 'with users', and 'by users' (cf. Eason, 1988). An approach 'for' indicates a fairly passive role for the user, that of contributing with, for instance, problem descriptions and experiences as a basis for product development. A 'by' approach, on the other hand, would reflect a very active user and a situation where the product developer's/designer's role is to operationalize what has already been specified as the 'design solution'. A 'with' approach, finally, would reflect a participatory design process where users and product developers/ designers bring their respective skills into a common arena and work in a collaborative process, acknowledging each other's contributions to the design process and its outcome(s).

The arguments for participatory design, or co-design, have been for instance that involving those who are affected by the outcome in creating the solution is a way to better fulfil their needs and requirements and for achieving sustainable solutions, i.e. solutions that will be accepted and adopted by the specific target group. The co-design concept embraces, furthermore, the notion that all people are (or can be enabled to be) creative and that this co-creativity will contribute to innovation.

Co-design has traditionally been applied in projects with the purpose of developing computer systems (e.g. Ehn, 1993; Grønbaek et al. 1993) and workplaces (e.g. Broberg, 2010; Garmer, 2002) but it has also been used in other domains, such as service development (e.g. Albinson et al., 2007) and development of urban design and planning (e.g. Shin, 2009). Co-design has also been carried out involving specific stakeholders, for instance children. Examples include the development of school environments (Ghaziani, 2008; Newman & Thomas, 2008) and new technology (e.g. Farber et al. 2002), as well as school-based intervention studies (e.g. French & Stables 2003; Prell et al. 2005).

Co-design raises, as such, a number of questions but these may be further emphasized in projects which involve children: What is actually the different participants' contributions to the design process? What are the contributions of children? What is required from the process in order to establish ”true” co-creativity and design? Will the children's voices be heard? How can the shift in power, from that of product developers/designers to that of users, be managed? Can and will the children and the adults be collaborating on equal terms?

The purpose of this paper is to present some experiences obtained in a co-design project with children. The project was part of a larger research project, “Children as co-researchers of foodscapes” (Swe: Barn som medforskare i matlandskap, BAMM) with the overall purpose to investigate the feasibility of involving children in searching for deeper knowledge on children's food consumption and their relation to and thoughts on food, eating and health. In a first phase of the project, during the autumn of 2008, the children had taken part in a co-research activity (reported in e.g. Brembeck et al. 2010). The co-design project reported on in this paper constituted the second phase and was carried out during the spring of 2009.

The Case Study

Object

The design object was “food, eating and related items and environments”.

Participants

The children came from two different classes in the same suburban school, a total of 45 children aged between 10 and 11 years. The product developers/designers were teachers and students from an industrial design engineering university programme. The teachers had differing backgrounds in that some were mechanical engineers and others were industrial designers.

Process and Process Results

The process involved seven sessions over a period of four months.

Session 1: Introduction

The first session was held in December 2008. The purpose of this session was to familiarize the children with the concepts of design problems and problem solving, i.e. the idea that it is possible to change things. A PowerPoint presentation was put together illustrating different ways of changing people's consumption of food, eating and related items through, for instance, marketing, information/education, and/or design and development of new technology. The children were encouraged to contemplate different problems that they would like to find a solution to in the next phase of the project.

Session 2: Identifying problems

The second session, held in February 2009, focused on identifying problems to be addressed. Approximately six children and one teacher/student formed groups which started to generate problems together. The method used was brainstorming, a method that was already familiar to the children. All problems were written down on Post-it notes (sticky notes), one idea per note, and placed on a large sheet of paper. The objective was thus to elicit possible problems to address. In some cases this was also achieved but the line between problems and ideas for solutions, or simply "ideas", proved to be thin.

When the ideas ran out, the Post-it notes were collated and grouped in 'problem areas'. A discussion was initiated on which problems were feasible to approach and which were not. The children had no problem in ranging the problems and ideas as realistic and unrealistic and were often more strict in their assessments than were the designer/developer. 'Cost', i.e. money, for instance, was an issue frequently brought up by the children. The result of the session was a reduced list of problems/ideas that were considered feasible to continue working with.

Session 3: Choice of problem

The problems considered feasible were listed, some additional "problems" were added by the teachers/students, and the completed list was distributed to the children. They were to make a choice of which problem(s) they preferred to work with. The final choices resulted in a total of six different "problems" and in 10 different design team.

- *Healthy sweets*. Sweets are desirable, but they are also "unhealthy". It would be desirable to develop a sweet which tastes as sweets should do, but is not unhealthy to eat.
- *A fruit protection kit*. When fruit is transported in a school-bag, it is often damaged why there is a need to protect the fruit.
- *A wasp (bug) trap*. When lemonade and similar drinks are consumed in the summer, a wasp may end up in the glass. It would be desirable to reduce this risk.
- *'Making washing up more fun'.* Washing up is boring and some solution should be found to make it more fun, something you want to do.
- *The school canteen.* The existing canteen was considered somewhat boring but also inefficient. Two groups worked on the dining area and two groups approached how to make it possible to serve at least two different alternatives every day.
- *The children's supermarket*, which later evolved into the *children's city*, specifically designed to match children's needs rather than adults' needs.

Session 4: Generation of ideas and choice of concept

The design teams were reformed based on the children's choice of problem. Working in teams of 3-4 children and one product developer/designer, ideas were now generated in order to solve the problem chosen. The methods used were some of the various methods taught on the industrial design engineering programme, such as brainstorming, Osborn's idea-spurring checklist, "extreme thinking", association exercises, etc. The result of these idea-generating exercises tended to be either "crazy ideas", such as "tame monkeys working in the school canteen" and "furniture made out of real fruit", or very down-to-earth, even pessimistic: "We could repaint the canteen, but it will probably be too expensive, (the head teacher) won't buy it". To end the session, a list of evaluation criteria was generated as a joint venture between the children and the developer/designer, and the various ideas and concepts were assessed accordingly in order to reduce the total list to one or a few concepts for further development. The method could be described as a simplified Pugh matrix.

Session 5: Concept development

In the next session, the work continued for an entire day in a large facility equipped with tables, chairs, paper, pens, paints, and an arrangement of materials by which physical models could be created. The goal for the day was to conceptualize the concepts, first in terms of sketches and second in terms of physical models.

- The group working with healthy sweets did not have the opportunity to develop an actual product since the premises did not allow working with different food ingredients. A basic concept was, however, a recipe based on corn flakes and chocolate, both considered ‘healthy’. One child devoted his time to carving tiny dinosaurs in foam, with the intention that this should be the shape of the sweets. The group worked on different packaging (an example of which is snown in Figure 1), which should contain the sweets, as well as commercial advertising campaigns by which the sweets should be marketed. It was noted that the children came up with ideas for different brand names, and the character and content of the advertisements surprisingly quickly.
- The fruit protection kit resulted in a solution which could be used for different fruits, folding and unfolding depending upon the size and shape of the fruit (Figure 2). Much time was therefore spent on producing models of fruit to try the principle out.
- The wasp trap idea was developed into several different solutions (Figure 3). In this design team, ethics became an important issue and the main goal for the group was to come up with a design that did not actually kill the wasp, but trapped it so that it could be released elsewhere.
- In order to make washing up more fun, the work of the design team resulted in a solution similar to that of an old record player. The idea was to place the dirty plate on a turntable dish and then allow the plate to rotate. A dish glove fitted with pieces of scrub-sponges attached to each fingertip would then be used to actually clean the plate (Figure 4). To the music played through the loudspeakers, the user could use the glove to “scratch” as a real DJ would.
- One of the groups elaborated the idea for a canteen with a jungle theme, with fruit-shaped furniture, lots of foliage, green plants, and jungle motifs on the walls etc. (Figure 5). A second group decided on a more ‘classic design’, spending their time on deciding on wall colours. A physical model was created (1:10 scale) and the effect of different choices could be studied by putting sheets of paper in different colours on the walls. A third group built a paper model of a conveyor system delivering plates of food (Figure 6) while the fourth group built a model of a more traditional serving station adapted for two main courses (Figure 14).

Figure 1. An idea for a packaging of healthy sweets. The brand name, “Krioxo”, is clearly identifiable as well as the elaborated “𝒦”-logo.

Figure 2. A basic concept for the fruit protection kit.

Figure 3. A model of a conceptual wasp trap created from a disposable coffee mug.

Figure 4. Prototyping part of a new type of dish glove to make washing up more fun.

Figure 5. Development of a jungle concept for the school canteen.

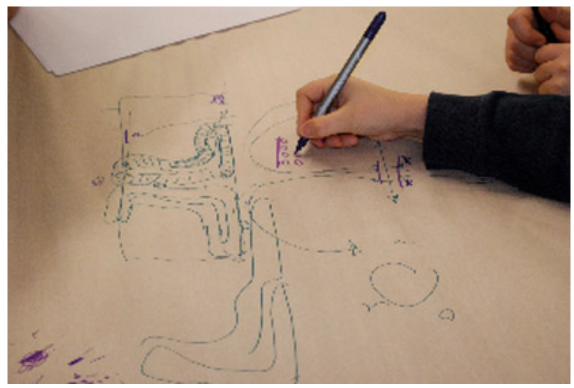

Figure 6. Sketching the conveyor belt solution for the school canteen.

- The children's supermarket became a shop on two floors, the ground floor for the parents and the first floor for the children only, offering an assortment of ice-creams and sweets. The children's consumption should be paid for by bonuses received on the basis of the parents' consumption. However, as a lot of sweets are consumed, this has to be offset by exercise. A sports hall therefore had to be added. The discussion in the design team ended in a children's city with a supermarket, a sports hall, a cinema, large parking areas, a roundabout (an important detail), and a place for events where, each week, a celebrity would turn up to sign autographs.

Session 6: Presentation of 'prototypes'

A week passed between sessions 2 and 3 and between sessions 3 and 4. After the concept development session had been completed, however, three weeks passed during which the product developers/designers continued to work on the concepts. The intention was to reach a 'prototype' level for at least some of the concepts. If a physical prototype was not feasible, a virtual prototype was created.

The final results included two dinosaur-shaped cookie cutters (Figure 7), posters for the different healthy sweets (Figure 8), a functional model (scale 1:1) of the fruit protector in ABS (by rapid prototyping) (Figure 9), computer models of the dish-washing device (Figure 10) and wasp trap (Figure 11), some CAD work on the canteen (Figure 12), a "fruit table" (scale 1:1) (Figure 13) and the city built in Google SketchUp.

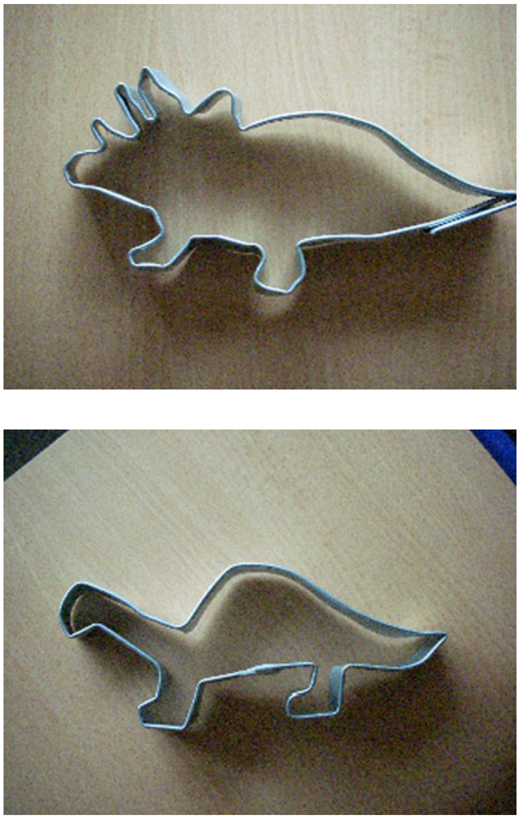

Figure 7. Cookie cutters shaped as a dinosaurs.

Figure 8. The advertising campaigns for “Rodeo”, “Rundat” (rounded), “Perstron” (a mix of “**per**sika” (peach) and “hall**on**” (raspberry), and “Krioxo”, argued to be “healthy sweets”.

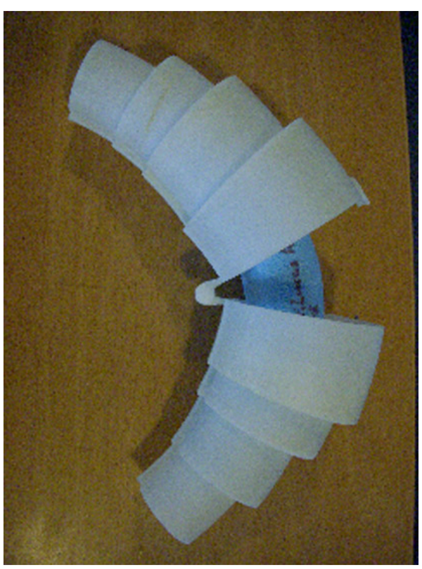

Figure 9. The foldable, and unfoldable, fruit protection kit.

Figure 10. The washing-up device in different versions.

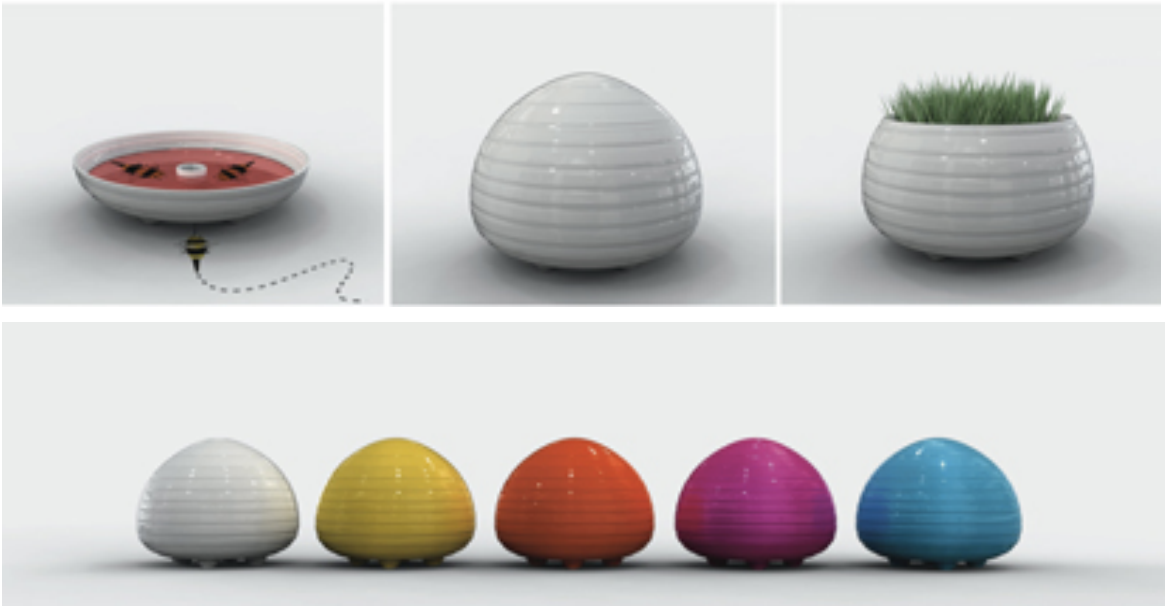

Figure 11. The wasp trap.

Figure 12. One of the design proposals for the school canteen had a jungle theme, here represented in CAD.

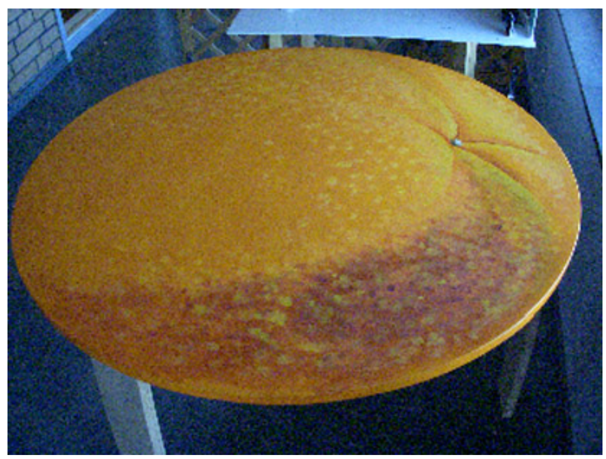

Figure 13. The “fruit table” produced in scale 1:1

The results of the prototyping work were presented to the children to gather their comments and impressions of the work. Did the concepts turn out according to their expectations? The discussion proved less dynamic than anticipated, however, and the children did not appear to relate to the prototypes as part of and/or the results of their work. The only prototype in which the children demonstrated a real interest was the virtual city in Google SketchUp which allowed them to interact with the software and make changes to the virtual representation for instance in terms of changing colours and perspectives.

Session 7: Communicating the project

Finally, in the sixth and last session, a small exhibition of the prototypes was arranged in order to communicate the results to other pupils at the school and to the children’s families. For the exhibition, posters were made illustrating the process in each design team, from ideas and early sketches to the final concepts. This time the children appeared more engaged than in the former session, taking part in completing the exhibition (an example shown in Figure 14) and even producing new product representations to further illustrate their work (Figure 15).

Figure 14. A model of the way food could be served in the school canteen.

Figure 15. A representation of one of the canteen solutions, the conveyor belt, produced by two children in GoogleSketchUp. The text reads approximately (with some spelling mistakes) "*The change of the food distribution in the school canteen"*

Evaluation

The project was evaluated and both children and product developers/designers were involved. The children were asked to write down their thoughts on the co-design project and what they had learnt. Overall the comments were that they had enjoyed taking part in the project as a whole (i.e. the autumn and the spring). Some children had preferred the earlier co-research activity, while others had found the co-design phase the most rewarding. Being able to "create" or "make" things had been "fun". However, there were also children who had found the co-design activity negative as they were not satisfied with their design solution (or the representation of the design solution).

The participating university teachers and students were interviewed regarding their experiences. Overall the response to participating in the co-design project was positive, but it had also involved some challenges. Excerpts from the interviews are presented below:

- " *… it was exciting. I thought it was fun to observe the creative ability of the children. ...// … They are very positive and unrestrained ...//…Then, of course, there are also problems associated with being unrestrained*."
- "*… The children could become extremely focused on a particular idea. …//…If this happened you had to put an end to it, well, I tried to broaden their thinking*."
- *"… I tried to capture their ideas as much as possible but at the same time one could feel that one was restraining them."*
- *"… to begin with it felt as though we have drifted away from the task and it felt as something negative as one is used to finishing a task if a task has been given. But then one had to say to onself that, well, what will this turn out to be? And if one doesn't end up with a store but with a house, I suppose that that is a result too."*

- *"I don't think they understood the process. I got the feeling that when they do something at school …//… you ask them if they have an idea. And then one tries to realize the idea…//… You move directly from idea to final product. One doesn't work in an iterative process, with evaluations, etc."*

Reflections and Lessons Learned

One outcome of the project consists of different problems and ideas for solutions to these problems. "Creating positive experiences" appear to be the "continuing thread".

Another result, which is the topic for this paper, includes experiences of co-designing with users. Some of these lessons learned are believed to be a consequence of the fact that the users were children, and may therefore be relevant only for other projects involving children as co-designers. How to maintain focus and concentration was, for instance, such an issue. Other experiences are considered more generic, i.e. issues which could emerge as important topics in any co-design process. Communicating an understanding of the product development process and the time and resources required for the product to develop from idea to prototype were considered such a generic topic.

Distribution of power and responsibilities

A first question to be posed is whether or not the project was, indeed, a co-design activity, i.e. a synergy of different skills. A related question concerns the allocation, or distribution, of power between the children (as users) and the adults (as product development/designers) in the project. The product developers/designer predominately worked with the children at their school, in the children's regular classrooms. It became evident that the adults, in the eyes of the children, were synonymous with "teachers" and hence the children accepted being told, but also to some degree expected to be told, "what to do". A slightly different relation was developed when the children and the product developers/designers during session 5 met on a more neutral arena. Hence, *the physical context should probably be considered* in these types of projects. The same concern has been raised, for instance, by Druin (2002), Jones et al. (2003) and Vaajakallio et al. (2009).

A factor contributing to the product developer/designer becoming the "teacher" or "supervisor" rather than the moderator was probably *the size of the team*. In the early phase of the project the design teams were fairly large with one senior product developer/designer and 7-8 children in each team. In the later phases of the project, the total number of product developers/designers was increased and the number of children per team therefore decreased. This not only helped balance the team, but also contributed to maintaining the design team members' involvement and focus. This issue has also been discussed by Druin (2002), Jones et al. (2003) as well as Vaajakallio et al. (2009), the concluding suggestion being that "*… a lot of resources including many adult facilitators … / /… are needed when working with children*" (Vaajakallio et al. 2009, p. 247)

Furthermore, a fundamental idea behind the project was that the children were to participate with their knowledge of, and with references to, being children. The product developers/ designers were to participate with their knowledge of design methods, skills in visualizing ideas etc. This could mean a drift in power, from the children to the developers/designers, a concern that was raised in the interviews with the product developers/designers. In co-design process it is, however, important that the respective participants are valued for and can play on their respective strengths. The designers' ability to sketch actually played an important role in facilitating co-creation in that the designers could rapidly visualize ideas, including the children's ideas, and these sketches could be used to discuss different issues within the team. The sketches thus became mediating tools, or enablers, for the design team as a whole.

Overall, the project proceeded as intended but not all design teams developed in the same way. It appeared unavoidable that the product developer/designer (i.e. the adult) took, or had to take, the role of “project leader” and/or “design team manager” but in doing so he/she also had to be aware of allowing the children's voices to be heard and to make a difference. The role could thus also be described as that of a moderator or facilitator. In the wasp trap team, the children participated actively and came up with different concepts. The designer developed the concept quite far from the early model in terms of how it looked but, nevertheless, the basic idea remained and the children recognized their “thinking” in the final product. The same holds true for the dish-washing device. In both cases the product developer/designer took control of the process, while still working hard to keep the children involved. In the healthy sweets team, on the other hand, the result of the process was that each child worked on his or her individual idea and the product developer/designer became the supervisor, or tutor, rather than a participant in the team. Hereby, the fundamental idea of co-creation was lost.

Maintaining focus and interest

Certain phases and tasks in a product development and design process require dedicated, focused labour in order to be successful. This can be assumed to apply also to the co-design process. The product developers/designers were, evidently, based on earlier experiences well aware of this and could consequently allocate the necessary resources. The children did not always manage, but there were large differences between the individuals. Some children were able to focus for a long time (even several hours) if they found the task interesting and meaningful. Two children, both boys, for instance spent four hours learning Google SketchUp and produced a usable drawing of their design concept, since they found that the product developer/designer had not accomplished this when developing the “prototypes”. Other children appeared to be able to focus for short periods of time, if at all, and the process had to be managed accordingly. Being able to understand the rationale behind a task, such as structured idea generation or assessment according to criteria, was identified as a key issue in maintaining the children's motivation.

However, in becoming unfocused or uninterested the children also communicated a self-projected inability to contribute to the work or contribute in a way they judged “good enough”. Most of the children appeared to face problems visualizing what they wanted, the way they wanted, on paper and in those cases where the model-making became too complicated for the children to be able to contribute substantially, their enthusiasm regarding the task clearly decreased. Evidently, the requirements on the participants in a co-design project must match their abilities and skills, and if the participants involve children particular care must be taken (cf. Vaajakallio et al., 2009). The question is, though, how much time should be dedicated to encouraging the participants of a co-design project if the process is based on the idea of ‘equal input’?

Focusing on and maintaining interest for particular design tasks were thus one issue. Maintaining the children's interest over time was another. The time lapses between the sessions were one to three weeks and each session, apart from session four, lasted for approximately 1½ hours. A week is most probably perceived differently by a child compared to an adult: a lot of things happened between weekly design activities, things which became more interesting and more urgent than the co-design project. In retrospect, more concentrated work where the teams had met every day or every other day but for a shorter time might have helped to maintain focus and interest over time.

Grasping process and methods

Various methods and tools were used for idea generation, evaluation of ideas, concept development, etc. These were examples of methods and tools typically taught to design students. The underlying thought was that children as a whole are no more creative than adults, and hence need support in terms of mediating tools. This assumption proved correct in that some children were very creative, while other children were not. However, based on the experiences obtained in the project, children and adults may have somewhat different needs when it comes to design methods. The children were noticed to, at times, become very focused on a particular idea and did not understand why further idea-generation was necessary why they needed encouragement to think further. However, methods devised to “free ones mind” and “think out of the box” did not always prove useful. A substantial number of “crazy ideas” emerged without any support and what was needed in these vases was instead methods and tools which maintained creativity but at a “working” level.

It was obvious that the children had, in most cases, very high expectations of what could be achieved during each session and in the few weeks allocated to the project. They did not appear to consider the results of the idea-generating session, or the concept development session, to be “results”. They had possibly expected “real products” or at least more realistic products to be the end result. This may be one reason why the computer generated images in general appeared to receive a better response than did the physical prototypes – the computer images probably looked more “real”. The fruit protection kit, on the other hand, did not impress the children at all even though it was developed into a working prototype in ABS, something that from an engineering perspective is quite impressive. It simply lacked the glossy plastic surface of injection-moulded plastic and it broke after half an hour.

It is most probably very difficult for someone not professionally involved in product development and design work to estimate the amount of time and technical problems associated with developing an idea into a completed product. Even though the development process, and its different stages, had been briefly introduced in session 1: Introduction, communication of the different design phases and their respective purposes and outcomes should probably have been given more time in order for all team members to fully grasp the progress. It is also possible that the co-design process per se should have been ”co-designed” to a greater extent in order for the different phases to be comprehensible to all those participating in the design work.

In conclusion, the project provided further evidence that co-design with children is a workable endeavour, with much the same opportunities and problems as co-designing with other categories of users. Nevertheless, some particular issues have to be considered: additional resources is needed in terms of adult facilitators, the requirements on the children as co-designers must match their abilities, and ways must be found by which focus and motivation can be maintained over time.

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Knowledge Transfer from Designers to Home Crafts Makers: Negotiating Methods to Study Actions in Context

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Abstract

This paper discusses the methodological problems arising in a dissertastion research project that investigates potentially productive relationships between professional designers and home based craft makers who have not received formal design training.

Informal observations by the researcher and other designers indicate that, when individuals from these two groups work together, in either professional or social settings, the craft makers' practices may develop in productive ways. We have observed that this can occur and be beneficial in traditional home craft work in Turkey (the main field of the research), post-industrial craft practice in Britain and small-scale industry in both countries.

In this research project, the designer-researcher is a participant observer dealing with non-verbal communication and the exchange of tacit knowledge stemmed from interpersonal relationships between the designer and the participants. In order to carry out a formal investigation of such a relationship a number of methodological issues must be addressed.

To develop a suitable approach we have examined theories with comparable features and explored the methods that would allow a managed programme of engagement between designers and traditional home craft makers to generate data and to process this data.

Since the knowledge transmitted or engendered in this research is tacit, it cannot be accessed purely by using language-based methods such as questionnaires and interviews although these can provide valuable triangulation. How to elicit the tacit knowledge transmission was the most important methodological question that we faced. That is why we reviewed methods for reflecting on the actions to elicit tacit knowledge transfer.

The questions we have explored include an evaluation of Action Research and Participant Observation, the advantages and challenges of observational video for capturing

spontaneous actions and reactions and the ways learning theories might help us to identify and characterise the essentially ‘silent’ tacit knowledge that is exchanged.

These methodological evaluations indicate the chain of methodological decisions that will be developed in this paper which will also speculate about how methods might develop during the practice in field work.

Since the aim of the project is to identify ways that designers and design researchers might act as enabling agents in developing the creative and professional understanding of well-motivated makers we will also discuss the nature of the methodology of practice that might emerge from this research as well as how we developed the hybrid research methods for this inquiry into knowledge transfer in informal production space.

Keywords
tacit knowledge, design learning, home crafts, informal production

The Research Context

The main question of this research is how to explain the gradual transmission of design knowledge in the works of home craft practitioners when they are exposed to designerly[1] thinking for a certain period. To explore this question methodological negotiations were made to design the research steps of a complex research question which involves capturing and studying actions that can only be understood via tacit knowledge.The ineffiableness of tacit knowledge has lead the authors to revise methods of research to develop strategies of eliciting reliable evidence by analyzing the making environment imbued with an intuitive understanding of the phonomenon. As a result of this elaboration the authors suggested a tentative methodology to study “concealed”, “silent” or “tacit” design learning in context.

To be able to work with tacit knowledge in this specific framework we have drawn on methods developed in recent practice-led research by Bowen (2009), Wood (2006) and Rahman (2010) as well as broader principles of exploiting tacit knowledge in design research previously developed by Rust (2004, 2007, 2009). In particular this work is guided by the

[1] “Designerly” way of thinking has been widely used in design research literature after Bruce Archer coined this term for the first time: “ There exists a designerly way of thinking and communicating that is both different from scientific and scholarly ways of thinking and communicating and as powerful as scientific and scholarly methods of enquiry when applied to its own kind of problems” (Archer, 1979). This ontological proposition has been widely cited and studied and it has also been the basis of some of the major works of Cross (2006,2007) and Schön (1983).

theories of Michael Polanyi (1958) who elucidated many of the fundamental concepts of how tacit knowledge is gained and used. This chain of arguement of methods can also guide further research in complex situated actions that embody design learning and tacit knowledge transmission.

Introduction

The reason for this inquiry is to observe how home crafts practitioners change their practice and attitude via exposure to design knowledge because the wide practice of home crafts might be a fertile ground to blend contemporary design practice and knowledge with local skills and knowledge particularly in Turkey: the field of the dissertation which is the source of the methodological argument that will be carried out in this article.

Another argument of this dissertation depends on how rapidly craft skills have been disappearing in post-industrial societies. Various research projects in post-industrial societies (especially the US and the UK) focus on ways of preserving hands on skills via contemporary media and concepts.

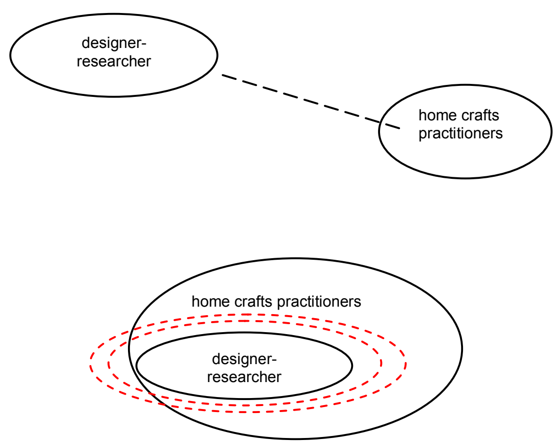

Figure 01. The designer-research joins a group of home crafts practitioners as a participant observer and studies the knowledge transmission that occurs during interactions with practitioners in workshops.

Having seen that these skills have been disappearing after a long history of industrialization in post-industrial societies, the dissertation also aims to build a methodology to understand and transform the minds of the practitioners of these skills and to explain this change with contemporary design theories.

This methodology could specifically be used as the initial step to enter a making environment by designers and design researchers who wish to engage with practitioners with hands on skills, particularly non-designers.

To study the tacit knowledge transfer from a designer to the home crafts practitioners we decided to organize three consecutive workshops where the designer-researcher is a participant observer. Each workshop is analyzed and the outcome of the previous workshop is used as data to structure the next workshop. The repeating analyses between the workshops have two aims: (1) Refinement of the designer-researcher's interventions (2) Elicitation of the transmitted knowledge, in other words measuring learning. The following sections of this article is going to explain how the research design represented in Figure 06 was devised depending on prior design research on tacit knowledge theory and situated learning theory.

Tacit Knowledge Transmission

As mentioned above the aim of the dissertation is to study the possible change in home based makers' practice and attitude when they work with designers for a while. The knowledge transfer that is expected to occur in this project is indirect, informal, unconscious and tacit.

In Personal Knowledge, Polanyi (1958) introduced the first concepts of tacit knowledge: that some part of our knowing occurs in relation to some *"unstated"* interactions among the various arrays of our prior knowledge in many fields. Thus, tacit knowledge embodies what we know but that we are not able to express with words (Polanyi, 1958). A popular example is riding a bike and not being able to explain how. This is highly relevant to crafts, design and all other making skills since we do not know how we make. And even when we make it we might not be able to explain how we made it with words. Yet, craft, design and other making is learned.

According to Polanyi (1966) tacit knowledge exists and is developed when the maker surrenders herself completely to the making. This process is defined as *"indwelling"* by Polanyi (1966) and it is cited by Rust (2004, 2007) as a crucial concept for design research:

> *"Polanyi was concerned with what he called the tacit dimension" in our knowledge. In particular he wished to give proper value to the process of recognizing, and making a commitment to, ideas and hypotheses, which may result from a rich understanding and*

> *knowledge but cannot be explained by tacit reasoning, in order to carry out the enquiry that will lead to them being more widely understood and accepted"* (Rust, 2004: 77)

Polanyi (1966) says that the apprentice unconsciously learns more than what the master thinks he is teaching: *"You follow your master because you trust his manner of doing things even when you cannot analyze and account in detail for its effectiveness. By watching the master and emulating his efforts in the presence of his example, the apprentice unconsciously picks up the rules of the art, including those which are not explicitly known to the master himself. "*(Polanyi, 1966, p. 53)

According to Lave and Wenger, this unconscious change that occurs over time might be called "situated learning". Lave and Wenger (1991) who are seen as the founders of situated learning theory suggest that learning occurs unconsciously within an action in a cultural context. Thus it is situated. According to Lave *"...learning is ubiquitous in ongoing activity, though it is often unrecognized as such."* (Lave, 1993) In other words, learning occurs everywhere during ongoing activity although we think that it occurs only in a teacher-student relationship. Since tacit knowledge acquisition is also impilicty embedded in actions, situated learning theory might also be able to guide a methodology to study tacit knowledge acquisition.

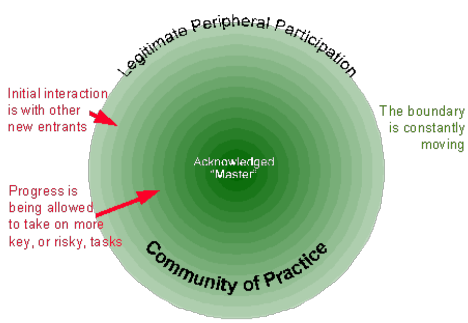

Figure 02 Graph of legitemate peripheral action theorized by Lave and Wenger, 1991.

The primary theory of situated learning defines how new learners learn more as they engage more with the learning context. According to situated learning a novice starts from a peripheral situation and progresses to the center towards the master in time. Figure 02 shows a basic diagram of how learning occurs according to situated learning theory (Lave & Wenger, 1991). In other words, newcomers to a community of practice are first in the periphery. As they keep working in the group they progress by feeling comfortable to take on more risks and experiment.

The vital point of moving towards the center from the periphery (also known as Legitemate Peripheral Action) for this research is that the movement is not *linear* but it is a *helix*. The "helix" movement towards the center- in other words "learning"- determines the duration of the research, the intervals between the workshops and the required analyses between each workshop.

Before each workshop the learner goes back to the previous action and reflects on the "learning". These are spaces between two circles in a learning helix. In other words, the transition intervals serve as check points where the novice looks back and acknowledges that she actually has made progress. Her perception of her work improves relatively from the previous cycle. Depending on this theory, we decided to structure several regular analyses with certain intervals to elicit the gradual progress in time as opposed to eliciting learning from the entire corpus of documentation.

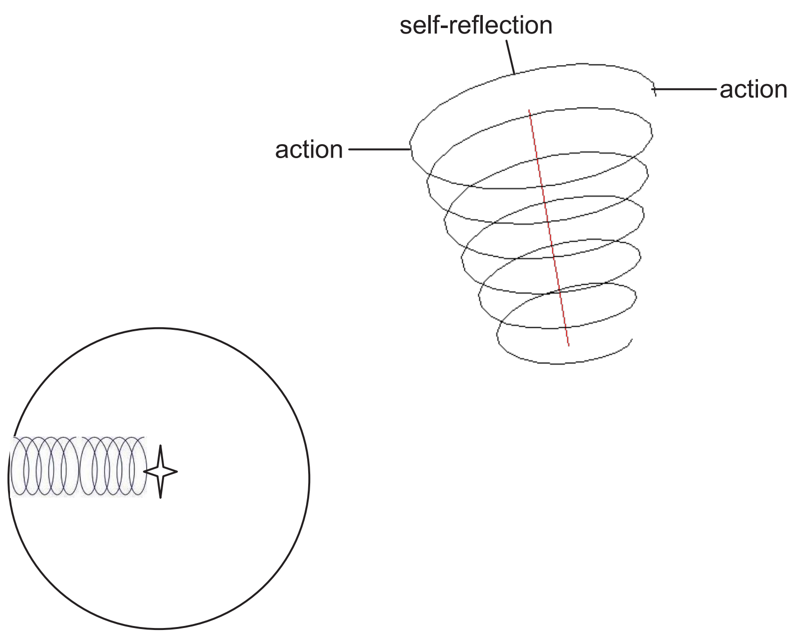

Figure 03. Graph of legitemate peripheral action theorized by Lave & Wenger, 1991. Learning occurs through a helix that moves from the novice to the master.

Capturing and Measuring Tacit Learning

To document the actions during the workshops observational video is going to be used because video captures sound and motion simultaneously and thus provides a rich resource for later evaluation. Having research data available to go back and re-evaluate is essential in this research because it observes gradual and subtle change. Wood (2006) explains this with an example in her research: When she was reviewing the footage with a master bowl turner Robin, he tried to catch up with the pace of the video footage and thus got frustrated due to lack of time and was not forthcoming. Having realized this Wood paid attention to the important matters that are being skipped and she rewound the footage again and again to provide enough time to open up the issues. Eventually, she noticed that the participants themselves opened up the issues when they were reminded that they could rewind the tape.

Being able to access video footage more than once is also important because it can be processed not only by the researcher but also by the participants. Measuring tacit knowledge transmission is complicated because the participants can not explicitly show what they have learned. This transmission can "partially" be traced from the designer-researcher's field notes and from her own analysis of observational video footage. That is why it is necessary to access what the participants think of the workshop experience by watching the observational video footage with the participants: in other words, to double check whether they agree on the researcher's findings. By asking the participants to reflect on their own actions might also help them acknowledge their progress consciously. This causes increase in self-esteem and self-confidence. This is how the participant internalizes the acquired knowledge (Schunk & Zimmerman, 1997). For this reason we planned to watch the observational video footage with the participants and analyze their verbal reports of self-reflection. To sum up, since it is not possible to explicitly identify tacit knowledge acquisition only by the researcher's interpretation we decided to "double process" observational video to see the interpretation of the participants of their learning experience. This can enable the participants to verbalize their interpretation of the knowledge acquisition process which can be called learning "bridges" (Wood, 2006).

Identifying Learning Bridges

Wood (2006) developed strategies for designing materials to help novices gain craft knowledge. She studies tacit craft knowledge to elicit knowledge that can be explicitly represented for learning resources. One of her findings in her research on transmitting craft knowledge, which is highly tacit, was a threshold where novices start communicating better with the craftsman. In other words, the initial interactions of the novices with the master can be painful and difficult. However, in time they develop a common vocabulary, understanding and communication. Wood (2006) explains the necessity of explicit information to form initial “bridges” to cover the gap of knowledge between the master and the novice during thet early difficult stage:

> *“The expert might start by demonstrating but, rather than leaving the novice to try and interpret what they see, the expert might provide a commentary, thus attending from his practice to his theory. The expert’s commentary will use explicit concepts in an attempt to bridge the gap, and the novice will need to undertake some form of action in response to this received knowledge, primarily imitating the expert, but in a reflective manner. The expert in turn should observe and reflect on the novice’s response considering revising his interpretation until a consensus of understanding is reached and the gap is bridged.”* (Wood, 2006, p. 131)

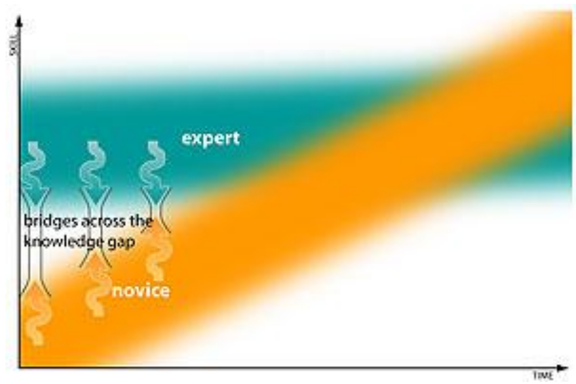

Figure 04. The knowledge gap between craft novice and expert. Wood, N. (2006) *Transmitting Craft Knowledge: Designing Interactive Media to Support Tacit Learning Skills*. Unpublished PhD thesis. Sheffield Hallam University: 147.

The mentioned treshold named as “bridges” during the tacit craft knowledge transmission process has been a compass to find out that there is indeed enough overlap between a designer and a home crafts practitioner to start a tacit learning process (Figure 04). Figure 05 shows where the participants of this research are in relation to the designer-researcher. In other words, home craft practitioners have enough exposure to the basic techniques of their craft and even enough motivation to work with institutions as individual entreprenuers. As shown in Figure 04 and Figure 05 in the beginning the makers might need some bridges to dwell into the overlap zone which is the locus of this research where they already have some similar skills with the designer to progress rapidly.

Looking at Wood’s theory and situated learning theory, we suggest that via this proposed methodology we can test that bridges are not only built in the intial phase of the master-novice interaction. Other bridges can be formed everytime the novice looks back at her work and reflects on it: in every turning point of the learning helix shown in Figure 03. For this reason, the analyses phases between in each workshop aim to explicitly define how new learning bridges have been built if not the bridges themselves.

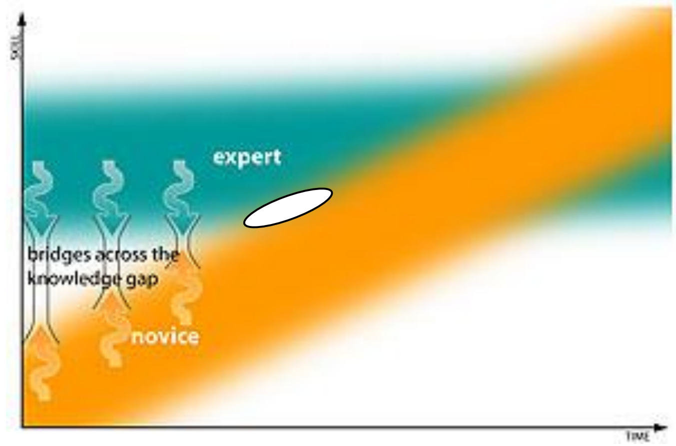

Figure 05. Locating this research on the theory of the knowledge gap between craft novice and expert. Wood, N. (2006) *Transmitting Craft Knowledge: Designing Interactive Media to Support Tacit Learning Skills*. Unpublished PhD thesis. Sheffield Hallam University: 147.

External Evaluation: From “distal” to “proximal”

The ways in which new learning bridges are built can be evident in the objects made in the workshops besides the interactions of the designer-researcher and the participant. The objects might also embody evidence of tacit knowledge that has been acquired from the designer-researcher by the participants. Analyzing what the participant might have learnt can be called looking (or *indwelling*) from “distal” to “proximal” in Polanyi’s words (Polanyi, 1958).

According to Polanyi (1958) tacit knowledge functions as an interrelation of two parts called *“proximal”* and *“distal*”. A simple example to explain this can be how a carpenter knows his hammer by its action on the nail and knows his muscles by the movement of the nail in wood (Polanyi 1958). In other words we cannot know of the hammer's use without the nail. To grasp the knowledge of the hammer we have to attend to the nail.

When looking from the proximal to distal, the proximal processing makes a leap towards the distal artifact as in the hammer-nail example. The relationship of the artifact to the process cannot be explained explicitly because it is tacit, yet can be validated through descriptive procedures. An example of this can be found in Bowen's (2009) process in his PhD thesis where he employed a tacit knowing relationship to *"process"* his experience of working with stakeholders (participants) by creating new design ideas. Bowen (2009) explains this processing as achieved through a tacit knowing relationship that has been creating by *"indwelling"*:

> *"In the case of my development of a critical artifact methodology, I suggest the comprehensive entity is the development of product ideas (as affected by the stakeholder activities). So, I can "process" my experiences of the stakeholder engagement activities by dwelling in them; by attending from these experiences (as the proximal term) to the designing of further conceptual designs (as the distal term)."* (Bowen, 2009, p. 173).

This proposition might work both ways. The other suggestion can be looking from the "distal" to the "proximal". In other words the artifacts (distal) can "*illuminate*" the reasons and aspirations (proximal) for which they were made.

Thus, in this research unlike Bowen's (2009) methodology the proximal and the distal are reversed as mentioned above: we will look at the artifact (distal) and track its motivation to be made (proximal). To achieve this, we are going to ask an external committee of experts with prior design research and practice background to evaluate the final work of the participants with reference to the initial work of the participants. This descriptive and comparative evaluation of objects will give us evidence about how the participants made progress.

The mentioned methodological decisions based on tacit knowledge theory and situated learning theory helped us shape the tentative methodology shown in Figure 06 to address our research question. Since we aim to observe tacit knowledge transmission we used situated learning theory because situated learning theory defines a structure for unconscious learning processes. This structure is a helix movement of learning from the periphery (novice) to the center (master). It is highly probably that the tacit knowledge is also acquired in a helix movement as it highly corresponds to the definition of situated learning: *"ubiquitous in an ongoing activity"* (Lave, 1993).

According to situated learning, the participant makes self-reflection on what she has learned in the initial step before moving on to the next step. That is why, the analyses steps have been placed at these points: between each workshop. In these intervals, the time between two consecutive workshops, the outcome of the previous workshop is analyzed in two steps. The first one is watching the video footage with the participants to hear their interpretations of their learning experience. The second one based on the two components of tacit knowledge:

tracing tacit knowledge transmission from “distal” to “proximal”. In other words external committee will be asked to evaluate the final work of the participants in comparison to their initial work (work documented before the workshop). Both steps aim to explicitly describe how learning bridges have been established.

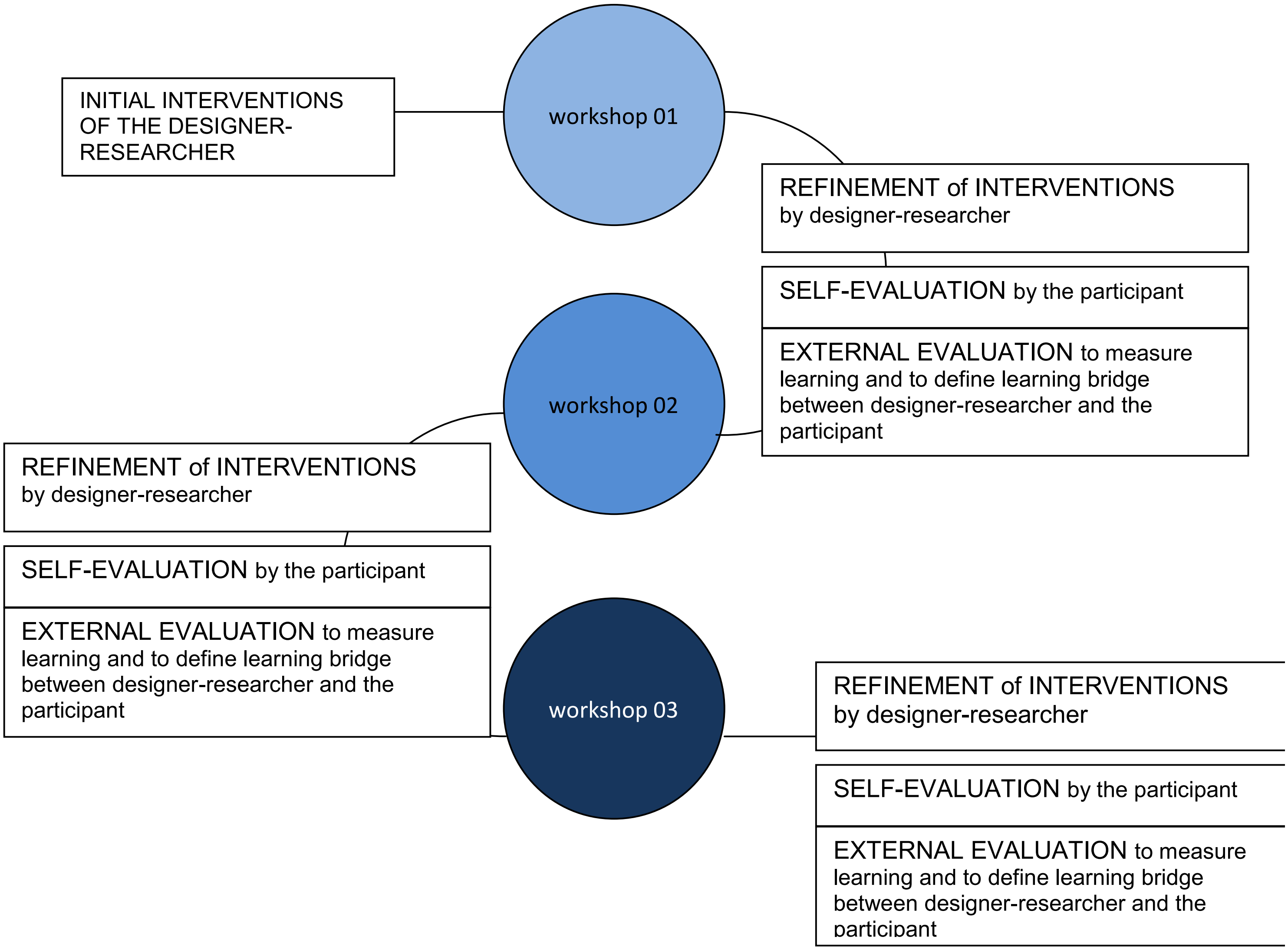

Figure 06. Research design to study how design knowledge is transmitted when a designer works with a group of home crafts practitioners.

Beyond Action Research

To study how a designer influences makers AR is essential for embodying action and reflection together during relationships.That is why AR is widely used in practice-based design research because AR focuses on incremental change (Pedgley 2007, Durling 2009). Although the methodology proposed above to study the mentioned specific research question highly resembles to AR it has some important differences. For this reason it is important to discuss why AR is almost but not exactly the methodology of this research. Although it illumniates the ideological roots of this methodology, it does not exactly correspond to the necessities of this research again mainly because the tacit nature of design are being explored.

In AR the researcher studies groups before, during and after an “action”, in other words “while doing things” to generate “change” and “understanding” consecutively: *“....It is thus an emergent process, which takes shape as understanding increases.”* (Sanoff, 2007, p. 214). According to McTaggart (2003) *“Fundamental to action research is the idea that the social world can only be understood by trying to change it.”* (cited in Brydon-Miller, Greenwood, & Maguire, 2003, p.15)

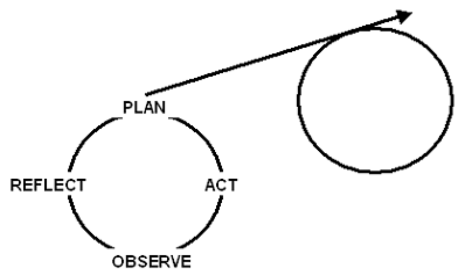

Figure 07. Steps of AR. Zuber-Skerritt, O.(1993). Improving Learning and Teaching Through Action Learning and Action Research. *Higher Education Research and Development, 12*(2), 45-58.

Although highly relevant, the method of this research is not exactly AR. While “following the problems” in a systemic cycle with respective logical steps shown in Figure 07, the subtle findings during the action might be missed because the elements shown in the cycle in Figure 07 (observe, reflect, plan, and act) have an integrated nature particularly in designing and in researching design (Swann, 2002). In this study it is not possible to identify these elements consecutively in cycles with certain logic because these processes are tacitly developed.

In her research on transmitting craft knowledge Wood (2006) indicates the same experience: *"....Whilst these elements are clearly identifiable in the research undertaken, they have not occurred as a sequence of separate and logically undertaken steps, rather the boundaries have been blurred and at times elements have been undertaken simultaneously."* (Wood, 2006: 14) Then, it might be discussed that some design researchers consciously use a non-identical twin of AR not to miss the tacit knowledge that is coming out during the action, like a good cameraman who might have to kneel down yet looking through the same frame.

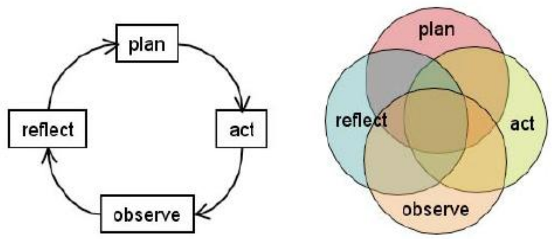

Figure 08. a. Action research b. Wood's (2006) interpretation of action research in practice lead research. Wood, N. (2006) *Transmitting Craft Knowledge: Designing Interactive Media to Support Tacit Learning Skills*. Unpublished PhD thesis. Sheffield Hallam University: 16.

Unlike action research, participant observation (PO) does not necessarily have logic of repeating steps of thinking and acting. Vice versa it is a method that tolerates blurry borders of planning, acting and reflecting to access entangled phenomena that cannot be accessed otherwise by other methods.

Participant observation is also appropriate for an iterative process where the researcher can go back to the event log (the notebook where the researcher writes down field notes) as frequently as she wants either alone or with the participants to revise it. This enables the researcher to pull the participants into the research. For this reason, the designer-researcher will work towards a specific methodology based on PO in consequitive workshops with intervals. This will constitute the field work.

Conclusion

This tentative methodology requires a relatively continuous long term study. First of all it is vital for the researcher to be present in every workshop, work with the participants and analyze workshops until a repeating pattern of the hypothesis is recognized. This is going to indicate when the research should be terminated.

Prior research most of which are practice-led dissertations have elicited, worked with and analyzed the tacit dimension of design knowledge due to their immanent connection to practice: “designing” and “making”. These researchers have been challenged by the difficulty of communicating their research because it is not possible to know how one makes. Yet it is possible to process the research through an argumentative analysis with detailed and clear procedures that document the entire process (Biggs, 2002; Durling, Friedman, & Gutherson 2002 ;Rust, 2004; Niedderer, 2007; Pedgley 2007). Prior research that document, analyze and synthesize tacit design knowledge also shows that the “tacit dimension” highly determines the methodology of the research as in this case.

In this article, we tried to explain how we reasoned our methodological decisions to adress a certain research question by the interrelations of learning theory, tacit knowledge theory and how these theories have been applied in prior design research. This methodology has been proposed to capture, measure and define tacit knowledge transmission during an action in a making environment. This chain of decisions can help design researchers who would like to study actions in context. The main argument of this article can be an example of how conventional research methods such as observational video and AR have been re-visited to address design-specific issues such as the tacit dimension of design.

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Ontological Design Ways of Sustainable Intervention: A Conceptual Framework

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Abstract
What is meant by the ontological way of sustainable intervention between technology and humans, and how can it be studied? This paper seeks to assist designers to structure their ontological reflection for sustainable intervention by discovering coherency in technological transformation. Grounded in the notion of ontological designing, this paper proposes a conceptual framework for sustainable interaction design. This framework imposes requirements on function, on behavior, and on meta-conjunction to reflect on and plan what a digital artifact is for; what the artifact performs; and what the artifact synthesizes. Four functional dimensions are highlighted: *Balancing* (B), *Prevention* (Pv), *Persuasion* (Ps), and *self-Motivation* (M). In each of the dimensions, the behaviors of digital artifacts are articulated as key design activities. Finally this paper attempts to justify the meta-conjunction process, which is established in each example of digital artifacts. Therefore, the results of these analyses show how ontological designs are shaped in a set of conceptual boundaries.

Keywords
ontological design; sustainability; conceptual framework; interaction design.

Our lives take place on the blurred boundary [18] between technology and the natural world. Today new technology systems are in need of sustainable intervention to address environmental problems. Designers' critical reflection can make the boundaries determinate and embody concepts of digital artifacts conscious and meaningful (e.g. a hybrid rather than a gasoline-powered car). Yet, if designers fail to carefully articulate the problem space of ongoing tensions, interventions may lead into unproductive directions. One possible approach is to envision ontological design ways in an alternative conceptual structure. This conceptual structure points out the reflective attempt to rediscover our connection with new technology systems and expose our true values.

Drawing on the questions, what is meant by ontological activity toward sustainable intervention between human and technology systems, and how can it be determined, this paper discusses the methodological approach of ontological designing [27]. This discussion lays the foundation for the role of designers in the ontological conversation with materials of sustainable interaction design [2], and how they perceive such activities. In this paper, the intervention seeks to discover possible context as the relation between the goal of human users and the behavior of a technology system. When interventions by designers are synthesized within a digital artifact, the digital artifact produces their functional behaviors, which are a useful set for leading users to reconcile their environment at micro and/or macro levels. Thus, this paper assumes the designer as a *critical agent*, whose concern is not limited to the explanation of the character of digital artifacts, but extends to the activity of producing design knowledge that transmits good design intentions.

In setting out the framework, this paper will use the term "*ontology*" in a sense that provides a systematic approach for describing the concept of a digital artifact and the synthesis, including functions and behaviors. By analyzing examples in current digital artifacts and future interaction scenarios that are vital to understand and predict complex human-technology networks, this paper highlights four functional dimensions, which are predominant purposes of sustainable interaction design: balancing, prevention, persuasion, and self-motivation. Each of the dimensions is modeled with the behavioral thread that provides key design activities of digital artifacts. These contexts and solutions imposed on the behaviors transform from the blurry boundary into critical design description.

What is Meant by Ontological Activities for Sustainability?

Willis's perspective on ontological designing [27], dealing with the nature of reflective thinking, contributes to designers' understanding of a subject matter of users. She asserts that "designing is fundamental to being human – we design, that is to say, we *deliberate, plan,* and *scheme* in ways which prefigure our actions and makings." The notion of ontological designing induces the purpose of advancing toward the intervention into interactions among humans, technology, and nature: The form of a digital artifact is an explicit formulation of ontological concept synthesized by designers. With radically different understanding of users' situations, reflection on ontological designing fits well with where/how a designer sees the focus of a particular formulation: on the role that his/her reflection plays in action, i.e. its effect on substantial intervention during the design process for solving ill-defined problems of the real world. While the designer explores the space of possible designs, ontological activity brings together interpretations of the current state of the world, effort, improvisation, and goals. The process of ontological reflection generates *coherence* for the expected world that the actions of the designer produce. This world is located within the interpreted world, as all goals and expectations can be viewed as interpreted representations of potential future designs.

For example, Oulasvirta [19] points out that people often have multiple digital artifacts and accessories tailored for specific tasks such as a mobile phone and a PDA. Although this current context of digital artifacts seems to provide such benefits as suitable display and manipulation choices, these benefits may not significantly change the user's practices of conservation: people might be asked to invest excessive attention and energy for operation as well as consumption of physical materials. Given that designers' reflective interpretations analyze where/how the advantage of a new technology system fits into and changes the existing practices, this ontological action help reach "a sufficient stage of maturity that information appliances are possible with adequate performance, high reliability, and reasonable cost." [15] If we would follow this path, then we would see the new technology aesthetic around us – wind power stations, hybrid cars, solar energy, and so on. Interaction designers consider their own intervention in the external world "not as an end in itself, nor as an artifact positioned to impact a situation" [21], but always as a challenge against accepted design knowledge. Ontological designing is re-creativity instead of mere analysis; autonomy instead of subordination; rationality instead of blind reaction; and intentionality instead of compliance.

The Conceptual Framework of Ontological Designing

An explicit formulation of how designers are intervening may help clarify expressions of ontological thinking, making possible coherency that could be effectively carried out. The so-called method of collection of *designerly* [6] activities for the formulation seems to offer a possible means for organizing discussion at the macro level, in which designers' thoughts are brought together and proceed to sub-classify the activities until, as one of the optimized decisions, the particular kind of activity emerges. The framework specifically aims to stimulate the constructive thinking by which interaction designers may modify current everyday practices with the advantages of functional systems of new digital artifacts such as smart materiality, intelligent architecture, wearable technology, persuasive technology, and ambient technology. (e.g., the shift of interface from the physical button of telephones to the intangible one in smart phones to decrease physical materiality) This framework imposes requirements on function, on behavior of digital artifacts, and on the meta-conjunction process to reflect and plan what a digital artifact is for; what the artifact performs; and what the artifact synthesizes. To categorize the most fundamental functions of the intervention, an analysis of over seventy papers in the sustainable design literature, in such academic disciplines as Eco Design, Industrial Design, and Human Computer Interaction (HCI), was conducted by the author from May to December in 2008. An investigation of ways to integrate the advantages of new technology systems into existing behaviors of digital artifacts was also conducted utilizing examples of advanced interaction scenarios and implementations as well as empirical studies.

This paper assumes that the ontological design activities represented can be viewed as describing requirements of *Function* (F), of *Behavior* (B), and of *Meta-Conjunction* (C) in developing a digital artifact. These aspects are the basic constituents of the ontological reflection that has been applied to various artifacts, including physical devices, software, and functional processes. By interchanging the variable factors of environmental issues and qualifications denoted, different compositions of functions and behaviors can be used to specialize a digital artifact interacting with the world. In this framework, the functional dimensions constituting a rectangle mainly explore these four functions as shown below. In Figure 1, each of dimensions is consistent with the behaviors of digital artifacts that enable designers to orient what they are doing in the synthesis process.

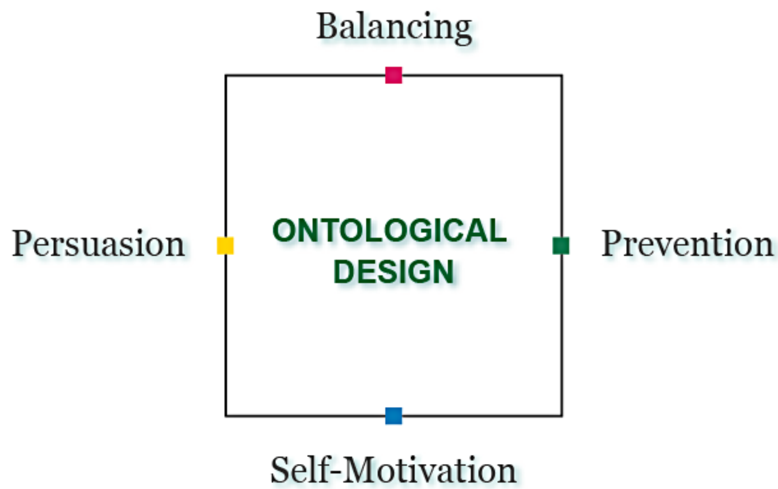

Figure 1 The conceptual framework of ontological designing

Function (F) of a digital artifact is defined as the purpose, "*what the artifact is for*". In this case of sustainable intervention, the indicated functions are "to balance between now and future", "to prevent environmental problems", "to persuade sustainable practices", and "to promote self-motivation of users".

Behavior (B) of a digital artifact is defined as the attributes, "*what the artifact performs*", that can be derived from its function. In the prevention example, behaviors include "using bio-degradable materials" and "using renewable natural materials (e.g., solar energy)".

Meta-Conjunction (C) of a digital artifact is defined as its components and their relationships, "*what the artifact synthesizes*". Components include those which are often specified by a set of variables, functions and behaviors described for a user community, time, environmental factors, constraints, technology, strategy, or materials. The notion of meta-conjunction can be applied at any level of designing. For example, depending on the class of an artifact and the perspective a designer chooses to take, he/she may imbue a radically different conjunction such as spatial conjunction, physical conjunction, information conjunction or organizational conjunction into a digital artifact: a designer's conceptual activity can be viewed as formulating a particular class of artifacts.

At the meta-conjunction level, all processes of design synthesis are unique, since individual designers' conceptual processes and perspectives crystallize the functions and behaviors of a digital artifact with the specialized mode of their understanding of users and environments. They internalize heterogeneous conceptual activities and produce design conjunctions as externalization. The design decision of each composition depends on the approach to synthesis which is used (e.g., synthesizing persuasion and prevention, or synthesizing behavior^1 and behavior^2). The resulting set of meta-composition is a way to position a key domain of design activities to see the relationships in how a digital artifact intervenes to address situational problems.

In the following section, this paper will define each notion of the four functional dimensions, and enumerate what behaviors each of the dimensions has. Each of behaviors is numbered to articulate the process of meta-conjunction.

Prevention of environmental problems (Pv)

The fundamental challenges of environmental problems involve not only improving the efficiency of products that guide consumption and human behavior, but also reducing the rate at which humans poison themselves and damage the world around them [9]. The primary concern of these immediate problems is related to avoiding toxic materials that cause environmental harm. The functional requirement in this dimension deals with the prevention of superfluous consumption of energy and materiality in the short-term. Designers may reflect on and contextualize behaviors of digital artifacts by considering what benefits of new technology can be integrated. This leads to products and services that can directly fulfill users' needs, deliver eco-efficiency, and decrease the materials and energy required to deliver the products' functions. Some of behaviors which designers can consider as the primary attribution in this function are:

Pv^1 Non-toxic material/noise pollution

Pv^2 Using renewable natural materials, such as solar energy, to create new functions

Pv^3 Dematerialization [8] in tangible and intangible products

Pv^4 Reduction of the materials consumed by both users and technology functions

Pv^5 Reduction of the needs of the manufacturing process

Pv^6 Usage of substitute technologies, such as nano/biotechnology, allowing the reinvention of old materiality, flexibility for users' contexts, longevity and durability

Pv^7 Multi-functionality that combines existing artifact capacity with the advantage of new technology without compromising the original functionality and performance

Pv^8 Bio-degradable organic user interfaces (OUI) [7]

Balancing between now and the future (B)

Ezio [13] points out that "good communication systems enable connections among people without the need for movement." As an example, effective communication system design can enable restaurants, along with other surplus food sources, to redistribute food that would otherwise have gone to waste. This averted surplus could be shared among those who need it, such as the homeless or impoverished. This is one possible way that information technology could satisfy the needs normally fulfilled through materiality. [8] Thus, design activity could not only conserve natural resources, but could also enhance balancing everyday practices of the current generation with the environmental interests of the future. In this functional dimension, obtained from eco-efficiency analyses, such factors as time, local resources, life style, production, disposal phase, life cycle [1], the network of product-information-service application, health, and socio-cultural patterns should be taken into account to mediate between the interests of current and future generations. By applying appropriate levels of technological benefits, this critical reflection will enable designers to facilitate the rebuilding of infrastructure and services in which everybody can easily participate. Some of behaviors which designers can consider as the primary attribution in this function are:

B^1 Exploring design activity to synthesize technological effect, user practice, and local environment

B^2 Understanding users' practices and local environments as an ever-changing complex

B^3 Observing vernacular design [20] developed by local community members

B^4 Searching for supply-chain management that uses minimal materials and resources, focusing on local sources

B^5 Applying appropriate technologies and services

B^6 Creating products and interactions that stimulate local employment and/or the local economy

B^7 Redistributing resources fairly within and between generations [18]

Technologies that persuade users to engage in sustainable practices (Ps)

Stegall [23] emphasizes "A profound role in making sustainability a reality is that a designer must persuade the general public to adopt sustainable behavior." In doing so, designers (as persuaders), may seek to discover the message that digital artifacts deliver to users and the distinct ways through which an individual's psychological world alters into an actionable social life. Thus, this dimension mainly stimulates designers to find ways to invite users to experience making consumption more meaningful. For example, these concepts of persuasive technology [11, 12, 13, and 26] discuss the communicative representations that use such clear metaphorical signifiers as words, images, acts, styles, narratives, sensory modes, emotions and/or music. Some of behaviors which designers can consider as the primary attribution in this function are:

Ps[1] *Understanding a digital artifact as a communicative possibility for transmitting sustainable meanings*

Ps[2] *Educating in regards to environmental issues, and indicating the efficiency of energy and materiality*

Ps[3] *Discouraging unsustainable behaviors and encouraging sustainable behaviors*

Ps[4] *Co-active persuading [22] in unobtrusive or obtrusive ways as needed*

Ps[5] *Achieving user friendliness that makes digital artifacts easier to understand and more fun to use*

Ps[6] *Supporting interactivity/user involvement that engages the user's abilities and skills in the artifact*

Ps[7] *Accommodating symbolic appeal, impact, and generative capacity that includes community agreement*

Ps[8] *Revealing a clear identity of sustainability such as in the visual style, the functions of a service agent, and materiality*

Ps[9] *Encouraging emotional connection to digital artifacts to support durability [4, 5] and longevity*

Ps[10] *Improving ergonomics/health and safety*

Empowering self-motivation (M)

Ehrenfeld [9] views the flourishing of immaterial notions like dignity, autonomy, freedom, and authenticity as fundamental in changing unsustainable behaviors. This humanistic and moralistic strategy is closely related to intellectual behaviors that users and community members as secondary producers can organize their own thinking and acting for ecological satisfaction. For example, design democracy, and alternative and self-help solutions (e.g., DIY products) inspire strong motivation, allowing users to manage their work and thinking. Design activity should discover how to empower and motivate users and communities to consistently participate in examining and implementing their identities and values. This design agenda may resonate with users' responsibility for social and environmental practices that protect natural resources. Some of behaviors which designers can consider as the primary attributes in this function are:

M[1] *Observing possibilities for creating empowerment*

M[2] *Creating a co-participatory opportunity as a primarily productive activity*

M[3] *Fostering creative/ontological thinking to enhance users' actions and thinking*

M[4] *Allowing democratic design [17] to help create good decision-making*

M[5] *Empowering community ownership*

M[6] *Universal design that allows the application of widely accepted practices, materials and technologies suitable for a wide range of end users and communities*

M^7 Improving the context-based wellbeing [10] of digital artifacts that serves their purpose better than previous designs

M^8 Eco-labels with improved identification of materials, energy, and production methods

M^9 Suggesting a social networking platform to share time, resources, and knowledge

Meta-Conjunction Process in This Conceptual Framework

The four functional dimensions are deployed as the initial statement made in Figure 1. Once a designer's ontological reflections explore possibilities with these functional purposes key behaviors can be synthesized to intervene in situational problems, and the behaviors can be selected depending on design perspectives or priority. (i.e., this conceptual design process metaphysically leaps among the requirements of functions and behaviors or edits some of them toward discovering most promising solution.)

The analysis of examples, derived from design processes or external results, shows justification of how the functions and behaviors would be synthesized to a certain creation of digital artifacts for any particular intervention into users' situations. This shows the centrality of functional behavior for categorization, which is in line with the adaptive view of design synthesis. The intentional view of ontological thinking also underlines the role intervened by the intention of designers of the artifacts. It should be noted however that the resulting set of processes do not represent any order of execution.

Applying wearable technology to existing artefact capabilities

In Figure 2, showing the Solar JKT from Zegna Sport [14], we can observe how wearable technologies have extended the basic function of everyday clothes. This interactive jacket was developed by Interactive Wear AG, in cooperation with well-known fashion and sports apparel manufacturers, to leverage a renewable resource, solar power. The main function of this clothing is focused on the prevention of environmental problems. To avoid the superfluous consumption of energy, the component of this artifact combines existing artifact capability with the effect of a new technology system, while not compromising the garment's original functionality and performance (Pv^7). In doing so, this artifact adopts the advantage of wearable technology that allows users to recharge cell phones, iPods or other artifacts through solar energy (Pv^2). The users can use the electricity generated from solar energy that is transmitted through conducting textile leads and stored temporarily in a battery or fed directly to a connected artifact. In turn, a conjunction of functional-behaviors in this interactive clothing demonstrates how ontological design perspective and development strategy applies appropriate technology system and service to current user practice (B^5). Figure 3 indicates the conjunctive relation with the two functions and behaviors: Prevention ^{2,7} and Balancing ^{5} synthesized in this example.

Figure 2. The wearable technology, Solar JKT

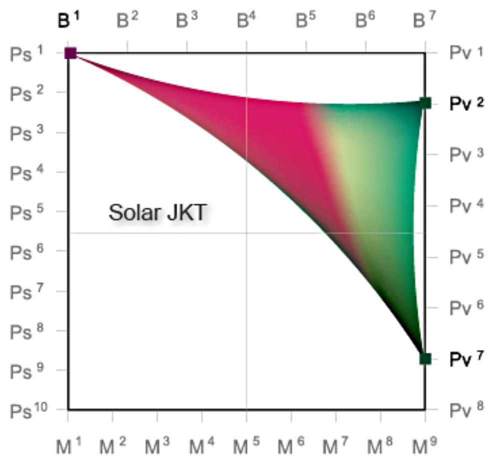

Figure 3. An ontological analysis of Solar JKT based on the framework

Reinventing a digital artifact with nanotechnology

In Figure 4, the Nokia Research Center has developed Morph [25], an elastic concept mobile phone. This concept scenario demonstrates the functional centrality for the prevention, that is, the possible usage of the substitute technology, nano-technology, which enables the reinvention of old materiality for longevity and durability (Pv^{6}). In this scenario, users can transform their mobile artifact into radically different forms—a keyboard, mobile phone or watch. This means that, by integrating the original purposes and performances which each of digital devices has, the components of the multi-behaviors offer users access to the technological variations in the same artifact (Pv^{7}). Users may then be fascinated by the interactivity for flexible accommodation of their different situations and needs (Ps^{6}). In doing so, to match the optimized point among spatial relations of information contexts, physical materiality and usage purposes of users, is a significant design factor here. In turn, this radical conjunction can fundamentally help reduce the consumption of physical materials used for both users' needs and technology functions with low-cost manufacturing and eco-efficiency in mind (Pv^{4}). Figure 5 indicates the conjunctive relation with the functions and behaviors: Prevention $^{4, 6, 7}$ and Persuasion ^{6} synthesized in this example.

Figure 4. Nokia morph concept phone

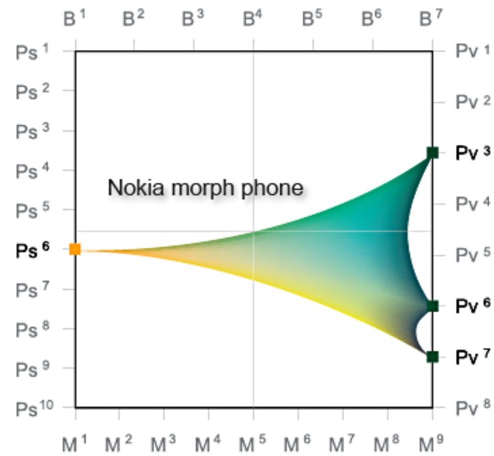

Figure 5. An ontological analysis of Nokia morph concept phone based on the framework

Understanding future sustainable habitat

In this future scenario [16], developed by the Philips's Design Probes Project (Figure 6), interaction designers can understand how new interactive architecture can be used in residential life to balance between the present and future environments. *The meta-conjunction* process of this interactive architecture is defined as the relationships that illustrate the possibility of a habitat as a dynamic eco-system, which deals with sustainable housing for an urban megalopolis in China in 2020. As seen on the right side in Figure 6, the interaction strategy enables the residents to live off the grid of the building while allowing the residents to retain their existing life styles. Regarding the behavioral performances, "the building surfaces, rather than being inert 'dumb' materials used only for construction and shielding, are sensitive skins that are 'alive' and act as membranes to harness energy.... [and create] a strong link between the exterior and interior of the habitat … collecting and channeling air, water, and light from the outside into the inside spaces." [16] In doing so, understanding users' practices in their local environments and constraints as an ever-changing complex (B^2) is fundamental. Designers should discover appropriate design activities to synthesize technological effects (the electronics and bio-chemical functionalities), user practices, and local environment in China (B^1). Searching for supply chain management of the natural resources available in the local environment is also a critical factor (B^4). In turn, this ontological design can improve the residents' current practices, ergonomics, and the welfare of future life (Ps^{10}). The conceptual activity of the design team can be viewed as formulating a particular class of organizational conjunction. Figure 7 indicates the conjunctive relation with the functions and behaviors: Balancing$^{1, 2, 4}$ and Persuasion^{10} synthesized in this example.

Figure 6. Off the grid: Sustainable habitat 2020

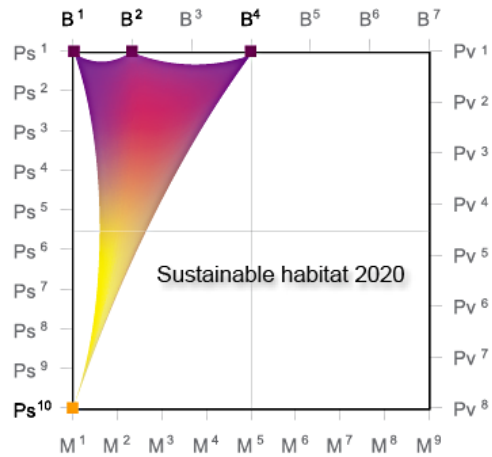

Figure 7. An ontological analysis of Sustainable habitat 2020 based on the framework

Unobtrusive persuasion of sustainable behavior

Both the symbolic and persuasive functions of the meaning of ambient technology have been discussed. In this Wattson energy monitor [28] in Figure 8, we see how the conjunction process applying symbolic expression of the digital artifact changes users' thinking and behavior by indirect persuasion. That is to say, by providing real-time feedback on total energy consumption, this digital artifact shows that the artifact can persuade users to keep monitoring consumption of energy within their home in unobtrusive ways as needed (Ps^4). A change in the intensity of color generated by the artifact gently helps users to understand the energy flow of all appliances in their home and to measure power consumption of each appliance. At this persuasive level of designing, the functional behavior enables them to try to reduce their total energy cost, sometimes by up to 20%. In doing so, designers need to understand the artifact as a communicative possibility for transmitting sustainable meanings (Ps^1). A persuasive strategy to alter users' practices of energy use should reveal a clear communicative message to save home energy in its visual style (Ps^8). Perhaps this persuasive component is also ultimately related to allowing democracy to create good decision-making by users (M^4). In turn, this design strategy can be viewed as formulating an information conjunction into a digital artifact in a certain user community. Figure 9 indicates the conjunctive relation with the functions and behaviors: $Persuasion^{1, 4, 8}$ and $Self\text{-}Motivation^4$ synthesized in this example.

Figure 8. The energy monitor, Wattson

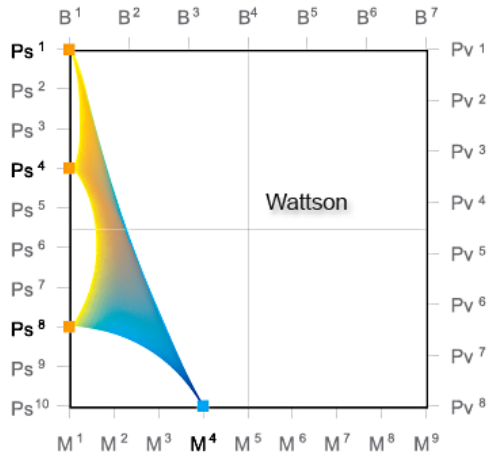

Figure 9. An ontological analysis of Wattson based on the framework

Eco-friendly approach for children

The ontological strategy of the interactive artifacts shown in Figure 10 is designed to communicate an eco-friendly message to children. The prototype toys developed by the "odo" design concept group, Sony Design Activities, [24] mainly aim to establish a sustainable function of self motivation through providing early education to children (Ps^2). To both instruct and make them engaged, the behavioral components of these artifacts tap into children's creativity as well as their curiosity about energy, introducing them to new levels of interactions (M^3). For entertainment while learning, some of these let children have fun moving parts, turning cranks, and using their bodies. This interaction between the children and the artifacts creates a co-participatory opportunity by which the children can be primarily producers to generate energy as they play (M^2). As a commitment to the environment, the behavior of the digital artifacts themselves will be made of recycled and vegetable-based plastics (Pv^8) to offer both new experiences for children and a sense of social consciousness. In pursuing such innovations, it is important that designers should consider universal accessibility that allows the widely accepted practices, materials and technologies suitable for a broad range of end users and communities (M^6). Figure 11 indicates the conjunctive relation with the functions and behaviors: Prevention^8, Persuasion^2 and Self-Motivation$^{2, 3, 6}$ synthesized in this example.

Figure 10. “odo" Design’s Products by Sony

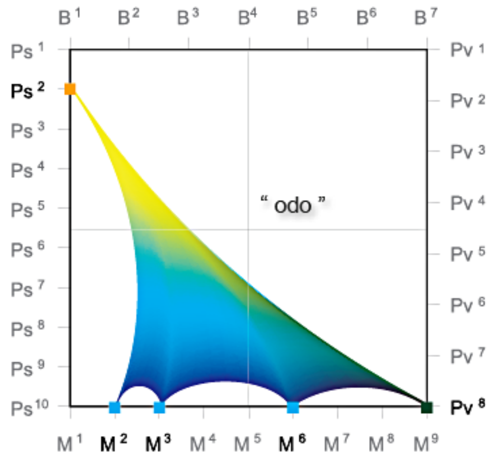

Figure 11. An ontological analysis of "odo" based on the framework

Discussion and Conclusion

This paper has discussed the design approach to guide designers to speculate on sustainable intervention between technology and human environments. This discussion established a design research foundation grounded in the philosophical idea of ontological designing. The conceptual framework proposed highlights the four functional dimensions of such intervention: balancing, prevention, persuasion, and self-motivation. Each of the functions features behaviors of digital artifacts, and these perform key design activities to stimulate designers' ontological thinking. These meta-conjunction processes in the framework radically delineate the different shapes in each of the digital artifacts. Each analysis of ontological views suggests that the capacity to infer a creation of digital artifacts depends on experience and prior knowledge of how to apply and use this conceptual framework. These analysis results provide designers with a uniform schema that could be configured as a goal-oriented, constrained, and decision-making activity; they can explore what variables and values might be appropriate for each ontological situation. The conceptual framework, therefore, helps provide a level of meta-conjunction that captures the designer's conception within the design situation to represent reflection in developing a particular digital artifact.

Although this paper suggests a conceptual framework to help implement ontological thinking within the four dimensions towards a more sustainable human civilization, it has only begun to construct the preliminary framework. A number of different digital artifacts and reflective interpretations of situations cannot be reviewed here. Moreover, designers might have different perspective in observing a design situation. There is still a long way to go for the framework to be improved for use in support of implicit ontological intervention, since sustainability is a loaded term in reference to ontological design. The current level should have more detailed ontological representations as a precursor to the designer's reflective conversation. This further development should be investigated with these categories: a wide range of target user groups or community members, various environmental contexts, design strategy, differing levels of user experience [3], stakeholders, and manufacturers. Development of the topologies of new types of digital artifacts is also important, since they can indicate the functional purpose digital artifacts perform.

This paper concludes that designers' ontological activity for sustainable intervention is an enlightened tool for re-conceptualizing the existing concept and functionality of digital artifacts, provoking meaningful reflection on new technology environments. Ultimately, the new structure of digital artifacts may not only emerge as set of additional, informal relationships, but also as a modified set of environmental components, eventually leading to new relationship with external design representation as if digital artifacts are part of organization of human technology environments. Designers may be able to structure their ontological determination by discovering coherency in technological transformation.

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Hyewon Kim’s work and interests have intersected across the following academic fields: industrial design, digital-media design, and Human Computer Interaction (HCI). She has been employed as a professional designer for several companies and a design researcher of Universal Design Research Center (UDRC) for the elderly in Korea. As a digital design theorist, she has explored design methodologies of HCI that not only include the relational processes of design, but also subjective processes that are not self-evidence. In doing so, she seeks to understand how to redistribute the communicative power between users and digital artifacts.

Speculative Visualization: A New Rhetoric for Communicating Public Concerns

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Abstract

Speculative design is an emerging rhetorical strategy in design practices and research to raise public awareness in social agendas that have been little explored. As a stream of this type of research, we propose *speculative visualization* that aims to achieve speculative design by utilizing techniques from data visualization and graphic design. Specifically, speculative visualization represents socially and politically meaningful data in aesthetic ways to provoke viewers' interpretation and further elicit discussions. In this paper, we report the diverse approaches of speculative visualization by demonstrating three exemplary studies and identifying their visual rhetoric. Based on the argument, we discuss research opportunities that speculative visualization can broaden its design sphere: the aesthetic adaptation of data visualization techniques, the methodologies of assessment, and the public's engagement in design activities.

Keywords
speculative visualization; speculative design; data visualization; visual rhetoric.

Over the past two decades, researchers have explored the capability and the role of design in increasing societal awareness, and motivating and enabling political actions (DiSalvo, 2009). This is evident in a diversity of endeavors, ranging from the work of individuals such as Natalie Jeremijenko,[1] design collectives such as Futurefarmers[2] and partnerships such as Dunne & Raby[3]. In their effort to empower the social and political actions, designers use visualization/graphics techniques to voice their and other's viewpoints though aesthetic displays.

We refer to this research paradigm as *speculative visualization*. In this paper, we begin by describing what we mean by speculative visualization and how it is connected to other disciplines, such as data visualization and graphic design. We also discuss its rhetorical power and thematic boundaries. Then, we present three studies of speculative visualization and exemplify how they invoke public awareness for the social and political issues that have been under-addressed. This paper contributes to the design community in two ways. First, it attempts to identify speculative visualization, the emerging phenomena across data visualization and graphic design, by identifying its core rhetorical aspects and breadth of topical diversity. Second, it provides researchers and practitioners with the opportunity to broaden their activity boundaries by opening a conversation on the potential of speculative visualization.

[1] http://www.nyu.edu/projects/xdesign/
[2] http://www.futurefarmers.com/
[3] http://www.dunneandraby.co.uk/content/home

Identifying Speculative Visualization

Artists and designers often express their views on political and social agendas through their work. One way they do this is through *speculative design* — the use of design products and practices to envisage possible, often critical, futures. Despite the short history, speculative design comes through a wide variety of design activities including participatory design workshops with community members, the final results in forms of product, graphic, interaction design, and conceptual proposals. The most distinctive quality of this line of research is that it provokes issues that are unconscious and hidden in people's everyday lives. It means that the design does not aim for a specific solution to a problem, but rather an open-ended discussion that is less predetermined and more unanticipated.

Speculative visualization is a particular group within speculative design that tries to achieve the thought-provoking work by using visual representation methods. Certainly, it is more than a piece of art, or a public display that, for example, informs you of current stock market data. Speculative visualization combines multi-disciplinary qualities; encompassing the challenging perspectives of artists, the aesthetic representation of designers, the analytic ability of scientists to interpret data, and the love for humanity of philanthropists.

This section is structured as follows. First, we situate speculative visualization in the context of other disciplines. In particular, we discuss how data visualization and graphic design helped create the groundwork for speculative visualization with regards to the resources of deliverable, representational techniques they employ and the common aesthetic languages they share. Then we discuss of the rhetorical aspects of speculative visualization that takes a central role of communication as a today's important visual medium. In addition, not to make the terminology too inclusive, we limit the thematic boundaries that the term can embrace.

Beyond Scientific Purposes of Data Visualization

Once data visualization was regarded as an exclusive realm of, by and for scientists and engineers, since it mainly functioned as a technical tool to support accurate and fast data analysis. However in the past decade, the visualization community's interest in non-analytical uses has increased. The importance of communicative and illustrative aspects is now well known, mostly as sub research areas such as "social visualization" that seeks to convey social information in non-scientific forms (Donath, Karahalios, & Viegas, 1999), or "casual information visualization" that is used by non-expert users to depict personally meaningful information (Pousman, Stasko, & Mateas, 2007).

One simple but important catalyst that initiated those light-weight visualization domains is the fact that more data has become accessible. Data collected by government agencies, or by other parties paid for with taxpayer money, are now being made available (Kosara, Cohen, Cukier, & Wattenberg, 2009). The vast amount of the data is about demographics such as population change, economic growth, health related issues, and much more. These data seem more relevant to human life than any scientific data that used to be an interest of specific groups. Thus, they have potential to become "stories" when handed to creative people to become part of the cultural discourse when they are displayed to the general public. Thanks to the flourishing accessible data, recent years have witnessed the expansion of the creators who make the stories through data visualization. Beyond a simple bar or pie chart from ten by ten spreadsheet, journalists and their colleague data specialists and designers utilize much larger data and create information visualizations to fortify their reports. Politicians or activists also use visualization to strengthen their opinions.

The expanded access of data allowed us to categorize visualizations by its ultimate purposes, which are impacting on people's ways of thinking, believing and further acting. With the involvement of Human-Computer Interaction (HCI) and interaction design, visualization has become a research topic that is more omnipresent and proximate to everyday life. For example, if personal health data are represented in more graspable visualization rather than its apparently unrecognizable numbers, the visualization can help the person change their habits to favorable state. In addition, when visualizations are exposed onto journalism websites in a timely manner, they can function an editorial contents (e.g., NYTimes Visualization Lab).

Recently, more abstract representation of data is also loosely considered as information visualization. Several survey papers (Kosara, 2008; Pierce, Odom & Blevis, 2008) distinguished two general types of information visualization, namely pragmatic visualization and artistic visualization. The former is a reconceptualization of the more "traditional" types of visualization, which minimizes distortion and foster immediate understanding. Pragmatic visualizations may not seem to be correctly labeled "speculative", since they mainly support dispassionate data analysis. However, when accurate and possibly shocking data are exposed to viewers, it has potential to influence their mind by increasing awareness of what they have not had a chance to think about as deeply before (Figure 1) (e.g. Rosling, 2009). By contrast, artistic visualization presents enigmatic representation to express a point of view and further stimulate the target audience. Artists or photographers, previously thought to exist out of scientific visualization community, create artwork based on data. The goal of artistic visualization is not meant to be scientific or analytic, but rather interpretive and expressive.

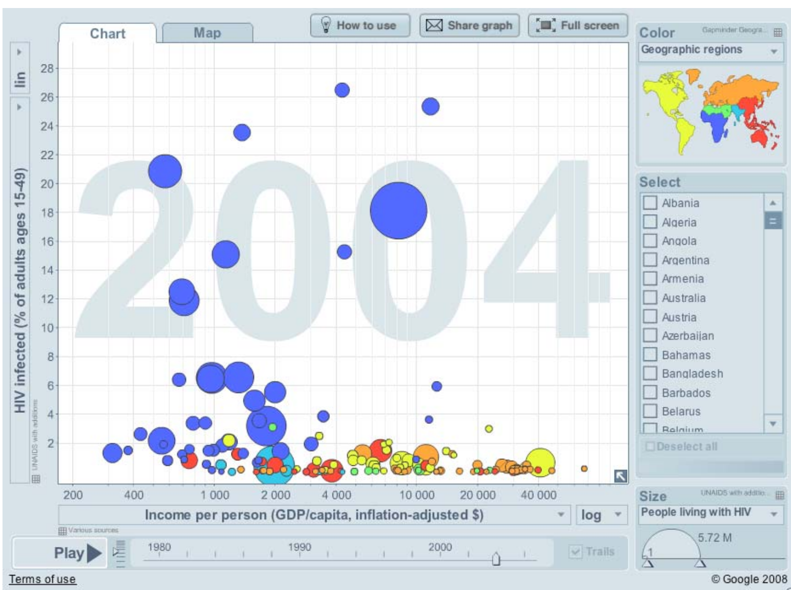

Figure 1. HIV epidemic 1980-2007 on Gapminder.org (URL: www.bit.ly/bfrBa7)

Expression of Social Issues through Graphic Design

Graphic design aims to communicate intended messages to specific audiences in an aesthetic combination of text and pictures. Types of graphic design range from simple forms, such as road signs, logos, trademarks to complex information graphics and advertisements and the essential goals of the messages are diverse. In the history of graphic design, we can find numerous temporal and spatial contexts that were related to social issues.

For example, in the early twentieth century, graphic design functioned as effective delivery methods of ideas and arguments. Politicians created and manipulated print-based graphics (e.g., posters) in order to imbue people with their ideology in a similar way as radio and newspapers. Due to the omnipresence of visual images and the easy acceptance by illiterate people, governments used posters to appeal to laymen, and even to enlighten and raise awareness. Against governmental propaganda, counter-production of posters appeared as well. A distinguished figure of this appropriation is a Dadaist John Heartfield. He used photomontage as a potent propaganda weapon and his images met with immediate identification and comprehension by the working class (pp. 248-249, Meggs & Purvis, 2005).

In the contemporary design scene, it is not difficult to find many design consultancies and graphic design firms that are specialized in designing for non-profit organizations and activists (e.g. Another Limited Rebellion[4], Yippa[5], Zago[6]). Beyond client-driven or in-house design circumstances, individual artists and designers have started to express their voices on social issues utilizing their aesthetic skills. At professional conferences such as AIGA and IxDA as well as academic research (e.g Forlizzi & Lebbon, 2002; Dilnot, 1982) have paid attention to ethics of designers and socially responsible design.

A Rhetorical View of Speculative Visualization

Rhetoric is the art of persuasion. Beyond the classical Greek definition, which means public speaking for civic purposes, rhetoric exists in written, visual, and oral forms. Although visual communication does not function as a means of direct persuasion such as oral rhetoric, images are more vivid than text or speech and therefore more easily manipulated toward visceral responses. In order to fill the lack of the direct persuasion visual rhetoric requires visual “arguments” to “supply us with reasons for accepting a point of view” (p. 22, Bogost, 2007). The field of *visual rhetoric* explores the many ways in which visual elements are used to influence people’s attitudes, opinions, and beliefs through the analysis of photographs, drawings, graphs, tables, and motion pictures (p.2, Hill & Helmers, 2004).

A designed message communicates by effectively ordering and representing the common visual languages of society. Therefore, it possesses great potential to affect viewers (Buchanan, 2001; Forlizzi & Lebbon, 2002). To view a relationship between audience and visual communication, Tayler (1992) analyzed design within a theory of rhetoric. The audience is characterized not as a reader but as a dynamic participant in an argument. In this rhetorical view, visual communication attempts to persuade a specific audience through argumentation by referencing established or accepted values and attributing those values to the new subject.

The rhetorical view of communication design allows designers and viewers to actively co-construct meanings through visual messages. The common visual language is the medium through which differences are assessed, and ambiguities are reduced. The agents taking part in the dialogue can establish common frame of reference, and then build bridges to shared values. Effective rhetorical communication allows individuals to relate to each other, provides a vehicle for expression, freedom, and the discovery of truth (Buchanan, 2001; Forlizzi & Lebbon, 2002). We argue that real data added to communication design can strengthen the vehicle since it serves as an objective and more believable evidence over imagination-based visual elements. By the visual rhetoric of speculative visualization,

[4] http://www.alrdesign.com/
[5] http://yippa.com/
[6] http://www.zagollc.com/

we expect to communicate public concerns and further change perspectives, attitudes or behaviors by creating the possibility for social agreement.

Thematic Topics of Public Concerns

In visual and cultural studies, the discussion of *rhetoric by image* covers a tremendously wide range of activities and artifacts, from advertisements selling products to marketing, and even propaganda, promoting political candidates or causes. However, since we identified speculative design as a realization of designers' societal responsibility and its ultimate goal as promoting public awareness and engagement in social and political issues, we attempt not to include virtually all about human life.

The interdisciplinary nature of speculative visualization allowed us to establish the thematic guides employing the ideas of technological concerns. Fogg (2002) suggested a wide range of persuasive technology and application, which includes commerce, personal relationship and occupational effectiveness. We argue that these applications for personal interests and marketing should not defined as appropriate topics of speculative visualization. Instead, we include such areas that actively require re-realization from individuals' consciousness toward socially pertinent issues so that they are expected to increase awareness and further change attitude and behavior in favor of community's well-being. Some of the relevant topics are environment conservation/sustainability, disease prevent, political issues and social responsibility/solidity. As a sub domain of speculative visualization, Eco-visualization (Holmes, 2007) is tremendously popular among HCI researchers and designers. Themes about social responsibility are not as pervasive and materialized as practical applications as sustainability and disease issues. However there have arisen many design collectives such as NeMe[7], whose projects include visualization work representing human rights in general and community related data.

Case Studies of Speculative Visualization

In this section, we take three examples of photography, motion pictures, and media installation that can showcase how speculative visualization communicates public issues. These selected pieces all obtain the resources from the raw statistical data that may appear difficult for laymen to understand. In contrast, visualizing the data in aesthetical ways help connect the numbers to the making meaning.

Example 1: Running the Numbers: An American Self-portrait

First example is a series of visualization by a photographer Chris Jordan. His work looks at contemporary American culture through the austere lens of statistics. The photographer's belief is aligned with what we mean by speculative visualization: "My hope is that images representing these quantities might have a different effect than the raw numbers alone, such as we find daily in articles and books… I hope to raise some questions about the roles and responsibilities we each play as individuals in a collective that is increasingly enormous, incomprehensible, and overwhelming" ("chris jordan photography," n.d.). Each piece portrays a specific quantity of mundane artifacts. For example, in *Plastic Cups* he depicts one million plastic cups, which is the exact amount of cups used on airline flights in the United States every six hours (Figure 3). If we see the image from a distance, it appears as an abstract drawing of pipelines, but in a close look, we can notice the fact that it is composed of

[7] http://www.neme.org/

myriads of disposable plastic cups. At the moment people realize the minimal unit that makes up the massive image, they become overwhelmed and wordless, and sigh deeply.

Example 2: What is a Black Balloon?

What is a Black Balloon? is a series of motion graphic advertisement as a part of statewide campaign in Victoria, Australia (Figure 2). It is a simple way to measure and visually represent greenhouse gas emissions from domestic environment such as kitchen, laundry room, dining room, as well as an entire house. The video attempts to deliver an obvious but possibly unrecognized fact: using less energy will mean less greenhouse gas emissions, and will help to reduce the impact of climate change. In the video clip appear black balloons, each of which represents a unit of measurement, 50g of greenhouse gas. A balloon pops out from a single appliance at first, followed by many others that finally fill the upper space of a house. However people except a baby in the advertisement do not recognize the existence of the balloons, the metaphor of potential threat to environment. Viewers are not expected to count the specific number of balloons and calculate the total emission of greenhouse gas. Rather they may have visceral responses such as panicking or emotionally paralyzing through the abstract and aesthetized statistics.

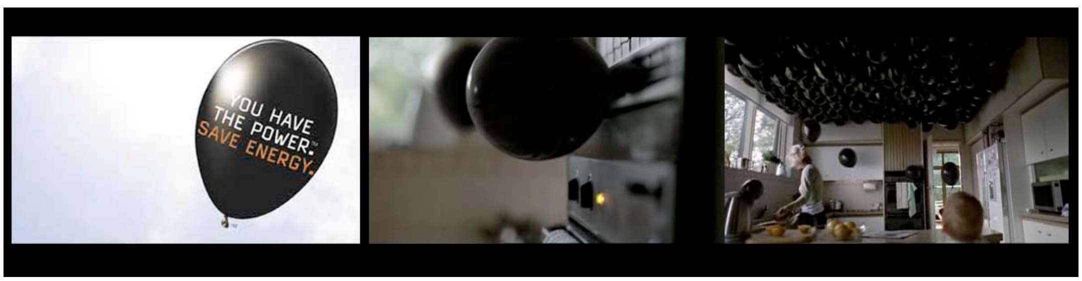

Figure 2 What is a black balloon? (http://www.saveenergy.vic.gov.au/)

Example 3: Smog is Democratic

Smog is Democratic is a digital media installation that explores air pollution and particulate matter through the medium of data and photographic visualization (Figure 3). As a subject, particulate matter brings together multiple themes in contemporary society: our concern with pollution, the relationship between urban living and hygiene; the tension between scientific representation and artistic expression of information; and the desire to produce techniques of measurement against the threat of the unseen. The visualizations in the installation are based off air quality, smog, and particulate matter data from for 2008, maintained by the Environmental Protection Division of the Georgia Department of Natural Resources. This database records both predicted and observed smog alerts as well as daily ratings of the air quality index. In the video visualization, the data are used to obscure the image by pixellating video of Atlanta highways—with the amount of pixelization generated from hourly air quality measurements in 2008. By obscuring the image, the visualization attempts to dynamically reflect the ways in which air pollution and smog obscure vision. This installation is interpretive and expressive, with the goal of considering how the sources and measurements of particulate matter might be rendered in order to generate reflection, discussion, and debate. The designer’s intention is to address the audience on an instinctive level and generate emotional responses that lie behind the data.

Figure 3 Carl DiSalvo and Jonathan Lukens, Smog is Democratic
(source: http://publicdesignworkshop.net/smog-is-democratic/)

Research Opportunities of Speculative Visualization

Because it is a nascent design genre and an interdisciplinary subject, speculative visualization has not been well investigated by design researchers. we suggest several opportunities and challenges for those who may potentially create speculative visualization and study it in a design research capacity.

Reimagination of Data Visualization Techniques

The information visualization (Infovis) community primarily comprises researchers from HCI, computer science, and statistics. Not attracting much interest from graphic designers, Infovis has continuously created various data visualization techniques, referred to as “visual styles” in designers’ terms. The endeavor to create visualization styles has continued for the purpose of representing a larger amount of data in a smaller area for more effective analysis. Therefore, one may consider such scientists’ suggestions not innately aesthetically pleasing. In fact, however, some of their innovative techniques have been inspired by modern art and graphic design traditions. For example, text visualization techniques such as Wordle and Tag Clouds were influenced by Soviet Constructivism (Viegas & Wattenberg, 2008). On the other hand, visual designers have attempted to manipulate scientific visualization techniques in aesthetic ways by blending color and typographic tactics with techniques. Among the myriad of techniques, radial graphs commonly represent networks or hierarchies, which have typically used by scientists (Figure 4). However, the graphs are being adopted to portray complex relationships between people and issues (e.g., NYtimes.com, 2007).

Beyond these relatively less complex techniques, interpreting the advanced formations of data visualization techniques with the touch of designers’ creative minds and hands will open opportunities for managing a greater volume of data and interactivity. Only a single datum can be impressive enough to generate viewers’ visceral stimuli as we earlier discussed in the case studies. Alternatively, we can anticipate that large data sets across regions and over periods may enhance complex feeling and in-depth discussion. In addition, supplementing layers of flexibility and interactions will provide audiences with more options to explore when compared with two-dimensional graphics. Several interaction techniques in formatted infovis such as Treemaps, Nodemaps and stacked graphs are now widely used to incorporate diverse data sets (Wattenburg, et al., 2008).

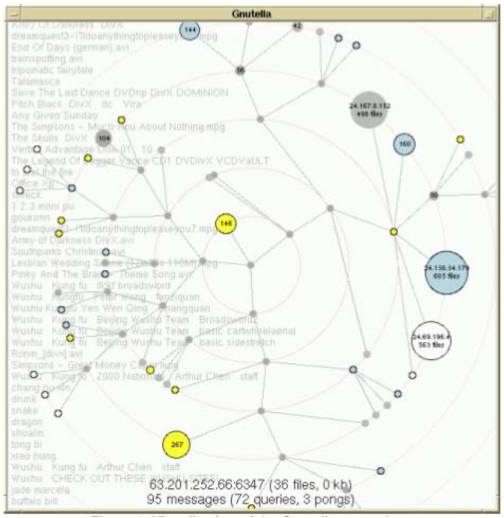

Figure 4 Example of Network Visualization on Radial Graphs
(Yee, Fisher, Dhamija, & Hearst, 2001)

Grounds for Assessment

When targeting visualization systems for analytical tasks, we have well established evaluation methods such as usability testing. However, evaluating the rhetorical aspects of visualization, even in collective and public situations can be challenging. The first impression of visualizations may be observed relatively easily through reading user comments or running simple surveys. For example, timely visualization of the stimulus bill passed by the U.S. congress led to some very emotional comments on a visualization authoring website, ManyEyes (Kosara et al., 2009). However, the influence on viewers' awareness, attitudes, perspective, and behavior was neither visible nor immediate. This situation opened up a new research opportunity: How do we design evaluation methods for a long-time experience rather than time and space constrained cognitive matters? In particular, how do we observe the social and cultural phenomena related to speculative visualization?

Engagement of Public in the Process of Design-making

It has been a rigid belief that the creativity of visual communication designers comes solely from personal intuition. However, if designers attempt to persuade audiences through visual messages without properly understanding whom they are designing for, inappropriate outcomes can result (Forlizzi & Lebbon, 2002). Understanding audiences does not require only traditional user research techniques. It also requires that designers envision methodologies that elicit the direct participation of the audiences. One possible way is inviting citizens in the process of data collection employing participatory design methodologies as discussed in a project by DiSalvo, et al. (2008). In this project, citizens engaged directly by collecting data from their local area, such as sound, air quality, humidity and temperature using sensing technology. Another manner of participation is people themselves becoming makers of the final artifacts as suggested by Gaver and Dunne (1999). Participating in the conceptual art work, senior citizens in a suburban city of poor reputation express their history of life, emotion, and the pride of the community. Finally the project acts as a socio-cultural intervention at personal, community, or political levels.

Conclusions

Visualization is what makes data accessible, intelligible, and interesting. When data visualization and graphic design meet together, each actively fills its absent traits with the advantages of the other; graphic design strengthens its arguments with objective and real data, while data visualization empathizes visual aesthetics adopting the principles of graphic design. Interconnecting the two realms in this way, speculative visualization makes data meaningful, insightful, and influential. To shed light on this emerging design research and practice field, we discussed its disciplinary traditions and rhetorical and communicative power with exemplary projects. Our attempt served to initiate a new research domain crossing visual design, rhetoric, and visualization community.

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Sensemaking and Framing: A Theoretical Reflection on Perspective in Design Synthesis

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Abstract

Sensemaking is a constant process of acquisition, reflection, and action. It is an action oriented cycle that people continually and fairly automatically go through in order to integrate experiences into their understanding of the world around them. A frame is an active perspective that both describes and perceptually changes a given situation. A frame is, simplistically, a point of view; often, and particularly in technical situations, this point of view is deemed "irrelevant" or "biasing" because it implicitly references a non-objective way of considering a situation or idea. But a frame – while certainly subjective and often biasing – is of critical use to the designer, as it is something that is shaped over the long-term aggregation of thoughts and experiences, through the above process of sensemaking, and is therefore a larger way of viewing the world and situations that occur in it. Like a point of view, a frame too will change, but will change over the long-term rather than the short term.

Designers make explicit the normally implicit processes of sensemaking and framing during design synthesis, as they attempt to make meaning out of data through interpretation and modeling.

This paper offers a theoretical reflection on the relationship between design synthesis, sensemaking and framing. This reflection, based on professional practice in a world-class design consultancy, attempts to tie research from various disciplines to what many designers feel is an implicit part of their process – the ability to apply their own "intuitive" ability to find meaning in complex situations and solve complex problems.

Keywords

Experiential Knowledge; Creativity; Reflective Practices; Design Synthesis; Sensemaking; Framing; Intuition; Perspective

Understanding Sensemaking and the Role of Perspective in Framing

Cognitive psychologists, social psychologists, and communication theorists all reference the word "Sensemaking" as an integral part of learning.

Robert R. Hoffman, Gary Klein, and Brian M. Moon are all cognitive psychologists who have been studying the connections between problem solving and intuition. They reference sensemaking as a way of understanding connections between people, places and events that are occurring now or have occurred in the past, in order to anticipate future trajectories and act accordingly. Their work positions sensemaking as an internal and reflective activity, where one is actively trying to solve a specific and contained problem, but also as an external and communal activity, where a group of people are trying to solve multiple problems in pursuit of larger, organizational goals (Klein, Moon, & Hoffman, 2006). Their view of the process is one shared of many organizational theorists [for example (Westrum, 1982)] where, in a large organization, various people may hold different pieces of data, and different levels of awareness of events, that are all critical to the success of a given project. Sensemaking is deeply related to a process of "socialization", whereby those with ideas and data share that with others in an effort to actively disseminate information and build consensus. Hoffman, Klein and Moon's view of sensemaking is a *process* that is both *personal and shared*, one that takes place *over a long period of time*, and one that is heavily dependent on a *perspective or point of view*.

Brenda Dervin, a communication theorist, describes sensemaking as a process that "reconceptualizes factizing (the making of facts which tap the assumed-to-be-real) as one of the useful verbings humans use to make sense of their worlds" (Dervin, 2003). As she describes, we make sense of complicated ideas by doing them, rather than studying them abstractly. The process of sensemaking is a process of learning, and it relies on and is subjectively dependant on the entire summation of knowledge, emotions, and prior experiences in the learner. This builds heavily on John Dewey's view of experience as being fundamental for education (Dewey, 1997), and implies that learning (and the process of solving complicated problems) must be an active process, and is always a subjective process. Dervin's view of sensemaking, then, is a *process* that is *personal* and *contingent on experience*, that *substantiates learning*, that takes place *continually and forever*, and is fundamentally based on each *participant's perspective or point of view.*

Daniel Russell and his team of researchers at Xerox PARC (and now Google) define sensemaking first as "the process of searching for a representation and encoding data in that representation to answer task-specific questions" (Russell, Stefik, Pirolli, & Card, 1993) and second as "the process of creating a representation of a collection of information that allows the analyst to perceive structure, form and content within a given collection." (Russell & Pirolli, An Overview of Sensemaking: A View from the Workshop CHI 2009, 2009) Both definitions describe the formation of a model – either a mental or actual, tangible representation – which can then be used as a hypothesis upon which to examine, test, and accept or reject specific questions and ideas. The representation is specific to the problem being addressed, and exists as a discrete model separate from larger "world views" or more abstract and general theories. Russell's view of sensemaking, then, is a *process* that is *personal*, that is *highly task specific*, that is useful for a *finite period of time*, and is fundamentally based on each participant's perspective or point of view.

David Snowden is a management scientist who has dedicated the majority of his career to understanding the complexity that exists in large corporations. In his work, Snowden frequently uses the word sensemaking as a descriptor to modify a noun. He's developed a framework that he calls Cynefin, and explains that "We consider Cynefin a sense-making framework, which means that its value is not so much in logical arguments or empirical verifications as in its effect on the sense-making and decision-making capabilities of those who use it. We have found that it gives decision makers powerful new constructs that they can use to make sense of a wide range of unspecified problems. It also helps people to break out of old ways of thinking and to consider intractable problems in new ways. The framework is particularly useful in collective sense-making, in that it is designed to allow shared understandings to emerge through the multiple discourses of the decision-making group." (Snowden & Kurtz, 2003, p. 468)

This implies that Snowden's view of sensemaking is on early and formative idea generation, and that the framework referenced supports the creation of mental models that can be used to think of problems, and solutions, in new ways. Snowden draws heavily on the use of narrative, and particularly fictional narrative, as a way of positing "what if" scenarios. His research has identified that participants who work backwards from a fictional end-state to reach a factual present-state are able to then identify the "sensemaking items", which he describes as the turning points inclusive of actors, communities, and factors in play (Snowden & Kurtz, 2003, p. 472). Snowden's view of sensemaking is a *quality* that can be applied to a framework or idea, is best embraced in a *highly collaborative environment*, has the most resonance during *early stages of problem solving* and for *a formal and finite period of time*, and embraces each *participant's perspective or point of view*.

Karl Weick, an organizational behavioural theorist at the Ross School of Business at the University of Michigan, ties sensemaking directly to organizational behaviour and particularly to the generation of organizational knowledge. As Weick describes, "… sensemaking is, importantly, an issue of language, talk, and communication. Situations, organizations, and environments are talked into existence… Sensemaking is about the interplay of action and interpretation rather than the influence of evaluation on choice." (Weick, Sutcliffe, & Obstfeld, 2005) From this perspective, sensemaking is a shared and communal activity that produces knowledge appropriate for action, but biased heavily based on the individuals doing the sensemaking – that is, each group of people who have the various sensemaking conversations will "talk into existence" a very different set of situations, organizations, and environments. Weick's view of sensemaking is a *process* that is *highly collaborative*, effective for *organizational growth and planning* in *both the short and long term,* and *highly dependent on interpretation.*

	Positions sensemaking as..	Style of engagement..	Effective for..	Length of engagement..	Highly dependent on..
Hoffman, Klein, and Moon	A process of problem solving	Both personal and shared	Long-term socialization of complex problems	A long period of time	Participant's perspective and interpretation
Dervin	A process of education	Personal and contingent on experience	Learning	Continually and forever	Participant's perspective and interpretation
Russell	A process of modelling	Personal	Specific tasks	A finite period of time	Participant's perspective and interpretation
Snowden	A quality of an artifact	Highly collaborative	Early stages of problem solving	Formal and finite period of time	Participant's perspective and interpretation
Weick	A conversational process	Highly collaborative	Organizational growth and planning	Both short and long term	Participant's perspective and interpretation

Thus, we see a landscape of researchers investigating sensemaking, coming to various (and abstractly consistent but specifically different) conclusions. Some of the views are tied to individual problem solving, while others focus on the abstract "organization" and its ability to make meaningful decisions. Some of the views describe sensemaking in an acute fashion, as an activity that has a start and end, while others view it is a long-term approach that serves as an underpinning for other activities.

Design Synthesis is a Process of Sensemaking

A fundamental consistency across all researchers above is the necessity of perspective, and an embracing of subjective interpretation as a fundamental aspect to both internal, reflective sensemaking as well as external, collaborative sensemaking. These are the same qualities that describe design synthesis – a part of the process of design found in all aspects of professional design work (including industrial design, interaction design, and service design) (Kolko, Information Architecture and Design Strategy: The Importance of Synthesis during the Process of Design, 2007). Design synthesis is an abductive sensemaking process of manipulating, organizing, pruning and filtering data in an effort to produce information and knowledge (Kolko, Interaction Design Synthesis: Translating Research into Insights, 2009). This process is used by designers during various parts of the larger design process, as they create new artifacts (used here to reference products, systems and services – both physical and digital).

While used throughout the process of design, synthesis is most commonly conducted at a precarious moment between research and definition. At this point in a project, a designer will have gathered large quantities of data from people, through a variety of primary research methods (such as contextual inquiry, interviews, ethnographic studies, cultural probe exercises, etc). They will have also gathered large quantities of data through secondary research methods (such as reading reports or journal articles). The intent of conducting this primary and secondary research is to inform the design of a new artifact, but the data itself does nothing to inform design, as data is inactive and lacking context (Shedroff, 2000). The designer must do something with the data in order for it to become active, and to actively inform design. They must "use" the data by extracting meaning from it or by generating meaning associated with it.

It is at this moment that design synthesis occurs, through an implicit and explicit series of actions. These actions are modified by the word "abductive": they all rely on a hypothesis as a form of inference (Peirce, 1998). Theoretically, these actions are limitless, as they are bounded by an infinite number of possibilities in both the specific domain knowledge being manipulated and in the experience of the designer performing the manipulation. There are, however, a series of common manipulation actions performed by professional designers; these actions include organization, pruning, interpreting, and reframing. All are driven by a personal perspective.

Organization describes the means by which a designer puts like items "near" each other, either physically (often by moving an index card around) or implicitly in their cognitive models of the data.

This nearness describes affinity, or likeness, and the intent of organization is commonly in identifying or deriving a series of patterns in the data – or in identifying opportunistic outliers, as these can act as stimulation for innovation. Organization also describes the ability for a designer to identify relationships and hierarchy, as is the case when creating a concept map, process flow diagram, outline, or tree-view of data. These relationships indicate prioritization and importance.

Pruning describes a selective measure of removing (and therefore both ignoring and implicitly prioritizing) data. Designers will prune data based both on popular similarity ("this was already captured once, no need to list it twice") and also rareness ("this was only captured once, so it's not important"), and in this manner, the pruning can be highly subjective and irregular.

Interpretation is the assignment of meaning to data (Holtzblatt & Beyer, 1998), thus extending (subjectively) the data and enhancing it.

This perspective from which interpretations are formed is in many ways synonymous with what Donald Schön refers to as a normative frame or appreciative system: "The very invention of a move or hypothesis depends on a normative framing of the situation, a setting of some problems to be solved… It is only within the framework of an appreciative system – with its likings, preferences, values, norms, and meanings – that design experimentation can achieve a kind of objectivity… Designers differ with one another, and change over time, with respect to particular design judgments, ways of framing problems, and generic perspectives manifest in their choices of problem settings, means, and paths of inquiry." (Schön, 1984) This frame is a bias, but one that designers frequently make explicit – and often put aside, shift, embrace, or actively reflect upon, through a process of design synthesis. In this process, a series of often subjective business, technological, decorative, or functionality constraints are deemed to be true, and this becomes the normative frame.

Reframing is the act of purposefully shifting the normative frame, often temporarily or in multiple directions at once, in order to see things from a new perspective. Designers may be able to manage multiple frames (commonly including "their own", "the user's", and "the business's") and realize tradeoffs when various frames are given precedent.

Synthesis actions are rarely mutually exclusive; that is, an action performed during synthesis might be both organizational and interpretative at once, or it might be an act of interpretation occurring in an effort to reframe from a new perspective. Regardless of the specific synthesis action that the designer takes, synthesis is always generative – it always produces more data, information and knowledge, than was present before the actions began. In this way, it is dissimilar to an empirical study that seeks to understand things that already exist (while remaining objective), and is dissimilar to a predictive behavioral study that seeks to identify causality and what people are likely to do (by remaining objective). Synthesis (and design in totality) seeks to understand the facets of things that do not yet exist by bringing them into existence, and the process of synthesis helps to guess what people will do, feel, or think once the thing that does not yet exists, exists.

A Need for Rigorous Approaches and Methods to Synthesis

While designers have historically referenced a period of design synthesis in their process, little has been done within the community of design research and design practice to formalize methods of synthesis or to describe a cohesive theory of synthesis. Instead, designers commonly performed design synthesis in the due course of solving a design problem, and it was rarely explicitly separated from forms of ideation and the "raw creativity" commonly associated with form giving. Additionally, synthesis was rarely conducted overtly – instead, designers would synthesize research through casual conversation in the design studio or – more commonly – through personal reflection, and much of the synthesis process was conducted "in one's head". However, it has become necessary to conduct design synthesis externally – publically – due to a number of factors:

1. **Design problems are more complicated**, and therefore, require a more rigorous and explicit process. Designers are increasingly enjoying a more prominent role in both large corporations and in creative agencies, and a result of this prominence is more responsibility for larger budgets and more in-depth projects (Brown, 2008). A typical design project in the 1970s might have been to define the way a chair or cup looked, or to define the identity

system (logo, letterhead, etc) for a corporation. A typical design project in the present day is to create a new software suite for a global brand, defining the features and functions, the way a user interacts with the system, and the manner in which the system changes when used on a laptop as compared to a mobile phone – arguably, today's activity is much more complicated, with more user-touchpoints, and certainly more complexity.

2. **Design teams have grown in size**, forcing processes to be externalized and formalized. In the past, designers may have worked independently, with a design review or critique (the "pinup" of sketches) occurring periodically in a formal manner. In-between these reviews, designers had no need to share their process with anyone except other designers. Integrated design teams, including engineers, marketers, project managers, consultants, software developers, and other constituents are now the norm, and designers are increasingly required to both describe and rationalize the decisions they are making, as they make them. Additionally, more members of the design team can claim to be "doing design work", as boundaries between disciplines on an integrated team may blur tremendously.
3. **Designed artifacts are increasingly invisible**, making discussion of in-progress ideas difficult without a formal, explicit, and descriptive process artifact to drive the discussion. A designer may be tasked with creating a system, service, or piece of software – things that have no physical qualities. In order to direct conversation, support decision making, and continually refine and expand ideas, the designer is forced to make their process explicit by creating diagrams, charts, models, prototypes, and other in-process artifacts.

The complexity of modern day design problems, the size of the design team, and the increasingly ethereal nature of designed artifacts has created a need for externalized, formalized synthesis of data.

Thus, design synthesis is presented as a fundamental part of the process of design, but a part of the process that lacks deep discourse and definition yet is increasingly both communal and complicated. This complexity demands a more formal theoretical understanding of synthesis, and designers require a better understanding of the cognitive and social structures that are used to support the various activities involved in synthesis.

The Role of Sensemaking and Framing in Design Synthesis

Sensemaking and Framing are the phenomenon that describe the process of design synthesis and begin to create a behavioral theory of synthesis both in and out of practice. These two theoretical constructs point to a structural framework upon which professional methodologies can be created – explicitly helping designers accomplish their work. Sensemaking, as presented above, is a process of making meaning that is highly dependent on unique perspectives and frames. In design, and particularly in design synthesis, this personal process becomes a communal and collaborative process and is used to create one or more working design frames. These frames are active, as they constantly change and adapt based on the circumstances of the project. Ultimately, these frames are the artificial boundaries of perspective, containing the scope of design work and acting as flexible constraints around a given design problem.

As both sensemaking and framing are normally internal mechanisms for understanding reality, design teams have begun to adopt technically rudimentary – but highly effect – methods and tools of sensemaking and framing externalization to create a shared "canvas" for synthesis.

Consider, for example, the following very brief snapshot of dialogue that occurred at frog design, a global innovation consultancy. The conversation took place between interaction designers who had just completed research for a new project, and were beginning the "concepting" phase of the project. They were tasked with simultaneously understanding a very vague business problem – "create a new competitive product for baby boomers and their parents" – and defining technical requirements for a supporting technology platform decision that was going to be made quickly.

> **Will**: "Let's try to get to a core concept and a set of high level constraints before we break for lunch."
>
> **Matt**: "Yeah, why don't you take the viewpoint of the older segment…"
>
> **Will**: "OK, I'll be my grandpa.. "

Matt: “OK; so, we know we have to use full and high bandwidth video transfer…” *(draws two big circles on the whiteboard, each labeled ‘mobile phone’, and draws another big circle on the whiteboard, labeled ‘cloud’. Draws a line from one phone, through the cloud, and back to the other phone, labeled ‘video – fast and HD’)* “…because it’s pretty awesome, and it’s basically the only known piece to the whole puzzle.”

Will, in character: “I don’t care about awesome, but I really want to be able to watch Junior at the soccer game…” *(grabs the whiteboard marker, and draws three stick figures. He labels one ‘grandma’, another ‘grandpa’, and the third ‘junior’)* “..because all I care about it being a part of his life.”

Grant, pointing at the figure labeled ‘grandpa’: “Yeah, but on your end, you don’t want to watch on a tiny screen. My grandma can’t even figure out how to use her answering machine, I think there must be messages on there from two or three years ago…” *(scratches out one of the Mobile Phones, and writes “TV”)*.

Matt: “Cool, so in our list of technical issues, I know we’re gonna run into some TV platform issues…” *(starts a list called ‘potential issues’ and write ‘TV platform – unknown, Microsoft? Open Source???’)*.

Will, in character: “If it’s going to be on my TV, I need an easy way to record Wheel Of Fortune, because it’s really pushing it to think I’ll miss the four o’clock game shows for little Will’s stupid baseball game.”

Matt: “Ok, so it has auto-DVR, and if you are watching streaming video, it automatically records…” *(writes ‘auto-DVR = cloud storage; Boxee?’)*

Will, as an aside: “God forbid he misses Wheel Of Fortune, and god help me if I ever get old and watch game shows…”

Grant: “A DVR seems really advanced for old people.”

Will, laughing: “What if there was a giant TV on wheels at the game instead of in their living room, and junior could see grandma and grandpa on the jumbotron, just like they can see him? *(draws a tv on wheels)*”

Grant: “Yeah, I mean, we add a low-fi version [of the software] that works with a webcam on the TV..”

Matt: “So we need bidirectional video, streaming?” *(writes ‘tons of bandwidth. 4G?’ in the ‘potential issues’ list)*.

In this brief portion of creative dialogue, three main synthesis techniques and approaches are used (albeit in a casual manner):

1. **Reframing from a new perspective, to empathize**. Will elects to represent the target audience, saying “OK, I’ll be my grandpa”. He clearly doesn’t intend to become his grandpa, but instead actively attempts to view the design space simultaneously as a designer as well as an older grandfather-like figure. He then participates in the discussion viewing the emerging design concept through at least three unique lenses, switching between them quickly and without much prompting:

    a. He contributes to the discussion as an older man, with particular wants, needs and desires related to television watching and inter-generational communication
    b. He offers colorful commentary of his specific grandfather, describing the idiosyncrasies that make his grandfather unique (the need to watch Wheel Of Fortune each night, the prioritization of a game show over a loved one)
    c. He offers contributions as a member of the design team, realizing that he can feel free to be provocative at this stage in the process by describing off the wall ideas (the TV on wheels) without fear of disruption or being called “inappropriate”

2. **Creative leaps, based on personal sensemaking**. Each team member offers ideas that change the nature of the design concept.

a. Matt has begun to add constraints related to technology capabilities, creating a list of more pragmatic issues, concerns, and features. His role, at least in this particular conversation, is one that is focused on technical realism. He translates the design and feature ideas into technological barriers, opportunities, and issues to warrant further discussion. This knowledge comes from his own personal interest and experience in technology; the knowledge is separate from the design problem that has been provided from the client, and it is up to Matt to bring this information to the problem.
b. Will has begun to add constraints and opportunities, related to his personal and intimate knowledge of his own grandfather. This is biased and highly subjective, yet Will clearly has a vivid mental image of his grandfather's peculiarities and uses these to spark new design ideas.
c. Grant offers statements that are practical, building on but simultaneously tempering the "blue sky" and biased qualities of Will's ideas. Grant clearly speaks from his own experiences with the elderly, as he describes his grandmother's inability to cope with technological complexity. He too offers new constraints and opportunities.

3. **Externalization, to create shared sensemaking**. Through the use of a whiteboard, and through the shared pooling and visualization of the ideas in a single democratic (and "unowned") dialogue and diagram, the team goes through a process of shared sensemaking. Grant and Matt have never met Will's grandfather, and neither Grant nor Will would have described the technological requirements that Matt saw from his unique perspective. But all three now have a shared view of the design space, the technological implications of design decisions, and the beginning of a central, high level, very conceptual design system idea.

Thus, the normally personal phenomena of sensemaking and framing are recast in a public light in the design studio, with the following outcomes:

1. The design team builds a shared understanding of the data that has been gathered, and acts on that data through organization, externalization, pruning, and interpretation. This is the beginning of design synthesis.
2. The design team collectively develops a series of artificial constraints, informed by but separate from the design space being studied and their own respective experiences. This is collaborative sensemaking.
3. These artificial constraints are applied in the context of the design problem as a flexible container, within which the designer can begin to solve a problem; this becomes the normative frame.

Perhaps the most exciting thing the design team could do next would be to "reframe" the situation, actively shifting the normative frame (the grandfather) and simultaneously shifting the design problem into the confines of the new container. The team might ask Will to play the role of the baseball-playing grandson, or the baseball coach, or a salesman at a consumer electronics store. Each of these new perspectives would generate a new frame of reference, and would result in new, innovative, and often ridiculous design outcomes.

Summary

Brenda Dervin describes Sensemaking with a rich and robust description:

… the human, a body-mind-heart-spirit living in a time-space, moving from a past, in a present, to a future, anchored in material conditions; yet at the same time with an assumed capacity to sense make abstractions, dreams, memories, plans, ambitions, fantasies, stories, pretenses that can both transcend time-space and last beyond specific moments in time-space. This portrait of the human subject… mandates positing as possible fodder for sense-making not only thoughts and ideas, observations and understandings, but emotions, and feelings, dreams and visions, pretenses and illusions, connections and disconnections. (Dervin 2003)

Dervin's point is apt: even a designer working on the most insignificant problem approaches that problem from a thoroughly complicated, unique, and both intellectual and emotional point of view, and this point of view is in a constant state of flux. This point of view forces a subjectivity on the design process and solution, and this definition of the "human subject" begins to illustrate how design solutions are deeply embedded in the culture of the designer themselves.

During synthesis, a designer simultaneously attempts to embrace *their own* unique experiences, emotions, and history – and to embrace *someone else's* unique experiences, emotions, and history. These are the elements that are crucial to making sense of the complicated design problem. Two designers may approach the same design problem in the same way and follow the same methods and steps, yet end up with a very different solution.

This difference points to the unique aspects of the designers themselves – their "style", or "design sensibility" – which is the collective and additive whole of their lives. It also points to the unique aspects of the designers in their ability to reframe and empathize – to consider what life is life from another perspective, and make logical inferences from this new point of view. In many ways, this is the unique skill of design: the ability to temporarily exchange or at least supplement one's own perspective with that of another.

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Author Biography

Jon Kolko

Jon Kolko is an Associate Creative Director at frog design, and the Director of the Austin Center for Design. He has worked extensively in the professional world of interaction design, working around complicated technological constraints in order to best solve the problems of Fortune 500 clients. His work has extended into the worlds of consumer electronics, supply chain management, demand planning, and customer-relationship management, and he has worked with clients such as AT&T, HP, Bristol-Myers Squibb, Ford, IBM, Palm and other leaders of the Global 2000. The underlying theme of these problems and projects was the creation of a solution that was useful, usable, and desirable. His present research investigates the process of Design, with a focus on Design Synthesis and the creation of meaning.

Kolko's present work is heavily influenced by his prior role as a Professor of Interaction and Industrial Design at the Savannah College of Art and Design, where he was instrumental in shaping the Interaction and Industrial Design programs. He presently sits on the Board of Directors for the Interaction Design Association (IxDA), and is the Editor-in-Chief of interactions magazine, published by the ACM.

Kolko is the author of Thoughts on Interaction Design, published by Morgan Kaufmann, and the forthcoming text tentatively entitled Exposing the Magic of Design: A Practitioner's Guide to the Methods and Theory of Synthesis, to be published by Oxford University Press.

Interaction and Mediation in Preadmission Clinics: Implications for the design of a telehealth stethoscope

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Abstract

A telehealth stethoscope would make it possible for doctors to perform physical examinations on patients at great distances. In order to develop a useful and useable telehealth stethoscope we have conducted fieldwork observations of existing anaesthetic preadmission clinics to understand how stethoscopes are currently used. Both face-to-face consultations and videoconference consultations have been studied. Our results indicate that the stethoscope plays a minor role in the consultation and that consultations are mediated by the administrative work that is the reason for the consultation. We suggest that a stethoscope plays an infrastructural role in the consultation. The implications of considering stethoscopes as infrastructure are explored and considered in the context of a future telehealth stethoscope.

Keywords

interaction, stethoscope, infrastructure, telehealth, expertise

We are developing a digital stethoscope for use with a telehealth communications network in order to allow doctors to examine patients remotely (a telehealth stethoscope). A future telehealth stethoscope for remote examination of patients will mediate the interaction between doctors' nurses and patients. Understanding this mediation and enabling good collaboration to take place is important if a telehealth stethoscope is to be effective. Though some research exists on telehealth stethoscopes (Belmont and Mattioli, 2003; Fragasso et al, 2007; Wong et al, 2004) it does not focus on interaction and is based on existing products. To ensure that the new device we develop will be appropriate we are conducting field studies of anaesthetic preadmission clinics in a major rural hospital in Queensland, Australia.

An anaesthetic preadmission clinic is a consultation that takes place approximately a week before a patient undergoes an operation. They meet with an anaesthetist who assesses the patient's general health and suitability for anaesthesia. Most of the preadmission consultation involves the doctor interviewing the patient about their general health and about specific aspects of their health that may affect the patient's response to anaesthesia. A small but important part of this assessment in face-to-face clinics is the process of auscultation or the examination of the patient's chest (heart and lungs) with a stethoscope. In telehealth preadmission consultations the interview proceeds as it does in a face-to-face consultation but no stethoscope is available. Consequently telehealth consultations are only offered to people who are known to be "low risk" -- that is patients who are young, generally healthy and who will not undergo particular sorts of high-risk operations. Patients who are deemed "high risk", typically the very old or infirm, must travel to the main hospital, sometimes for several hours, to have a face-to-face consultation. This travel is expensive and time-consuming. A telehealth stethoscope would allow remote consultations to take place for many people who would otherwise have to make long expensive journeys in advance of their operation.

In the studies reported here, we observed both face-to-face and telehealth consultations.

Research Methods

In order to understand the context in which a telehealth stethoscope will be used we conduct field studies of anaesthetic preadmission clinic consultations. In these consultations, doctors and nurses examine patients about a week prior to surgery in order to assess the patient's suitability for anaesthesia.

Our data is collected through video-recorded observation, think (talk) aloud protocol and retrospective protocols, interviews and focus groups. Noldus' The Observer (2008) software aids our analysis of video data. We also conduct retrospective protocol with the doctors and nurses we have observed in order to clarify their actions. We use Atlas.ti (2008) to analyse verbal data.

The coding scheme (Kraal and Popovic, 2009) we used was developed through close examination of the videos of consultations.

Initially we sought to understand how the stethoscope mediated interaction in consultations and the coding scheme that was developed reflected this (Kraal and Popovic, 2009). That approach led to a deeper understanding of the context and the subsequent redevelopment of the coding scheme to better reflect how preadmission consultations are conducted. The next section briefly describes our previous research.

Communication between doctor and patient

In our earlier research (Kraal and Popovic, 2009) we saw that the way doctors conducted face-to-face consultations and telehealth consultations was very similar. We had expected that the different types of consultation would be different. Instead our research showed that there was no discernable difference in how the communication between doctor and patient was conducted. The only noticeable difference was that telehealth consultations did not include the use of a stethoscope. In contrast to the existing literature on telehealth video conferencing (eg Kaplan and Fitzpatrick, 1997; Li et al, 2006) in which communication between participants in remote interactions is sometimes difficult we have found that communication between doctors and patients was similar in face-to-face and remote consultations (Kraal and Popovic, 2009). We speculate that the similarities between the two types of consultation occur because the doctor's goal is always to assess a patient's suitability for anaesthesia.

The use of a stethoscope in the observed face-to-face interactions is largely perfunctory and serves a confirming, rather than specifically diagnostic, role. Only when a patient is elderly or has pre-existing medical conditions that may hinder effective anaesthesia do the doctors make detailed use of a stethoscope. The lack of a stethoscope in the remote consultations has shown that in cases where the patient is generally fit and healthy a stethoscope is not needed. Patients who are remote but whose poor physical health necessitates a detailed examination are always seen in person, which requires them to travel to the main hospital.

We also observed that the tools the doctors use in the consultations, both face-to-face and telehealth, are more extensive than the stethoscope. The primary tools that the doctors use in the consultations are the questions they ask patients and the patient's medical record. These tools are, obviously, available in both types of consultation. It seemed that the questions and medical record were mediating the interaction between doctor and patient in consultations. We collected more data and analysed it using the new coding scheme (table 1) to obtain further data on this aspect of the interaction between doctors and patients.

Mediating Artefacts in Preadmission Consultations

In preadmission consultations there are different stages of interaction. These different stages are (i) the initial interview between doctor and patient, (ii) the physical examination of the patient by the doctor and (iii) the end of the consultation when the doctor summarises their decision about the patient's anaesthetic needs and invites questions from the patient. We have examined all three stages in this research. We anticipated, and our analysis has shown, that the stethoscope mediates interaction between doctor and patient during the physical examination. The doctor's actions during the physical examination draw strongly on tacit knowledge. It is this finding that most significantly impacts on the design of a future digital remote stethoscope since such a stethoscope will require doctor, nurse and potentially patient to work together in a way that requires high use of explicit knowledge.

Further analysis of the entire preadmission consultation has shown that the administrative aspects of providing a patient with anaesthesia mediate the entire interaction, most significantly during the initial interview. The artefacts of the administrative aspects of anaesthesia are the patient's (paper) medical record, a form on which the doctor records their interview with the patient and, occasionally, the computer on the desk in front of the doctor which is used to look up parts of the medical record which are stored electronically. Most of the time, the doctor requests information from the patient to confirm or elaborate on information that is contained in the medical record. For example, doctors often ask patients about their previous experiences of anaesthesia. In two instances we have observed the patient does not have an extensive medical record and the doctor must ask them more detailed questions about their general health to obtain the same information that is normally in the paper record.

To describe these activities a coding scheme was developed (table 1) which sought to capture the activities that occurred in the preadmission consultation in a more refined way than that used by Kraal and Popovic (2009).

Code	Description
Examination	Conducting a physical examination of the patient
Medical Record	Doctor's attention is on the patient's medical record
Computer	Doctor's attention is directed at the computer
Writing	Doctor's attention is directed at writing
Patient Conversation	Doctor's attention is directed at the patient

Table 1: Coding scheme

There are five codes in the scheme. The Examination code was used when the doctor performed a physical examination of the patient. Three codes, Medical Record, Computer and Writing, describe activities where the doctor is focussed on administrative activities. If the doctor was speaking with the patient and engaged in an administrative activity, only the administrative code was used. The Patient Conversation code describes when the doctor was focussed on discussion with the patient.

Figure 1 shows the average times spent on different activities during the preadmission consultations we have observed. The activity that takes the longest is the conversation between doctor and patient with an average of 00:05:17 minutes. Writing the record of the consultation took and average of 00:03:44 and the other activities, the physical examination, using the medical record and using the computer took approximately two minutes each. Averages presented are calculated on times where the code occurred. For example, examinations only took place during face-to-face consultations so that average is calculated on 9 episodes.

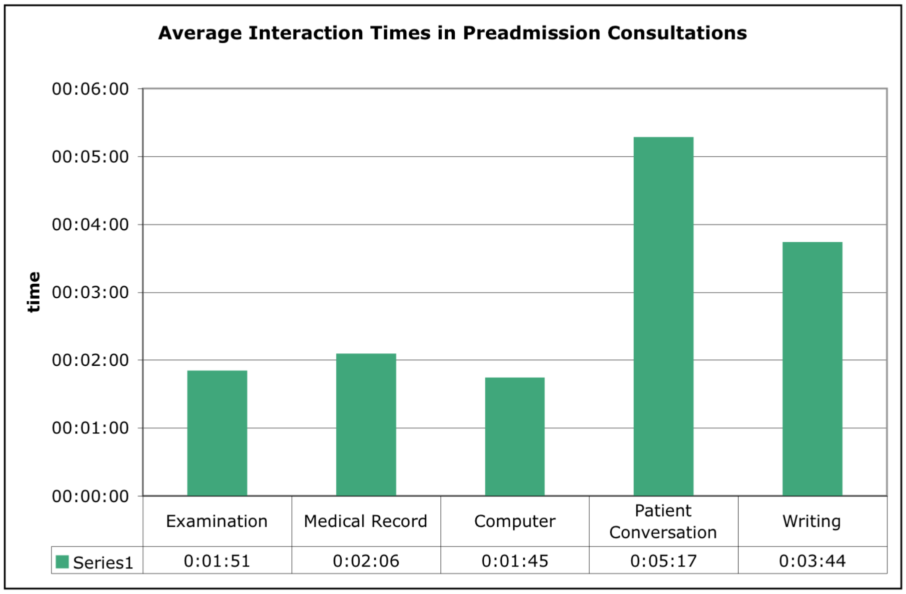
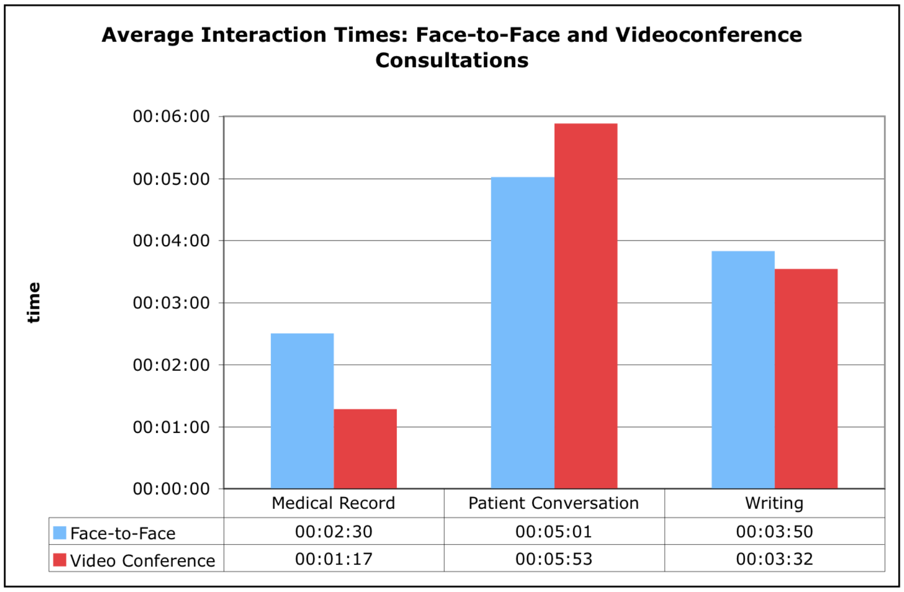


Figure 1: Average Interaction Times in Preadmission Consultations

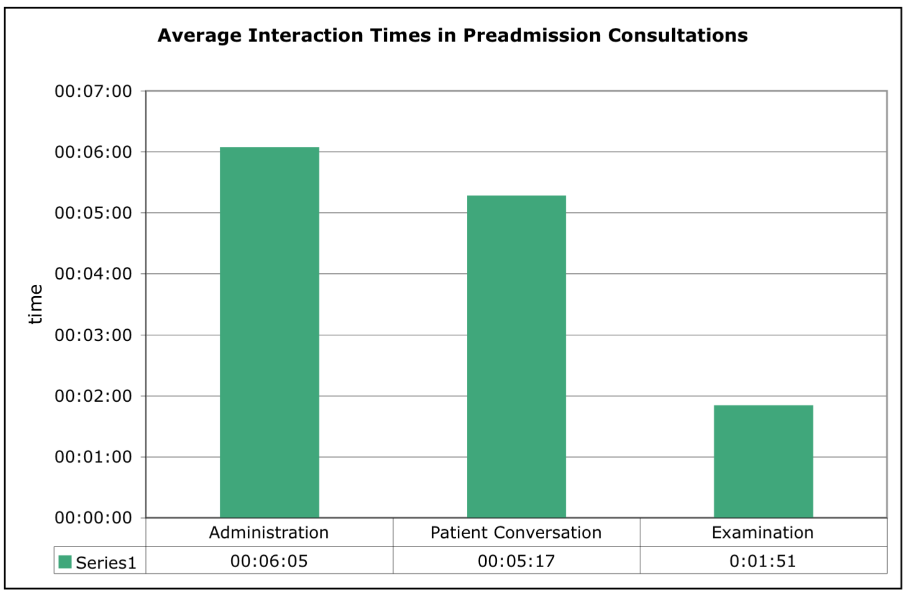
There were some differences between the face-to-face consultations and videoconference consultations that were observed (figure 2). Patient examination times are not shown in figure 2 as no patient examination occurs during videoconference consultations. Additionally, doctors did not interact with the computer while engaged in videoconference consultations so that data is also not shown in figure 2. While the average amounts of time spent on patient conversation and writing the consultation record were similar between the two types of consultation, the amount of time spent dealing with the patient's medical record was different. In face-to-face consultations the doctors spent an average of 00:02:30 minutes examining and working with the patent's medical record while they spent 00:01:17 with the medical record in the videoconference consultations. However, this difference is likely a result of the limited number of videoconference consultations that have been observed.

As figures 1 and 2 show, a lot of time is spent on interacting directly with the patient. Exactly how much time is shown in figures 3 and 4 which combine the medical record, computer and writing codes in "administration". Figure 3 shows that, considered in this way, administration makes up the largest block of time during a consultation an average time of 00:06:05 minutes, followed by conversing with the patient, 00:05:17 minutes, followed by the short time spent on the physical examination, 00:01:15 minutes.



	Medical Record	Patient Conversation	Writing
Face-to-Face	00:02:30	00:05:01	00:03:50
Video Conference	00:01:17	00:05:53	00:03:32

Figure 2: Average Interaction Times for face-to-face and video conference consultations.



	Administration	Patient Conversation	Examination
Series1	00:06:05	00:05:17	0:01:51

Figure 3: Average Interaction Times in Preadmission consultations, all administration activities collated

Figure 4 shows the administration and patient conversation times split by consultation type. The differences in the average times for administration tasks and patient conversation activity are likely to be due to the relatively small sample size, particularly of videoconference consultations.

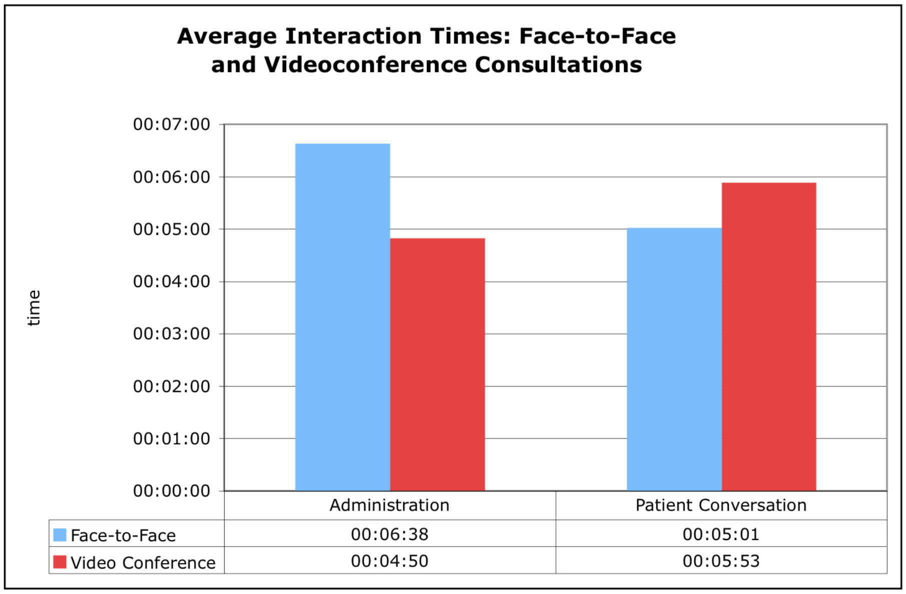


Figure 4: Average Interaction Times, all activities collated, by consultation type

These data show that in the consultations observed the doctors spend the most time dealing with the administrative elements of the interaction and that the physical examination is completed quickly. This is not to say that the physical examination is unimportant but that its importance, when measured by time taken, is not as significant as we had expected it to be. Only in cases where the patient is very high risk do the doctors spend a long time on the physical examination.

We have collected data from physical examinations of two high-risk patients. These patients requested that their entire consultation was not filmed, so there is no data on the length of the administration or patient conversation aspects of the consultation. In the high-risk consultations the examination lasted for 00:03:09 minutes in one case and 00:04:23 in the other. Stethoscope use was 00:01:11 and 00:02:32 respectively.

	Stethoscope Use	**Examination**
High-risk patient A	00:01:11	00:03:09
High-risk patient B	00:02:32	00:04:23
Average of other patients	00:01:06	00:01:51

Table 2: Examinations and stethoscope use in High risk patient consultations (Kraal and Popovic, 2009)

As table 2 shows, it is not possible to say that the doctors use a stethoscope for a significantly longer period of time during a “high risk” consultation than a “normal” consultation. However, it seems that the physical examination itself lasts for noticeably longer in the “high risk” cases than in the average of the other cases observed.

As these results have demonstrated, the interaction between doctor and patient is mediated by the doctor’s need to complete the paperwork that provides the record of the consultation and the advice to the doctor who will actually anaesthetise the patient. The stethoscope plays an important but subsidiary role in the consultation.

While the medical record always has a strong role in the consultation the stethoscope acts as a tool that is brought into use by the doctor as needed. Patients who are generally healthy receive a brief auscultation. Patients who are infirm or who have potentially dangerous existing conditions receive a similar length auscultation but a longer physical examination. The similar length of auscultation suggests that the skill of auscultation is in the interpretation of the sounds from the stethoscope and that very similar techniques are used to obtain the required sounds, regardless of the patient. The observations have shown that the doctors are able to use their stethoscope as it suits them and they use it with great fluidity, demonstrating great expertise. The fluid, natural, way that the doctors use the stethoscope and the subsidiary role it plays in a consultation has several implications for the design of a telehealth stethoscope.

Implications for the Design of a Telehealth Stethoscope

The results of this study, and our previous analysis (Kraal and Popovic, 2009), suggest that a good telehealth stethoscope will have two inter-linked properties. First, a telehealth stethoscope must be a good stethoscope and second, it must be as similar to an existing acoustic stethoscope as possible.

The first criterion, that a telehealth stethoscope be a good stethoscope, means that it must transmit sound from the patient's chest to the doctor's ears accurately. It is difficult to acquire the skill listen to the subtle sounds of the heart and lungs and doctors learn to expect to hear those sounds in particular ways. The second criterion, that a telehealth stethoscope be very similar to an acoustic stethoscope, means that the method of interaction with the telehealth stethoscope should fit with a doctor's existing experience with stethoscopes. A telehealth stethoscope should therefore look and feel similar to existing acoustic stethoscopes.

Different Stethoscopes Sound Different

The first implication arises because all stethoscopes have slightly different frequency response -- that is, they sound different. Callahan, Waugh and Matthew (2007) have shown that the sound reproduction of acoustic stethoscopes differs markedly and that accurate sound reproduction is not correlated with price. Dolan, Oliver and Maurer (2002) tested one acoustic and two digital stethoscopes and also found that each had a different frequency response.

As doctors tend to acquire a stethoscope and use it for several years it can be assumed that they become familiar with the way their stethoscope sounds. This familiarity makes up a significant part of a doctors expertise in auscultation. A telehealth stethoscope will almost certainly sound different from a doctor's own. It is unclear whether differences between stethoscopes result in less accurate diagnoses by doctors or even if the differences, while measurable, cause the doctors difficulties.

There seems to be no remedy to this problem. A telehealth stethoscope will necessarily sound different to any other stethoscope and as it seems there is no accepted or documented standard for what a stethoscope should sound like. Doctors will have to use the telehealth stethoscope in order to acquire expertise with it. However, even if it is carefully designed, it will be harder to acquire expertise with a telehealth stethoscope because it will be as much a system as it is an artefact.

Telehealth Stethoscopes are both Systems and Artefacts

An acoustic stethoscope, of the sort that the doctors we have observed use in consultations, is a relatively simple artefact consisting of a "head" comprised of a simple diaphragm that transmits sounds from the patient's chest to the doctors ears through a few lengths of tubing. The addition of a "bell" to complement the diaphragm, as the bell and diaphragm are able to transmit different types of sounds, is often the most complexity seen on a typical stethoscope. Various types of digital stethoscope also exist and these are usually variations on acoustic models usually with some type of amplifier and volume control available on the main tube of the device. Both acoustic-analogue and digital types of personal stethoscope are largely self-contained – that is they can be engaged with as artefacts. However, a telehealth stethoscope will be both a system and an artefact and this duality could be problematic, particularly with regard to the research findings presented in this paper.

The most relevant finding is that the interaction between doctor and patient is mediated by the administrative aspects of the consultation and not by the stethoscope. That the stethoscope can play a subsidiary role reveals that the doctor and patient treat it as infrastructure. Star (2002) describes infrastructure as that which is “part of the background for other kinds of work” (Star, 2002, pg 116). The stethoscope acts as infrastructure because it aids the doctor in their work of completing the administrative actions that are the reason for the consultation. However, the stethoscope can only act as infrastructure because the doctor is able to use it so easily. The relationship that the doctor has with the stethoscope is what makes it act as infrastructure. If that relationship were broken or changed in some way, the stethoscope would cease to act as infrastructure and would become a thing to deal with in and of itself. A telehealth stethoscope must therefore be able to operate as infrastructure, allowing the doctor and patient to interact for the consultation and largely ignore the stethoscope.

Ignoring a telehealth stethoscope will be more difficult as it will be a system of physical artefacts and software. All elements of the telehealth stethoscope must work correctly to allow a doctor to treat it as a stethoscope. In order that an acoustic stethoscope functions correctly it must simply be in good repair with no cracks in the tubing and a diaphragm that is intact. In a face-to-face consultation (figure 5), auscultation is mediated by a very simple artefact. In contrast, a telehealth stethoscope places a large number of artefacts and systems between the doctor and patient and also requires new relationships between people in order for auscultation to be performed.

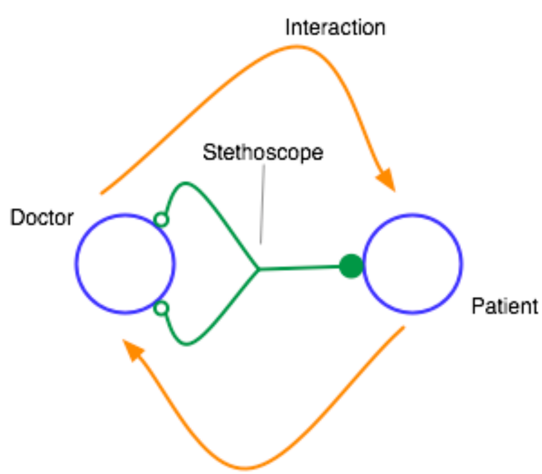


Figure 5: Face-to-face auscultation interaction

Figure 6 shows the mediations and interactions required for successful telehealth auscultation (teleauscultation). There are three participants in the teleauscultation shown, the doctor, the patient and the nurse. The nurse places the head of the digital stethoscope on the patient and has earpieces to listen to the patient’s chest. The digital stethoscope is also connected to the telehealth infrastructure to transmit the patient’s heart sounds to doctor. The doctor has earpieces that allow them to hear the patients sounds transmitted over the telehealth infrastructure. The doctor and the nurse must work collaboratively to listen to the sounds of the patient's chest. The additional interaction between doctor and nurse and the collaboration that is required to obtain good chest sounds is not currently taught to doctors or nurses and is something that will have to be learned in order to make a telehealth stethoscope useful. The collaborative work of using a telehealth stethoscope will need to become part of the infrastructure of the system in order to make the system work.

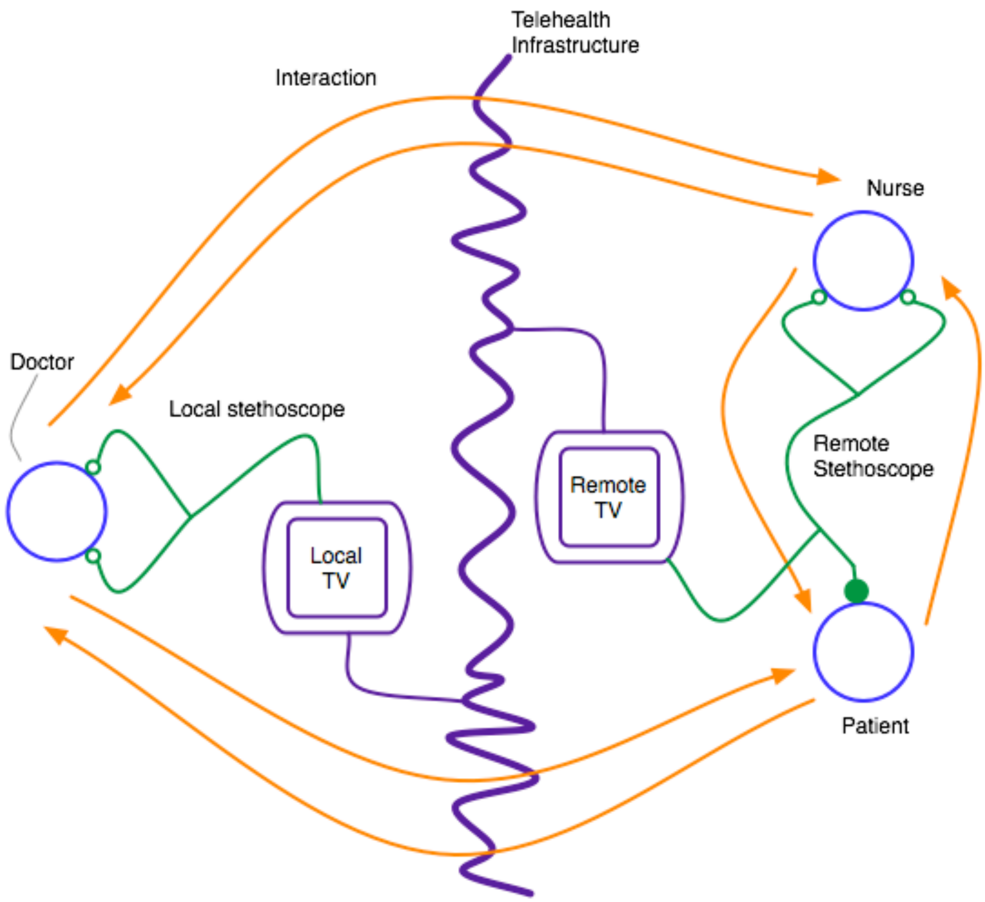


Figure 6: Telehealth auscultation interaction

Previous studies have shown that teleauscultation can be successful (Belmont and Mattioli, 2003; Fragasso et al, 2007; Wong et al, 2004). This research we have conducted has found that acoustic stethoscopes act as infrastructure in face-to-face consultations. The complexity of a telehealth stethoscope makes it more difficult to be used as infrastructure. The implication for design of this analysis is that designing the artefact of a telehealth stethoscope is not sufficient, what must be designed is the system that makes the use of the artefact possible.

In the context of our research, some elements of the system for teleauscultation already exist. The telehealth infrastructure is already in place. The findings described above suggest that the elements of the system that perform as stethoscopes should resemble stethoscopes. What must be designed is the interaction between the human actors in the system and the coherent functioning of the system as a whole.

Conclusions

The goal of this paper has been to examine how existing preadmission consultations are conducted, with a focus on how stethoscopes are used during such consultations. Analysis of the activity of doctors and patients during consultations showed that the majority of time during consultations is spent on administration and communication and that the physical examination of the patient is a minor aspect. We argued that the brief use of stethoscopes in preadmission consultations shows that doctors treat them as infrastructure, that is, as an artefact that allows work to be performed, rather than a site of work itself. We have then argued that if stethoscopes are infrastructure then that has implications for the design of telehealth stethoscopes.

The two implications for the design of future telehealth stethoscopes are related. First, a telehealth stethoscope will be a shared artefact, not a personal one. All acoustic stethoscopes reproduce the sounds of the chest slightly differently and doctors learn to interpret those sounds through their personal stethoscopes. A telehealth stethoscope will sound different to a doctor's own stethoscope and this may have an impact on their diagnostic and interpretative ability. Second, using a telehealth stethoscope will be much more complex than using an acoustic stethoscope because of the systems that must be created and sustained in order for a telehealth stethoscope to function. While some systems, such as the telehealth infrastructure, exist already, other systems and social protocols, such as how doctors, nurses and patients will interact, are yet to be created.

The conclusion of this work is that the design of a telehealth stethoscope must encompass the design of the artefact itself and the design of the systems that will make a telehealth stethoscope possible. Some of those systems exist already and will need to be appropriated into the design of the telehealth stethoscope. Others, such as the system that will allow accurate transmission of chest sounds, are yet to be created. And some aspects of the system that will make a telehealth stethoscope useful, such as the methods of interaction between doctor, nurse and patient, can be suggested but never truly designed.

These preliminary findings are significant because they provide new knowledge about the factors influencing the adoption of telehealth stethoscopes for remote patient assessment. If the systems that will support the use of a telehealth stethoscope are not adequate, then the telehealth stethoscope will not be able to be used. These findings allow a deeper understanding of what a successful tool will encompass and will ultimately lead to the production of an advanced telehealth stethoscope that will enhance the ability of doctors and nurses to conduct remote auscultation assessments.

Through careful analysis of current interactions we have been able to identify aspects of the new situation that must be carefully considered in a new design. This approach is adaptable to many situations and can contribute to the design of innovative systems and artefacts that can be readily inserted into complex situations. Our approach deals with important problems that are shared by significant application domains in rural health care. The new methods and techniques we are developing contribute to new knowledge within the domain of telehealth but also apply to other areas where the introduction of innovative tools must be studied. These methods and techniques are themselves new and contribute to the body of knowledge on conducting design research.

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A Proposal for the Web 2.0 Revolution in Online Design Education:
Opportunities for Virtual Design Learning Using Social Networking Technologies

Karen Kwan, York University, Canada

Abstract
New Web 2.0 tools are enabling new avenues for online communication. Social networks that have sprung up from these tools are not only the basis of information dissemination but also a means of sustained learning. Educators are now able to investigate beyond traditional teaching pedagogies and student participation roles. By exploring learning theories and the philosophies of design education, this research proposes a framework for leveraging recent innovations in social networking technologies to facilitate these values in an online environment. Unlike many other subject areas, at the center of design learning is an underlying method of inquiry and dialogue that cannot be objectively transferred to students through typical learning management systems. The growth and popularity of social networking services has created a communications space that is distinct from the confines of the physical world. By taking advantage of the rich complement of applications that comprise this alternative communication space, educators can import the reflective learning approach essential to design education.

Keywords
Learning; Reflective Practices; ICT

This paper examines the pedagogy of university-level online design education with specific emphasis on the utilization of Web 2.0 social networking tools. By exploring learning theories and the philosophies of design education, this research proposes a framework for leveraging recent innovations in social networking technologies to facilitate these values in an online environment. The goal is to open up the discussion of eLearning in design by investigating design education in conjunction with its virtual counterpart.

The area of design has been somewhat slow in adopting online eLearning formats. Perhaps because design learning is so tied to the tacit knowledge gained during the production process that forays into online design education has been somewhat tentative. There is now, however, a critical mass of data from which meaningful conclusions can be drawn as design vaults itself into the online realm.

With the advent of Web 2.0, the growth of eLearning has taken on a new complexion. Open source programs and application programming interfaces are now available to provide richer, more enhanced learning experiences. Web 2.0 has the potential to bring enriching experiences to online design education. A prototype design course environment using a selection of current Web 2.0 tools is presented in Appendix A; demonstrating the potential of these emerging technologies.

Current Online Learning
In general, online courses at universities are administered through one of several popular learning management systems. Typically, there is a personal homepage where general announcements are posted, courses are listed and tools such as calendars, task reminders and grade reports are available. On specific course pages, there is space for a syllabus as well as a medley of communication tools including email, forums and provisions for digital drop boxes. On the backend, instructors have a vast array of database-driven modules for building quizzes and lessons. Also available is a set of statistical tools showing student performance which can be used to generate learner profiles and help instructors prescribe remediation activities as needed on an individual basis (de Castell, et al., para .20).

Proponents of these systems have detailed a number of documented success stories and contend that the tools in these systems allow for engaged learning experiences. However, as Susan de Castell et al. explain in their article “Object Lessons”, despite the sophistication of the LMS environments with their powerful content management capabilities and integrated communication functions, the majority of courses do little more than utilize the display and distribution capabilities of computers and the Internet.

The argument continues that this pre-programmed approach to education is fundamentally rooted in textbook-based knowledge that encourages compliance above learning. Clearly, as advanced design education is a subject area that has few explicit textbooks of knowledge, the pedagogical constructs of current online learning would have limited application for design courses.

To address the needs of design courses we first turn to a consideration of the principles of design learning as it occurs in the design studio. This assessment will establish a concrete definition of design learning needs before attempting to evaluate how the unique capabilities afforded by new Internet technologies can be leveraged for online design courses.

Design Learning Defined

Particular to design education is the studio as an environment for instruction. The elements and philosophies of design learning were investigated with the following means.

1. An historical account of studio-based design learning

   Tracing the history of studio learning will provide a deeper understanding of the purposes and goals of this model of learning. This understanding would, in turn, provide guidance to the application of new methods and processes afforded by the current information age.

2. A close reading of the studio learning model as proposed by Professor Donald Schön

   Described as being “among our generation’s most influential philosophers of design and design education,” (Waks, 37) Schön’s detailed study on studio learning provides insight into the specific workings of design studios – the roles of students and educators and the interactions that constitute design learning.

3. The observations of a current studio-based class at the undergraduate level

   To understand the goings-on in the contemporary design studio and how design learning is imparted in such a setting, in-class observations of a studio-based design course were undertaken. The course description and project brief given to students at the beginning of the term is included in Appendix B.

Design Studio Origins

As a learning model, studio-based training can trace its roots to the guilds of the Middle Ages where apprentices learned under the direction of a master artist or craftsman. More formally in North America, the teaching system of the Ecole des Beaux Arts has been recognized as one of the standards under which studio-based education was founded. (Lackney, para. 2)

Beginning with a preliminary sketch of the “design problem”, then progressing to an interim critique (“crit”), the Beaux Arts system culminates with a final juried evaluation. Throughout the term, studio instructors guide students towards the completion of a final product. Although it has been over two and a half centuries since the adoption of this system, the essential elements within it has remained largely unchanged in present-day studios found at institutions of higher learning.

Donald Schön and Reflective Learning

In the 1980’s Professor Donald Schön put forth a series of essays that examined modern design studio learning in detail. After presenting the dialogue from a hypothetical design review between a student (Petra) and the studio master (Quist), Schön dissects the exchange to substantiate how learning in the studio environment is a reflective process. Reflection-in-action takes place on the part of both the studio master and the student. As Quist probes Petra about her design experiments he is testing (or reflecting upon) the effectiveness of his interventions and the student’s understanding of design. To the extent that Petra can translate Quist’s interventions and express them through design experiments demonstrates her process of reflective learning. Through a series of “telling” and “demonstrating” by Quist and “listening” and “imitating” by Petra, the master and student engage in what Schön refers to as “reciprocal reflection-in-action” until there is a convergence of meaning. (1985, 64)

Schön’s framework of the design studio has three implications: (Waks, 44)

1. Design can only be learned by experimentation. No explicit teachings can achieve the same results. Schön recognizes this dilemma by calling it the paradox of reflective learning whereby the student must start working on a design problem without adequate knowledge; the knowledge required can only be gained after working on the design problem.
2. Design cannot be learned in isolation. Each move or experiment undertaken affects the whole, which in turn affects subsequent moves putting constraints on possibilities. When Quist instructs Petra to make a move that can always be changed later, he demonstrates how design is to make new coherent patterns and meanings of all the components of the situation.
3. Designing depends on the ability to appreciate or recognize the desirability of outcomes whether or not they were intended. Negotiating the outcomes of successive experiments through operational moves and material back talk will develop a student’s ability to designate the quality of designs achieved.

This process is unique to the studio-learning environment and the fact that this learning model uses a conversational approach is significant. The dialogue is not only between student and instructor; it is also between students and their classmates and between students and their work. Social media that has expanded and enhanced the communication space of the Internet points to increasing possibilities for online design courses without compromising the core principles of design learning.

The Contemporary Design Studio

To explore how the traditions of the design studio and Schön’s model of learning have evolved, in-class observations of a current studio-based design course at the undergraduate level were conducted. Key features of the course revealed limited detraction from the studio system as it was adopted in the mid-nineteenth century and a close mimic of the descriptions presented by Schön.

As the course/project descriptions indicate, assignments are semester-long endeavours that start with an initial proposal, proceed through a series of “crits” before the final is submitted. In the sessions attended, the focus was on progress critiques for each student. Each week, classes were structured such that the iterations of student projects and work-in-progress was presented for class “pin up” reviews or one-on-one critiques with the instructor. This fostered “culture of criticism” akin to the imported model from the Ecole demonstrates this feature as a fundamental aspect to design learning.

In terms of the roles of the instructor and students in the course, interactions were a close match to those described by Schön. As the expert in the studio, the instructor’s role in the observed class was primarily centered on guidance and feedback. In fulfilling this role the instructor used a combination of lecture-style presentation material, group peer review or “pin-up” sessions and personal one-on-one critiques. To address the class as a whole, the lecture portion of the class concentrated on showing examples and highlighting areas of significance. The presentation was relatively short, spanning less than 20 minutes in a four-hour class. The remaining time was reserved for providing feedback to students. During the observed classroom “pin-up” session the instructor emphasized the need for all process work to be available in order to understand how different pieces of the same publication fit together to create a unified whole. While the session provided a non-confrontational opportunity for students to look at each other’s work and make suggestions, students were generally reluctant to show their work and hesitant in offering comments. Comfort for sharing ideas and sketches changed remarkably during the one-on-one critiques. The instructor was also the most thorough during this portion of the class. As Schön describes, through both classroom and personal critique sessions, the instructor guides students using a series of “telling” and “demonstrating” while students learn by “listening” and “imitating.”

Further to the instructor-student relationship described by Schön, the studio environment also allowed students to “tell” and “demonstrate” or “listen” and “imitate” amongst themselves. When not engaged with the instructor, students were observed to be actively helping each other, giving constructive feedback, answering “how to” questions and wandering about looking at each others' work.

By acknowledging that the process of design learning is predicated on a series of reflective dialogues and social negotiations, it becomes evident why online design courses have so far only shown moderate success. More often, successes have come in design courses where the objective is the acquisition of a design-related skill (i.e. software tutorials) that had little need for peer/instructor feedback.

What has changed? The online environment has evolved.

Advent of Web 2.0 Social Media

Background

Web 2.0 has brought a new set of principles on the use of tools available online. These principles, described by Tim O'Reilly, from whom the term was originally coined, include: (O’Reilly Media, para. 6)

1. The web as a platform
2. Harnessing collective intelligence
3. Data is the next Intel inside
4. End of software release cycles
5. Lightweight programming models
6. Software above the level of a single device
7. Rich user experience

These principles show that Web 2.0 was founded based on a platform of sharing and participation where users are in the driver’s seat and collaboration builds success. This essential aspect of Web 2.0 closely aligns with the established fundamentals of design learning. Continued growth and penetration of these tools has created fertile ground for offering online design courses in an increasingly accessible platform.

Growth in Popularity

The surge in the adoption of Web 2.0 tools, particularly social media, has touched nearly every facet of life. Marketing gurus dare not discount the feedback of online network groups; during the most recent election, political spin masters were abuzz on Twitter; and our daily vocabulary has been permanently expanded by the terms YouTube, Facebook and Wiki. A recent technology presentation by Morgan Stanley highlighted the fact that social network connections had 16% of worldwide online time, second only to the general category of communication at 22%. More astounding is that the category of social connections did not even exist four years ago. (Morgan Stanley, slide 9)

To visualize Web 2.0 in terms of the specific tools being used, a sample of 100 popular web services and applications were analyzed. Since Web 2.0 tools are in continuing flux with new applications being pushed out by developers on an almost daily basis, the larger sample of 100 services (out of 3,000) were surveyed to avoid bias or misrepresentation. The tools were chosen for this study by combining the popularity votes on various Web 2.0 directory sites[1] with the rankings and statistics from Compete.com.[2]

Statistics showing the number of unique monthly visitors for each site was mapped in the word cloud formation in Figure 1. The comparative size of each is provided in the top left-hand corner. From this image its can be seen immediately that the giants in the Web 2.0 universe are YouTube, MySpace, Wikipedia, Facebook, Amazon, craigslist and Blogger. A larger version of the graphic is available in Appendix C.

[1] These sites include: www.go2we20.net, listio.com, www.allthingsweb2.com.
[2] Much like the Neilson TV ratings statistics, Compete collects data from over 2 million Internet users and extrapolates their usage patterns to generate web domain analytics.

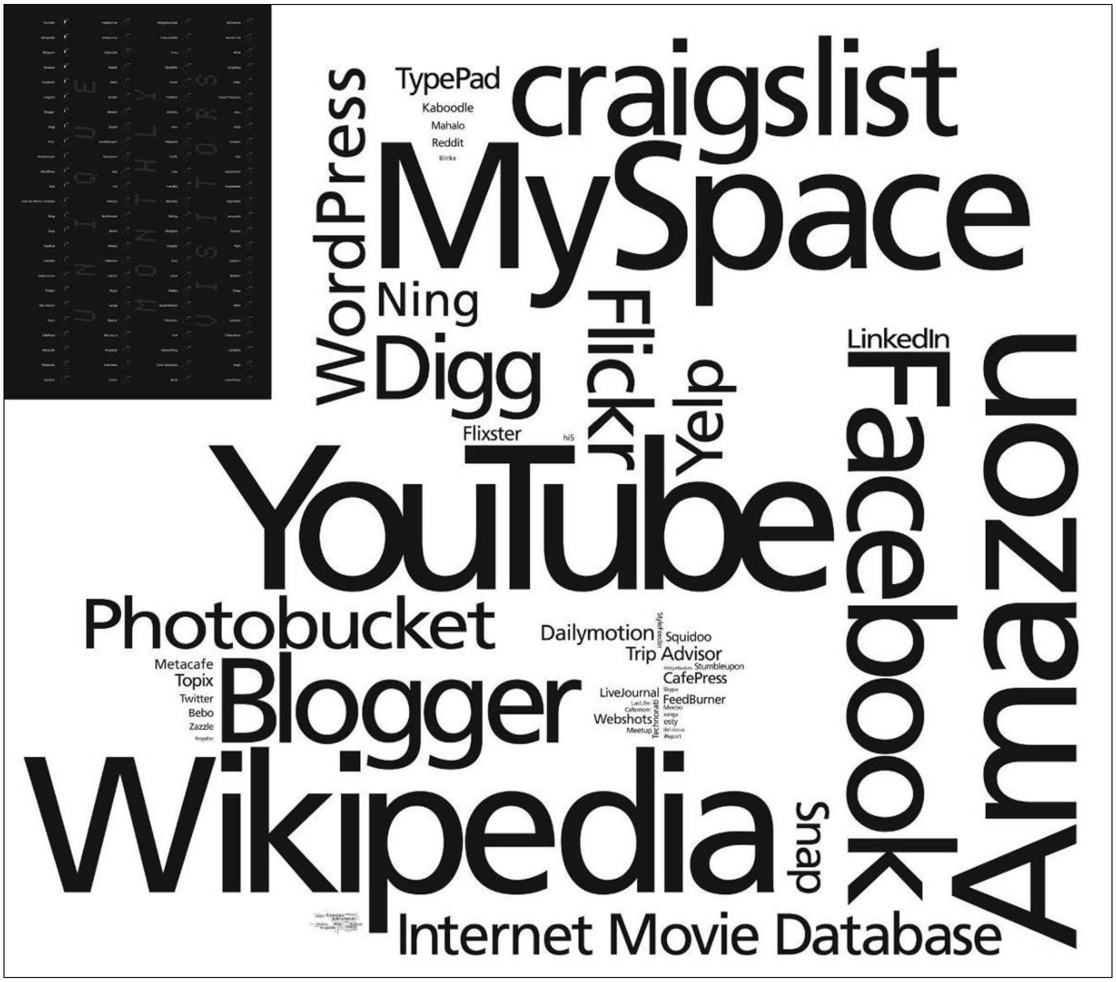

Figure 1 Word Cloud of Popular Web 2.0 Tools

Alignment with Learning Theories

As online learning via Web 2.0 tools begin to gain wider traction with mainstream institutions and students, this section evaluates these tools with established learning theories and how they align with the previously defined concept of design learning. Specifically, the learning theories examined are:

- Social Constructivism: where learning is an active and contextualized process of constructing knowledge rather than acquiring it. Knowledge is constructed based on personal experience, interactions and social negotiations.
- Cognitivism: where the focus is on the inner mental activities – opening the "black box" of the human mind. Learning under this theory centers on the individual and how they "make sense" of their environment.
- Behaviourism: a worldview that a learner learns by responding to environmental stimuli. With this school of thought the learner is assumed passive.

The "culture of criticism" handed down from historical models of studio learning and demonstrated in the observed undergraduate class is a close match to the social constructivist theory of learning. In the studio setting, the constant feedback from peers, instructors and invited guest experts all contribute to a student's learning experience. It can therefore be seen that in this model of learning, student students construct knowledge in a process that is mainly social.

Cognitivism delves deeper into the impact of the dialogues taking place in the studio setting. The progress of students relies heavily on their own interpretations of the materials and situations they encounter. Students will have different experiences in the course based on their ability to grasp a given lesson. Using this understanding, the learnings from a design studio mirrors Schön's reflection-in-action model where the focus is on the individual.

In contrast, behaviourism aligns with the view of education where textbook knowledge is emphasized. This learning theory is at odds with how design learning has been identified. The theory does, however, correspond to the characteristics of current online course offerings where the assumption is that student gain knowledge by reading the content on CMS portals. Without any additional form of participation required, this process of learning could be considered passive.

Distilling the three learning theories into the three factors of 'social', 'individual' and 'passive' and pairing them with their opposites – 'isolated', 'group' and 'active', these six factors of learning, result in a framework for evaluating the alignment of Web 2.0 tools against the three fundamental models of learning. The diagram in Figure 2 summarizes how these six factors were derived.

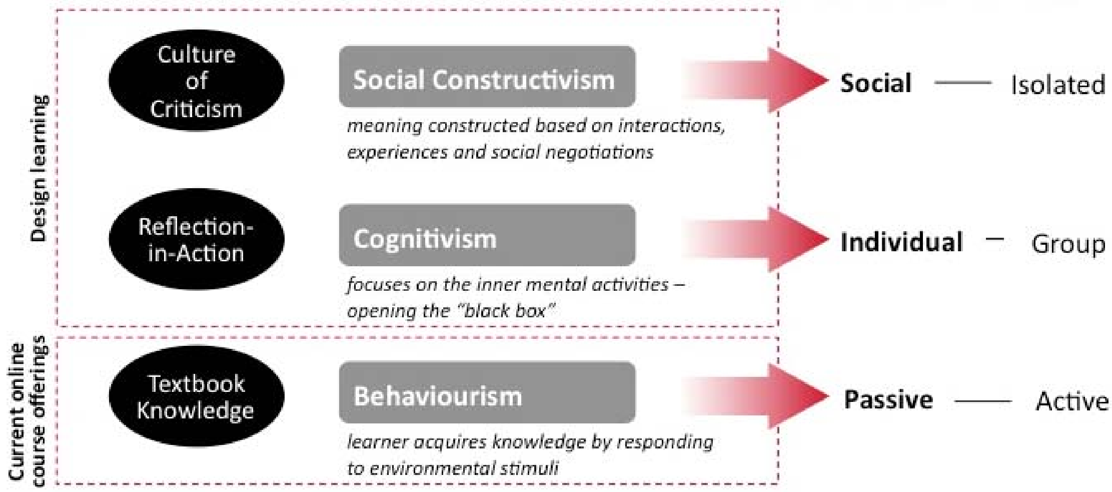

Figure 2: Learning Theories and the Six Factors of Learning

Taking each pair of factors, the 100 web services sampled previously were evaluated on a sliding scale from zero to ten, the higher the number the greater extent the tool displays that characteristic. In each case, the sum of the pair would equal ten. For example, if a particular web service rated 10 for passive, it would automatically receive a zero under the active column. This was done to control for the relative comparison between tools such that applications with multiple capabilities could be compared to a micro tool with only one function. If a site had eight functions and seven functions enabled interaction (bookmarking, commenting, sharing, voting, tagging, ranking, emailing), that web service would receive a nine for social and a one for isolated. Likewise, if a site had only one feature and it enabled interaction, that service would receive a ten for social and a zero for isolated. The result of this mapping is shown in Figure 3.

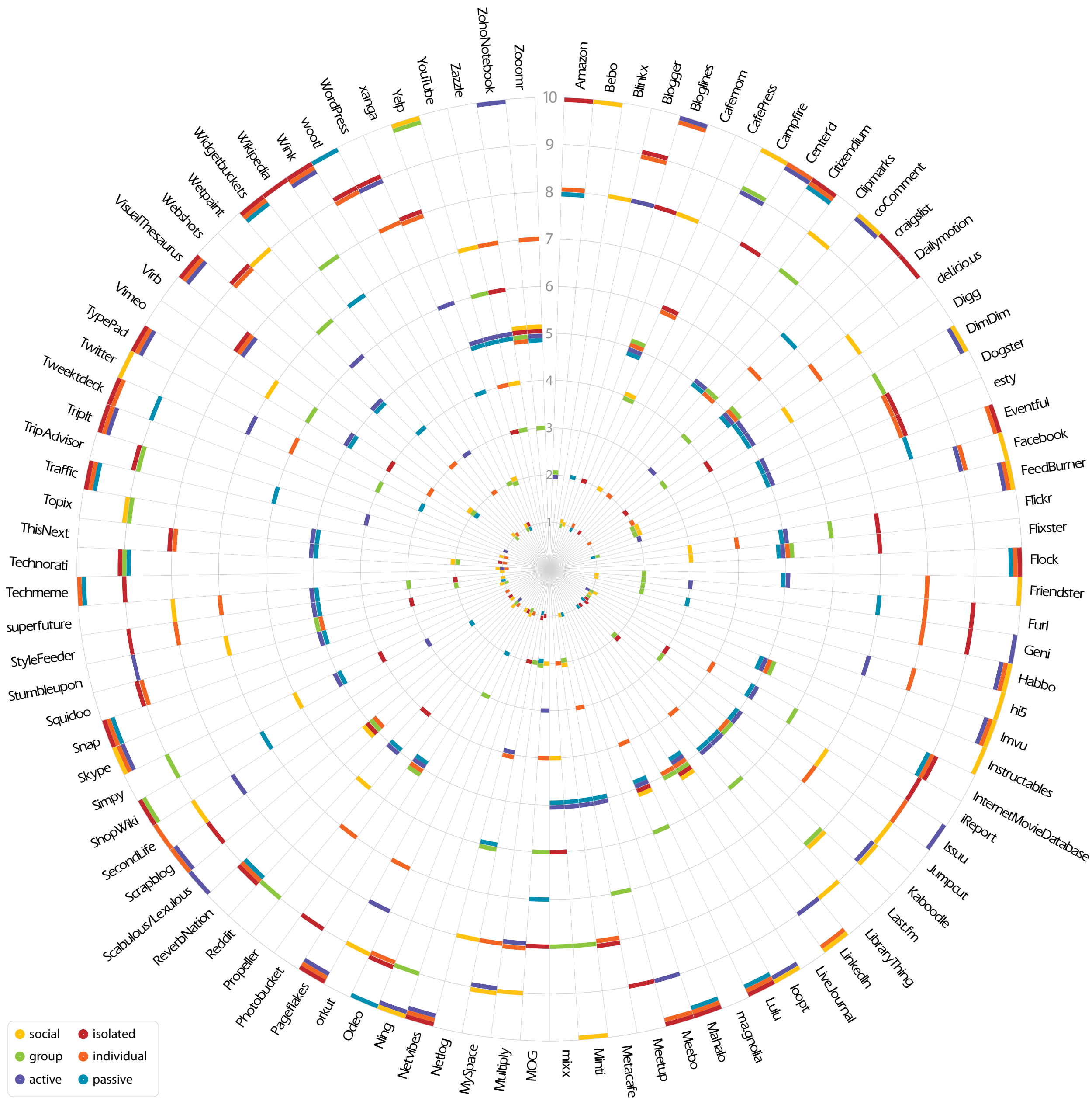

Figure 3: Mapping of Web 2.0 Tools and Factors of Learning

Taken as a whole, this diagramming of web services shows the range and diversity of the tools available in the Web 2.0 universe with its ability to accommodate a variety of learning situations.

To focus on the individual component parts of this visual, the six extractions shown in Figure 4 isolate each factor and represent them as “starbursts.”

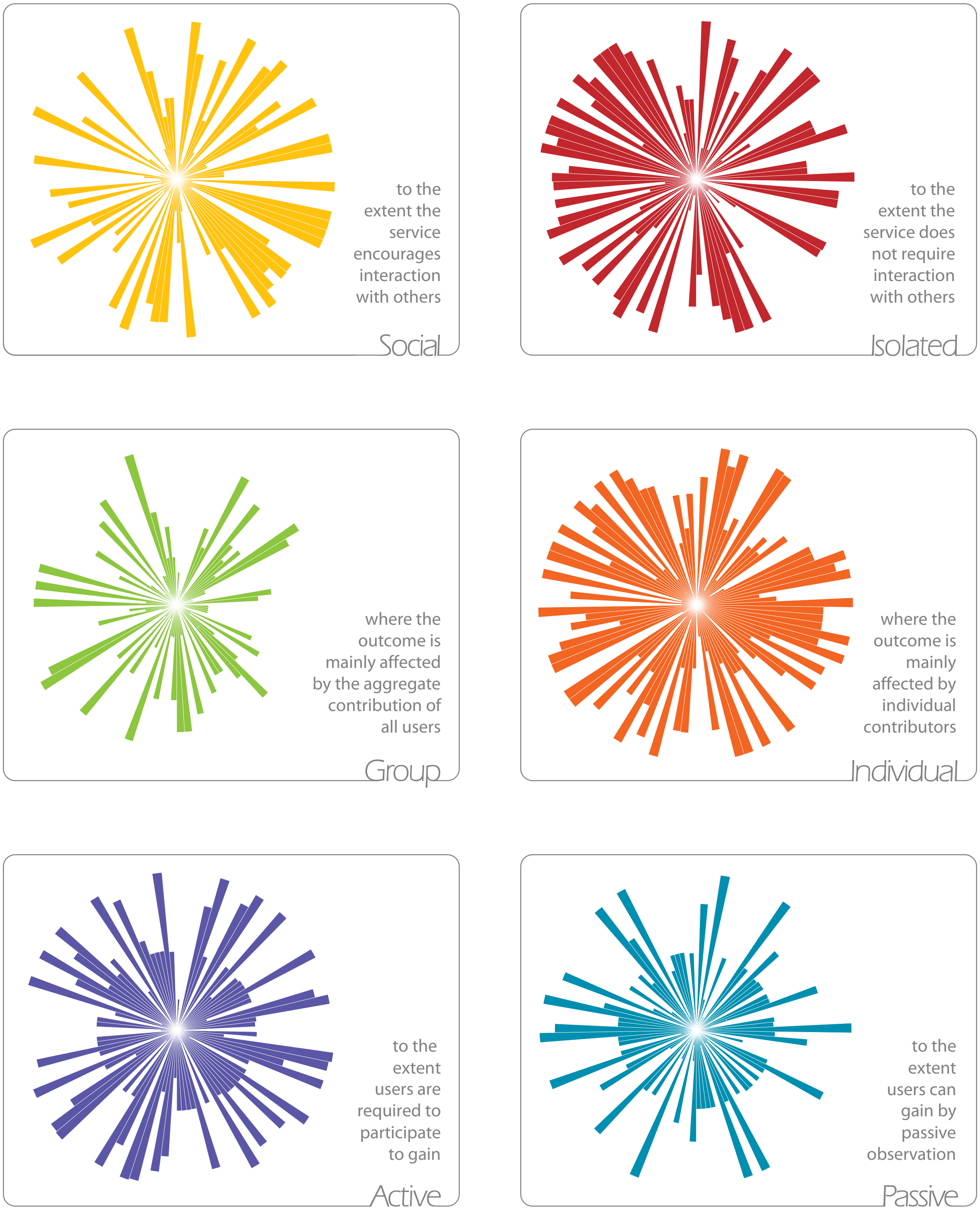

Figure 4: Individual Factors of Learning

Each pair of these “starbursts” represents the extent to which Web 2.0 tools facilitate the given learning theory.

Looking at the social constructivist pairing of “social” and “isolated”, the results indicate that there are a number of tools and services available to mitigate the physical isolation of using a computer. While the comparative sizes of the starbursts show that a slight majority of services do not necessarily require interaction with others, there is a growing trend towards encouraging more interaction.

Turning to the “group”/”individual” pairing that represents cognitivism, its can be seen that this is where online resources could be superior. The results illustrate that the vast majority of web services support an individualistic approach where there is ample space for reflective learning. Services like blogs or personal pages would be an example of these spaces.

Finally, when assessing how the behaviouralistic approach is applied to Web 2.0, the split between its two component factors “active” and “passive”, imply that users now have a choice as to whether they want to be active or passive – a departure from the traditional concept of Internet content which was mainly built on a “read-only” basis.

With this analysis, there is evidence of a close alignment between Web 2.0 capabilities and the principles of design learning. The results also present a plethora of tools available to build online course environments.

Change in Value Proposition

The advent of Web 2.0 social media tools has slowly changed the value proposition for online courses. Previously, the main advantage of online courses was its ability to transcend time and space. All knowledge was contained in neatly packaged modules that students could access whenever and wherever they pleased. However, since social media tools have created an alternative communication and learning space, the possibility of a fixed time and location for online courses is now available. The advantage of online courses, therefore, can now be expressed as a matter of technological relevance rather than mere freedom from temporal or physical limitations.

This shift in the perceived value of online courses has immense implications for online design courses. As established, the fundamental value of design courses is rooted in the various real-time dialogues that occur in the design studio. The non-location/time specific benefit of LMS-based online courses resulted in a dissociative and isolated experience that had limited applicability for design courses. Web 2.0 social media tools now present the possibility of truly offering virtual design courses that are both meaningful and engaging.

Tightly Integrated versus Loosely Coupled

Pre-packaged learning management systems have tools and resources are bundled and tightly integrated. These proprietary systems have highly developed tools that have been thoroughly tested by dedicated teams and function as stand-alone units. Their ability to interact with other resources on the Internet, however, is limited; most even have their own email repository that can only be accessed through their specific own portal. As visualized in Figure 5, these tools are neatly integrated into a tight package that constitutes an entire system. The tools in these systems are reliable and standardized but there is no option to customize functionality or “plug-in” external resources. By its very nature, the “closed-off” environment proposed by LMS products becomes a barrier in its adoption for studio-based design courses.

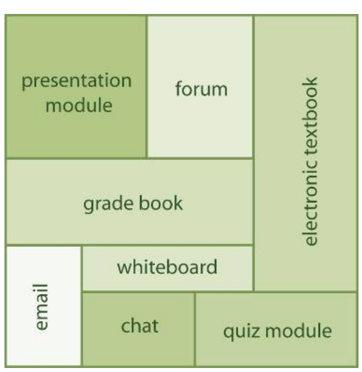

Figure 5: Tightly integrated course environment

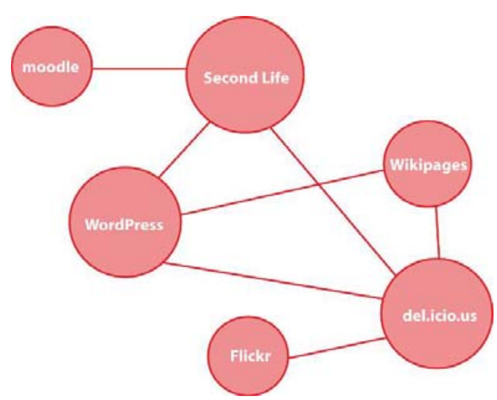

Figure 6: Loosely coupled course environment

In comparison, by looking at the individual tools available, rating their functions, popularity and propensity for educational value, the framework suggests a more flexible and somewhat ad hoc method of deciding which tools to employ for online design courses. Course environments, in this case, are built as networks of resources; they are loosely coupled to enable quick changes and flexibility. As an example, the diagram in Figure 6 shows numerous Web 2.0 tools connecting to one another to form a course environment. As different tools become available they could be incorporated into the network or even replace certain parts of it without disrupting other components.

The adaptability of this course environment model is in close keeping with the long tail development norms of Web 2.0. As rapid advancements in technology increases the variety, functionality and degree to which tools can be integrated, this nimble approach allows courses to be continuously enhanced and remain technologically relevant. In terms of design courses, instructors are at liberty to include or exclude tools as they build their virtual classroom. As the selection of the tools would be based on their usability, the tools themselves would be more natural and familiar, thereby eliminating the technology learning curve for both students and instructors. In addition, as the majority of these tools are independent entities that essentially provide one service, they are simpler to understand and their development is more responsive to user needs.

For the area of design, the growth of these tools has particular significance as the subject matter and the ways in which it is taught do not fit within the established structure of learning management systems. More importantly, these tools have also changed the way online courses are perceived.

Opportunities for Online Design Courses

There is a clear match between the capabilities of Web 2.0 social media tools and the priorities of design learning. While the pedagogy of existing online design courses belie the core principles of design learning, the prudent application of new Web 2.0 technologies can push beyond VLEs and create new opportunities for providing experiences that are as fulfilling as traditional studio-based design courses.

Social media tools provide a space for “show and tell” scenarios and reflective learning. As the previous analysis revealed, these types of tools are closely aligned with the social constructivist and cognitive theories of learning. Social media services enable peer and instructor feedback in a user-friendly graphical interface while the encouragement of individual contributions fosters reflective practices. Moreover, these tools promote the “pin-up” session behaviours that instructors try to create in a physical studio. As a computer network mediates this environment, the perceived risk is lessened allowing for a more productive learning situation. As observed in the studio class, students are inclined towards peer assistance where there is a heightened level of comfort and safety.

Virtual reality/3D services like Second Life and Imvu offer an additional level of interaction. Using a computer persona known as an avatar, these services provide the opportunity for design classes to meet classmates and instructors in a real-time environment. This environment fosters dialogue akin to the intimate conversations that occur in a bricks and mortar studio. While other disciplines like law and medicine have used virtual spaces to train students on required interactions within specialized settings, in design learning there are no special equipment or protocols. Rather, design educators can use the same tool to imitate and build the kind of atmosphere of communication uniquely available in design studios.

Conclusion

If design education is intent on using the Internet as a platform, educators must adapt their applications of technologies or risk becoming irrelevant. Controlled VLEs that are currently being used to house design courses may have their place in the management functions needed to administer a course but as this research as evidenced, there is a need to open up these environments to allow for effective learning conditions.

Unlike many other subject areas, at the centre of design learning is an underlying method of inquiry and dialogue that cannot be objectively transferred to students through typical learning management systems. There is a necessary amount of real-time interaction with instructors and peers in fostering a design “know-how.”

Web 2.0 tools and services have the potential to bring engaging experiences into a virtual classroom. The growth and popularity of social networking services has created a communications space that is distinct from the confines of the physical world. By taking advantage of the rich complement of applications that comprise this alternative communication space, educators can import the reflective learning approach essential to design education.

As Manuel Castells writes in The Information City, “[a] technological revolution of historic proportions is transforming a fundamental dimension of human life: time and space.” (1) It is now imperative that its implications be understood and explored.

Appendix A: Prototype Course

To demonstrate how an online course environment comprised of Web 2.0 tools could be conducive to online design learning, a prototype design course that integrates Second Life, Moodle and a variety of media sites was developed to show their potential.

For the course, Second Life, a virtual 3D social space is used as the main platform for interaction while Moodle, an open-source course management system, forms the administrative back-end to provide a secure repository for course-related paperwork. Additional media such as videos, images and web blogs are drawn into Second Life and are used as supporting material when needed.

Second Life was chosen to act as the interface component of the course because as an immersive social environment it can function as a close surrogate to actual face-to-face conversations. As Jim Blascovich describes in his study on social psychology and immersive virtual environments, social presence is a psychological rather than physical state where "the individuals perceives himself or herself as existing within an interpersonal environment." (130) Therefore, with virtual spaces and avatars the reflective dialogues so ingrained in design learning can be brought online without sacrificing the operational value of studio-based learning.

Moodle, meanwhile, was chosen because of its ability to connect with outside resources and its wide adoption rate. As an open-source program, Moodle can be modified and adjunct services added as required. That it has a high install base is an added advantage, helping to shorten the necessary learning curve.

The technology used to link the Second Life environment and Moodle comes from a UK-based research initiative called Sloodle (simulation linked object oriented dynamic learning environment) funded by Eduserv. Development and updates to their open-source work continues to enhance the collection of tools available across both applications.

Description

The prototype course environment consists of five key areas:

- Registration and course information area – for course enrolment and disbursement of course tools
- Auditorium – for general whole class meets and presentation-style lessons
- Student breakout rooms – for informal group meetings and peer gatherings
- Gallery – for the display of exemplar student work
- Office space – for one-on-one dialogues between students and instructors

The first two spaces, registration and auditorium, are areas that have would be typical of any course regardless of subject matter. The latter three were created based on the needs of design learning as discussed in this research.

Registration and Course Information Area

This will be the initial point of entry for the course environment. As shown in Figure 7, this area consists of a registration booth set up to allow for enrolment, an access checker that verifies enrolments, a vending machine (containing in-world tools) and an information dispenser (containing a folder of note cards with the course description, schedule and project briefs). Each resource is accessible by a simple touch from the avatar.

Similar to the administrative processes needed for physical classes, this area provides the requisite tools for students to enrol in and access the Second Life environment. More importantly, the initial in-world enrolment will link the students' avatars to their real-world identities.

The access checker, functioning much like lab access cards issued to students in the real world, enables an added level of security to ensure that only registered students gain access to course resources.

Finally, the vending machine and course information dispenser serve as convenient repositories for an unlimited supply of courseware. If students loose, corrupt or otherwise destroy their copy of the resource, supplicates can be obtained through these distributors.

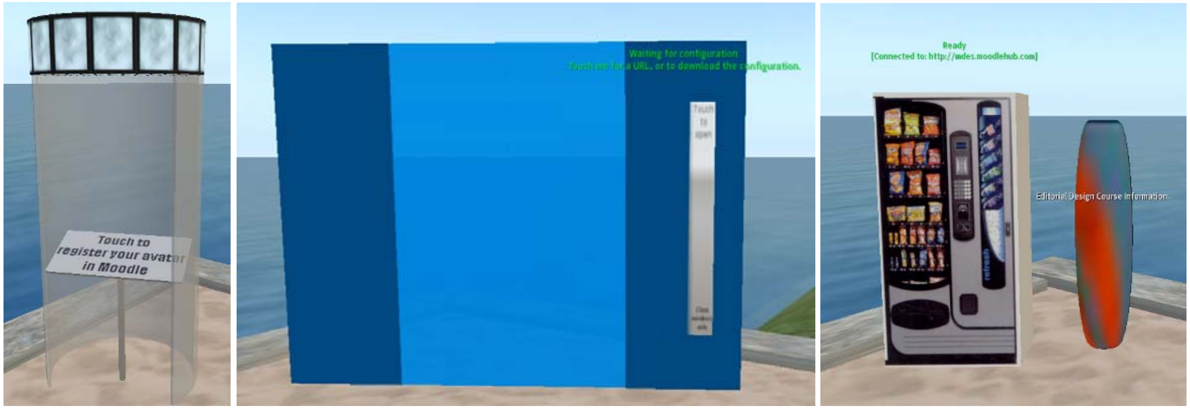

Figure 7: Booth, Access Checker and Courseware Dispensers

Auditorium

To address the component of learning where reference materials are needed, the course environment will have a lecture or theatre space where presentations, expert examples or pre-recorded movies can be shown to the entire class. As Figure 8 illustrates, this space would take the form of a familiar auditorium-style room. The only difference would be that students could return at any time to replay material.

Figure 8: Auditorium

This area is essential to provide a “home-base” for the course. Physical classes are structured such that there is an initial gathering space for the purpose of general announcements and lectures. Even in studio-based courses like the undergraduate course that was observed, there was an expectation that the instructor would address the class as a whole or give a lecture to mark the beginning of the class.

While this group meeting place defies the conventional “advantage” of online courses – freedom from time constraints – the comfort and psychological familiarity provided by this space would allow students a smoother transition into a virtual classroom.

Student Breakout Rooms

As a gathering place for students, the breakout rooms will have a number of tools for reference and to facilitate communication. Shown in Figure 9 are the resources students would have access to when visiting the breakout rooms. The flat-screen TV can be configured to stream videos or images from external urls, the “chat logger” box allows conversations to be recorded and stored in Moodle, the laptop is a pre-programmed tool that contains resources to for students to become more familiar with Second Life and the large book is an interface for accessing a Moodle-based glossary. Figure 10 shows the breakout room in its entirety. Also shown in Figure 10, on the outside of the breakout room, is the Adobe projector where students can load their work and gather around for discussion.

Figure 9: Tools in Student Breakout Room

Figure 10: Student Breakout Room

As a low risk environment to facilitate the social constructivist “culture of criticism” inherent in design learning, the breakout rooms allow students to learn from one another. As seem in the observed editorial class, students were more inclined to give open critiques of each other’s work when not in the presence of the instructor. The breakout rooms provide an informal space for that particular learning opportunity.

Gallery

In terms of space for displaying student work, the gallery, as shown in Figure 11, incorporates additional chat loggers to record any comments students wish to leave. The gallery space provides a continued arena for interaction as well as a place for individual cognitive development.

Figure 11: Gallery

Visiting the gallery in groups, students have the opportunity to record their comments about the various work displayed using the chat loggers placed throughout the gallery. Using the Moodle interface, students would be able to retrieve the logs for later reflection.

Because instructors are displaying exemplar work in the gallery, students can also view the space as a place of “demonstration.” As Schön describes, one of the roles of a design instructor is to show or demonstrate design know-how until students are able to “imitate” that know-how in their work.

Office Space

The office space (see Figure 12), equipped with a chat logger and reference materials make up the final distinct area in the course environment. Outside of the office, a drop box is available for project submissions using an interactive sketchbook.

Figure 12: Office Space

To emulate the one-on-one critiques observed in the undergraduate design class and the reflective conversation Schön described in his study on studio learning, the office space has a comfortable environment to facilitate communication. Students have space to show the instructor their work and the additional resource room allows instructors to reference external material as appropriate for each student.

This prototype course is one example of the many possibilities available for design education. By actively experimenting with Web 2.0 tools just as other subject areas have already begun doing; virtual design learning can become a viable reality.

Appendix B: Course outline and project brief from observed class

Information pertaining to contact information has been removed to preserve the anonymity of participants.

York University / Sheridan College Joint Program in Design

Editorial Design

Optional Practicum Course Fall Term 2008–2009
[redacted]

Contact information
[redacted]

Prerequisites
Communication Design 2 (ysdn 3004) and Typography 4 (ysdn 3003).
Basic working knowledge of InDesign. Intermediate knowledge of Illustrator and Photoshop.

Course Description
This course will focus on the design of print and electronic editorial documents. Students will investigate the relationship between type, illustration, photo and graphic imagery.

Students will research a range of editorial vehicles as part of an investigation into the nature of current editorial design practice. The projects in the course will give students an opportunity to practice the skills necessary to produce effective editorial print documents.

Topical outline
- Behavioral effects of visual communication design
- Typography / image relationships
- Print fundamentals & electronic page makeup/imposition
- Editorial style and typesetting
- Documentation of the work process
- Administrative and production positions in editorial design

Learning Outcomes
Upon successful completion of the course, students will have demonstrated their abilities to:
- Understand and apply the design process in the development of effective print-oriented and electronic design solutions
- Achieve both breadth and depth in concept and image development
- Visualize concepts with clarity and economy
- Perform cross-media research
- Organize and prioritize information and work flow
- Create meaningful and emotive relationships between words and images
- Communicate verbally and in written form about work process and intentions
- Achieve professional standards in the presentation of comps and prototypes

York University/Sheridan College Joint Program in Design

Editorial Design

YSDN3011

Fall Term 2008

Course Brief

Assignment
Students will be asked to conceive a new magazine, included name, identity, format, size, grid and typeface selection. Students can select from an array of genres such as cooking, politics, lifestyle, sports, music, fashion, the arts, literature, etc.

Procedure
This process will begin with a sophisticated critical analysis covering content, audience and visual considerations. This study will include both observations as well as a personal analysis and hypothesis report. Following this research study, students will execute and develop a new Identity for this chosen publication, thus creating a new visual voice based on their findings from the research study. After completing the logo/identity design, students will begin to develop and create specs for their publication ie. type styles, leading, grids, gutters, heads and decks and implementing these master grids in Adobe InDesign. The term project will consist of three projects; Project 1 will involve designing a feature story utilizing typography only and using type as a vehicle for self expression, Project 2 will involve utilizing illustration as the main design vehicle and Project 3 will involve utilizing photography as the main design vehicle. Students can use the same manuscript for all three projects.

Grading
Research study 10%
Project 1: Magazine format and design, contents page, department page(s) 20%
Project 2: 1st Feature story design 20%
Project 3: 2nd Feature story design 20%
Project 4: Cover and logo design 20%
Attendance, participation 10%

Deadlines
Meeting 4, Research study
Meeting 5, Magazine logo
Meeting 8, Project 1 (Typography)
Meeting 10, Project 2 (Illustration)
Meeting 12, Project 3 (Photography)

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Author Biography

Karen Kwan has several years of experience as a graphic designer in the private sector. She has been the Course Director and Teaching Assistant for an online design course offered by the department of Design at York University. This research was completed in partial fulfilment of the MDes (Master of Design) program at York University.

Identifying Familiarity in Older and Younger Adults

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Abstract

This paper discusses empirical research into the familiarity of older and younger adults with contemporary electronic devices. Prior research into the field of intuitive interaction is examined, and the links between experience, familiarity and intuitive interaction are highlighted. An experiment is presented which investigated the differences in familiarity between older and younger adults. Overall the results suggest a negative relationship between age and familiarity, but exceptions to the rule are also demonstrated. This shows that age is not a determinant of familiarity, but it is often associated with a lower level of familiarity. This research also shows that older adults show verbal cues for familiarity far less frequently than younger adults, yet still display familiarity during task execution. The implications of these findings are discussed.

Key words

intuitive interaction; older adults; familiarity; prior experience; industrial design; interaction design.

Worldwide demographic shifts (with the exception of parts of Africa) are moving towards a model which has more adults over the age of 65, in terms of both absolute numbers, and the percentage of the entire population (Fisk, Rogers, Chareness, Czaja & Sharit, 2004; Lloyd-Sherlock, 2000). There are wide reaching social implications as a result of these changes. For example, it is expected that over 50% of the workforce in Australia will be over the age of 55 by 2018 (McDonald & Kippen, 1999).

People interact with a wide array of products on a day-to-day basis, and increasingly these products are electronic, with advanced technology, and more inbuilt functions and services (Heskett, 2002; Margolin, 1995). There is movement towards a more inclusive society, yet older adults often have difficulties using these complex digital devices which are now so prevalent (Djajadiningrat, Wensveen, Frens & Overbeeke, 2004; Docampo Rama, 2001). Devices such as mobile phones, which are firmly embedded in many younger adults' lives (Eisma et al., 2003), frequently baffle older adults (Lawry, Popovic & Blackler, 2009; Pattison & Stedmon, 2006). This can create frustration, which in turn can flow on to feelings of increased social isolation, reduced motivation, and even depression (Mynatt, Essa & Rogers, 2000).

It is becoming more important, on a societal, economical, and ethical level to address the usability issues that older adults are having with modern electronic devices. There are potential benefits, not only for older adults themselves, but also for society in general. Some of these benefits include improved social integration, higher levels of independence and improved health management (Mynatt et al., 2000). All of these benefits are likely to lead to a more fulfilling life (Fisk et al., 2004), and a more valuable contribution to society.

Incorporating intuitive interaction into user interfaces is one way of enhancing the usability of contemporary electronic devices for older adults. Intuition is a cognitive process that can be utilised in interactions with a product interface. Some typical characteristics of intuitive use include a lack of awareness of intuitive behaviour, and quick purposeful interactions (Blackler, 2008). Research into intuitive use and its application to interface is a new and emerging field.

Blackler, Popovic, and Mahar (2008; 2010) identified that intuition and familiarity are related, and that various elements of an interface design can contribute to intuitive interaction. Empirical investigations revealed that older people are less likely to utilise interfaces intuitively (Blackler, 2008). This research investigates and examines the differences in familiarity between older and younger adults with familiar contemporary devices.

Intuitive Interaction

There is no single concrete definition of intuition. Bastick's (2003) comprehensive examination of intuition and Klein's (1998) discussion of the role of experience in high pressure decision making situations have both assisted in shaping an understanding of intuition. Blackler (2008) has conducted an extensive review of intuition which resulted in the following definition: "Intuition is a cognitive process that utilises knowledge gained through prior experience…" (Blackler, Popovic & Mahar, 2002). Additional properties of intuition identified in Blackler's literature review include an increase in speed, higher levels of efficiency than other cognitive processes, and a lack of consciousness regarding what is taking place. For a full review of intuition, see Blackler (2008).

There is a difference between intuition, which is a cognitive process, and intuitive interaction, which is the use of intuition in an interaction. Blackler states the following definition, highlighting the distinction:

> Intuitive use of products involves utilising knowledge gained through other experience(s) (e.g. use of another product or something else). Intuitive interaction is fast and generally non-conscious, so that people would often be unable to explain how they made their decisions during intuitive interaction. (Blackler, 2008, p. 107)

The first empirical investigations into intuitive interaction by Blackler, Popovic and Mahar (2003) reached a number of conclusions. The most relevant conclusions from this research show that interface features which are less familiar are used less intuitively, older adults use products significantly less intuitively than younger adults, and interaction speed is affected by experience and familiarity with similar products (Blackler, 2008). Blackler (2008) suggests that further investigation is required in the area of age and intuitive interaction. Indeed, Blackler, Mahar, and Popovic (2009) have conducted further investigations focusing on exploring the effects of ageing on intuitive interaction. Their investigation included an examination of the role of cognitive decline, as a result of the ageing process, on intuitive interaction. Results show that both cognitive decline and the level of technological familiarity affect time on task, number of intuitive uses, and number of correct uses. Technological familiarity was measured using a questionnaire about relevant electronic devices and how familiar the participant was with certain aspects of the devices. Familiarity had a slightly stronger effect than cognition (Blackler et al., 2009).

Hurtienne and Blessing (2007) report on the definition of intuitive use developed by the Intuitive Use of User Interfaces (IUUI) research group from the Technische Universität Berlin: "A technical system is intuitively usable if the user's subconscious application of prior knowledge leads to effective interaction" (Hurtienne & Blessing, 2007, p. 2). Hurtienne is focusing his research on intuitive interaction with image schemata. Image schemata are knowledge structures that are based upon an understanding of the world developed through interacting with our environment (Hurtienne & Blessing, 2007).

The Engineering Design Centre at Cambridge University is investigating the role of prior experience within inclusive design. From their initial experiments they have concluded that “prior experience with similar products and product features is a strong predictor of the usability of products” (Langdon, Lewis & Clarkson, 2007, p. 190).

Experience and Familiarity

Examining the definitions of intuition and intuitive interactions, the central themes of knowledge and prior experience emerge. There is a close relationship between experience and familiarity. Blackler (2008) states that intuitive interaction is based on internal and external consistency, and that external consistency relies upon familiarity. Familiarity has been defined as “…an understanding, often based on previous interactions, experiences and learning…” (Gefen, 2000, p. 727). Gefen (2000) describes familiarity with a product as an awareness based on experience, where one has an understanding of the behaviour, function or action. Experienced is defined as “having become skilful or knowledgeable from extensive participation or observation” (Hanks, 1990). These definitions show the importance of knowledge developed through prior interactions and experiences to familiarity, and thus also to intuitive interaction.

New products are built upon old products. New products always make reference, in some way, to the previous generation of products (Lewis, Langdon & Clarkson, 2008). Users utilise the knowledge base they have built with previous products when interacting with new products and new interfaces (Docampo Rama, 2001). If the differences between the knowledge required to use the older product and the knowledge required to use the new product are too great, then the new product may be harder to learn, use, and understand (Singley & Anderson, 1985; Sweller, 1999).

Experiment

The purpose of this experiment was to examine familiarity with contemporary devices in older and younger adults. The aim of this research was to identify potential methods to extract familiarity from users in order to design intuitive interfaces.

Experiment Procedure and Analysis of Data

The experiment was conducted in the participant’s home, as it was easier and more comfortable for the participant, and it also provides a context which is much closer to a realistic scenario than a laboratory. The experiment also required the use of familiar products that are kept in the home. Four age groups were used for the experiment. The groups were 18 – 44, 45 – 59, 60 – 74, 75+. There were four participants in each age group, four male and four female. A total of 32 participants took part in the study.

The experiment was split into two parts, with each part addressing a different experiment question (Table 1). Part A utilised a semi-structured interview, to extract information about consumer and home-based devices that the participants used. Questions were asked regarding products such as televisions, microwaves, cameras, and blood pressure monitors. The questions varied in depth from frequency of use, to what the product allows the participant to do. Part B utilised a semi structured interview, an observation, and a retrospective protocol. The interview was used to identify a familiar product, and to identify a familiar task with that product. The participant also described the step-by-step process required to execute the task, from memory, with no prompts from the product itself. The observation then required the participant to perform the activity with the device. The participants were required to deliver concurrent verbal protocol while performing the activity. The audio/visual data from the observation was captured with a digital video camera. The video of the participant performing the activity was then transferred to a laptop computer. The audio was muted, and the video played back to the participant, while the participant delivered a retrospective protocol on the interaction.

	Part A	Part B		
Data collection method	Interview	Interview	Observation	Retrospective Protocol
Experiment Question	What products are the participants familiar with, and what role do the products play in everyday life?	What are the differences in description, execution and reflection of a task with a familiar product?		

Table 1 Experiment structure

By comparing the steps the participant described to perform the activity, with the steps that the participant actually undertook to execute the task, it is possible to identify the level of familiarity the participant has with the product, and with different parts of the interaction. A coding scheme was developed in order to define the activity and provide information regarding the steps taken (Table 2).

Coding Scheme

The coding scheme was applied to the participant's description and the participant's execution of the task using the video recording of the task. Each step performed by a participant during the task execution was coded. Steps are any action the participant makes which involves the product they are interacting with, such as picking up a remote, or entering a time on a microwave. Data input, such as entering a phone number, or time in a microwave was coded as a single step, rather than multiple steps.

Each step was first coded in terms of the matching description given by the participant before hand, and also the correctness and familiarity of the step. The codes used in relation to the description were: Accurate Description, Inaccurate Description, No Description, Incorrect Description, Grouping, and Failure to Execute (Table 2). The 'Accurate Description' code is used when the description of that step matches the execution of the process exactly. The 'Inaccurate Description' code is used when the step is not quite correct, or the step is performed out of order from the process given during the description. The 'No Description' code is used when the participant performs a step and there is no mention of that step in the description given by the participant before hand. The 'Incorrect Description' code is used when the step performed is contradictory to the description given, but still leads the participant closer to the required outcome. The 'Grouping' code is used when the step performed is described in a manner which includes multiple steps in a single description.

The codes which describe each step of the interaction are the Correctness and Familiarity codes. The correctness codes are: Correct, Incorrect, and Inappropriate. A step is coded 'Correct' when it takes the participant closer to the required outcome. A step is coded 'Incorrect' when the step takes the participant further away from the required outcome. The 'Inappropriate' code is used when the step is not required in the interaction. The Familiarity codes are: Very Familiar, Moderately Familiar, and Not Familiar. These codes have been adapted from Blackler's (2008) coding heuristics, where similar codes were used to help identify intuitive interaction. The 'Very Familiar' code is used when the participant performs a step quickly and fluidly, and with no obvious thought or reasoning. The ‘Moderately Familiar’ code is used when some uncertainty is shown in the performance of the step, and the interaction is slower, and is executed with some hesitation. If a step is executed very slowly, with indecisiveness and hesitation, then it is coded as ‘Not familiar’. The concurrent protocol also contributes to the identification of familiarity, through lack of verbalisation, and in depth descriptions of possible alternative actions for example.

Category/Code	Statement	Interpretation parameters
Step Description		
Accurate description	The specific step is described correctly before hand.	A specific step is described accurately and precisely.
Inaccurate description	The specific step is described incorrectly before hand.	The specific step is described before hand, but is not described correctly.
No description	The specific step is not described before hand.	No mention of the step before interaction.
Grouping	The step is described in a manner which groups multiple steps together.	Generalisations, including multiple actions in one sentence.
Failure to execute	Step is described beforehand but not performed.	Step is described before hand, but the participant does not perform during the interaction.
Correctness		
Correct	The step is correct for the activity.	The step takes the participant closer to the required outcome.
Incorrect	The step is incorrect for the activity.	The step takes the participant further away from the required outcome.
Inappropriate	The step is inappropriate for the activity.	The step is not performed at the right time.
Familiarity		
Very Familiar	The step is very familiar to the participant.	Quick use, no obvious reasoning.
Not Familiar	The step is not familiar to the participant.	Uncertain, slow interaction.
Intermediate familiarity	The step is moderately familiar to the participant.	Some certainty shown.
Procedure identification		
Procedure	Identifying groupings of steps.	Consecutive ‘very familiar’ steps with no interaction break.

Table 2 Coding Scheme

The final code used is the ‘Procedure’ code. The procedure code is similar to the grouping code in that it identifies where several steps have been grouped together. The procedure code is used to identify groups of steps during the interaction. This differs from the grouping code as the grouping code applies to the description by the participant, where the procedure code applies to the steps the participant makes during the execution. A procedure is coded when a participant performs consecutive 'Very Familiar' steps with no gaps or breaks in the interaction. A procedure is a very fluid interaction.

Procedures are coded as periods of time, as they are coding a series of actions executed during the task. Individual tasks are coded as being grouped, rather than being coded as periods of time. This allows the grouped steps to be coded for familiarity and correctness, rather than how long the grouping lasted for.

The coding scheme was applied to the observational data using The Observer XT 8.0 (Noldus, 2009).

Analysis

By examining the coded observational data, it was possible to identify the differences in familiarity across the selected age groups. The time-event logs (or data maps) display the data from individual participants (Figures 3 and 5), while the graphs (Figures 1, 2 and 4) display the mean of the data across age groups.

It is important to note that time is not a relevant variable for this experiment. Each participant chose a product that was specifically relevant to him or her, and performed a task which was also specifically relevant to him or her. Thus a comparison of time between individuals, or age groups is inappropriate. This experiment is investigating the differences in how people remember, execute, and reflect upon a familiar task, in order to identify experiential knowledge.

Figure 1 illustrates the mean of the percentage of total steps that were coded as grouped, by age group. The youngest age group (18 – 44) demonstrate the highest percentage of steps that had been grouped with 34% of executed steps coded as grouped. The 45 – 59 age group demonstrated the next highest percentage of executed steps coded as grouped with 25%. The next age group (60 – 74) had a much lower percentage of executed steps coded as grouped, with only 8%. The 75+ age group had only 4% of executed steps coded as grouped. This shows a negative relationship between age and the percentage of executed steps coded as grouped.

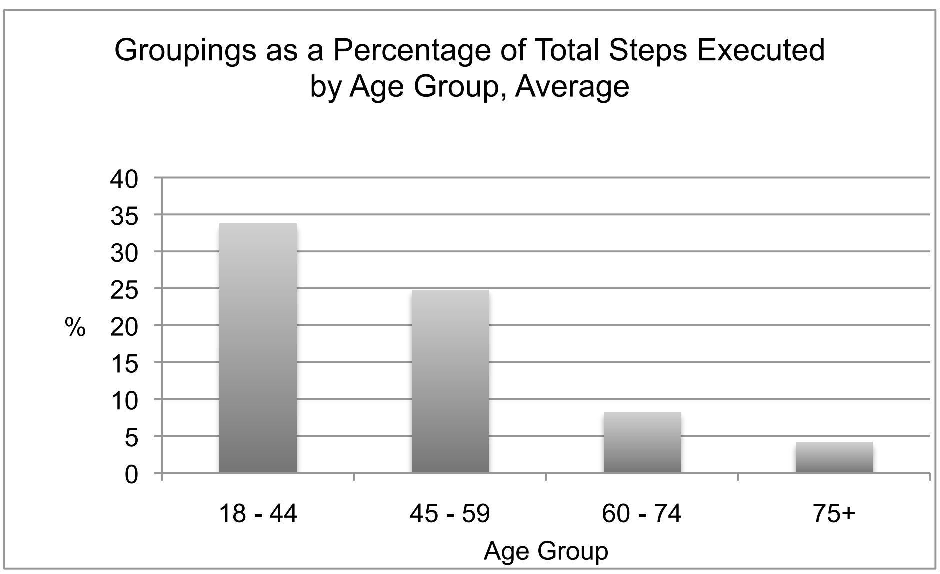

Figure 1. Mean by age group, of groupings as a percentage of total steps executed

Figure 2 shows the mean total time for which a procedure code was present during the task. It shows the mean percentage of the total task time which is spent in procedure. This illustrates that the 18 - 44 age group spends 66% of time using the product in procedure. The 45 – 59 age group spent, 44% of the total time on task in procedures. Time spent in procedure for the 60 – 74 age group was 24%. The 75+ age group spent 18% of the time in procedure. This demonstrates a negative relationship between age and percentage of time in procedure while executing a familiar task. Also, the 18 – 44 age group spends considerably more time (50% more) in procedure than the 45- 59 age group.

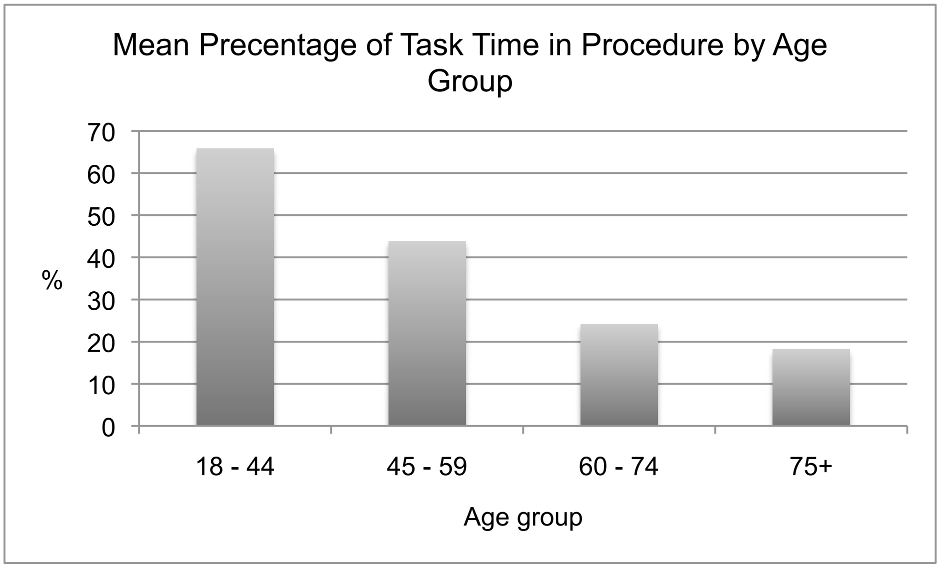

Figure 2. Mean by age group, of percent of task time spent in procedure

The time during the task execution where the participant was in procedure was isolated. The time in procedure was analysed in terms of whether grouping occurred with in the procedure or not, and by age, and step description. An example of the map created highlighting the time the participant spent in procedure can be seen in Figure 3.

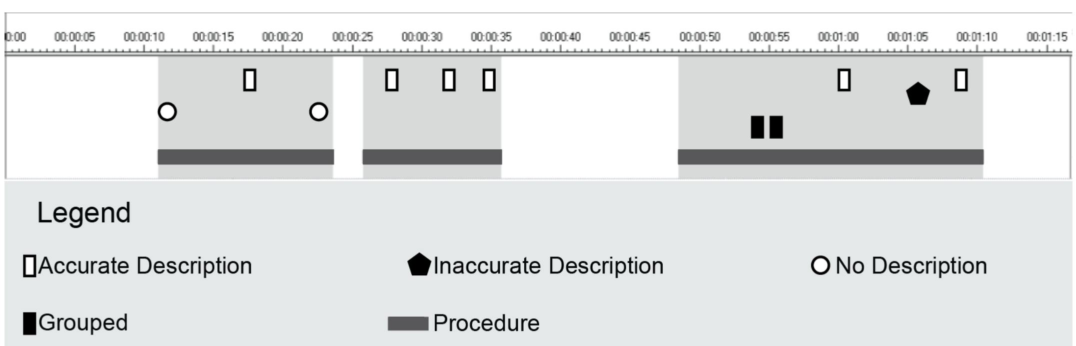

Figure 3. Example of data map showing procedures isolated

The light grey areas show the areas where the data is being displayed (Figure 3). Each vertical mark represents a coded step. In this example you can see that within the first procedure, the participant executed two steps that were coded as 'No Description' and one coded as 'Accurate Description'. The second procedure contained three 'Accurate Description' steps. The third procedure contained two 'Grouped' steps, two 'Accurate Description' steps, and one 'Inaccurate Description' step.

Figure 4 shows the percent of procedures that contained grouped steps. In other words, this displays the percent of performed procedures which were described beforehand as a grouping. The 18 – 45 year old age group had 71% of procedures conducted include grouped steps. The 45 – 59 age group had 50% of the procedures they executed contain grouped steps. The 60 – 74 age group had 22% of the procedures they executed contain grouped steps and 11% of the procedures the 75+ age group executed contained groupings. This displays a negative relationship between age and the occurrence of grouped steps within procedures. The data presented is the mean of each age group.

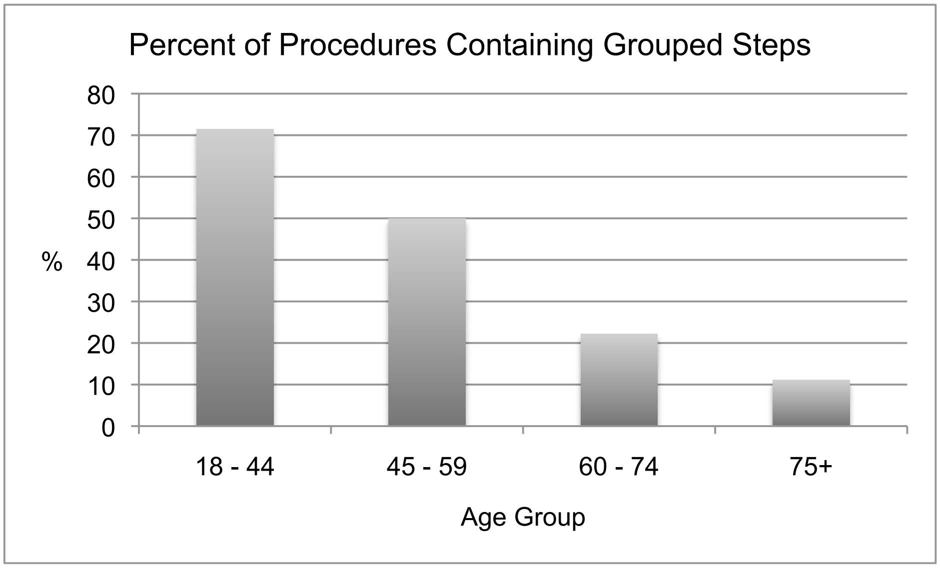

Figure 4. Percent of procedures, by age group, containing grouped steps by age group

The data presented to this point suggests that, generally, age has a negative relationship with familiarity. Figure 5 shows maps of three participants from different age groups. The following maps show that individual familiarity can be high regardless of age. The first is an example from a participant in the 18 – 44 age group. The second, a participant from the 45 – 59 who exhibited a high level of familiarity. The third map is an example from the 60 – 74 age group. The second and third maps demonstrate a high level of familiarity comparable to that of the participant from the youngest age group.

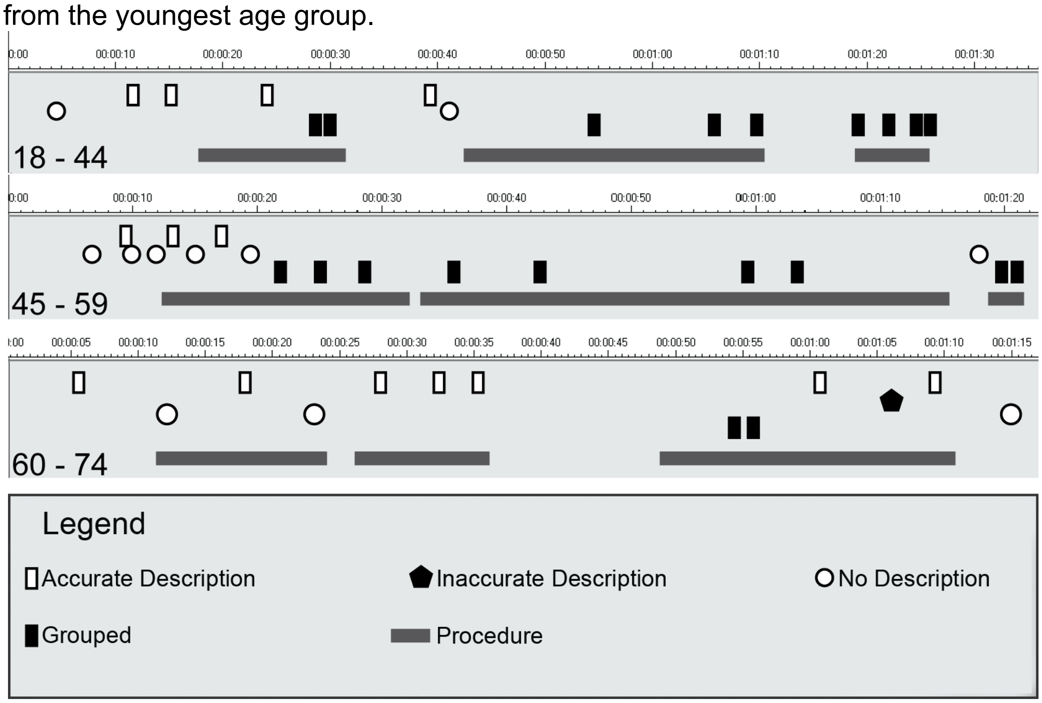

Figure 5. Examples of participants displaying high familiarity over different age groups

The levels of familiarity displayed are fairly similar. All three participants spend over 50% of their time in procedure. The 18 – 44 year old participant spent 50.4% of task time in procedure (mean for age group is 65.8%), the 45 – 59 year old participant spent 77.4% of task time in procedure (mean for age group is 43.9%) and the 60 – 74 age group participant spent 58% of task time in procedure (mean for age group is 24.2%). The number of grouped steps is the same between the 18 - 44 year old and the 45 – 59 year old at 9, while the 60 – 74 year old grouped only 2 steps together.

Discussion

There are some interesting results demonstrating the difference in familiarity across different age groups. In general, the results suggest that familiarity decreases with age, in the execution of a familiar task with a familiar product. The analysis shows negative relationships between age and the occurrence of both groupings and procedure. This suggests that age is a predictor of familiarity. Figure 5 shows that older participants can be just as familiar, if not more so, than their younger counterparts. Despite the analysis suggesting a negative relationship between age and familiarity, the findings in Figure 5 demonstrate that there are exceptions showing older adults who are just as familiar as younger adults, if not more so. Indeed, Fisk et al. (2004) say that age results in an increase in wisdom experience and knowledge. Vercruyseen (1997) states that age does not have to limit motor behaviour, and the use of adaptive behaviours of will put an older adult on par with younger adults (Bosman, 1993; Czaja & Sharit, 1998; Lundberg & Hakamies-Blomqvist, 2003).

Groupings

Groupings are the integration of a series of steps which would be executed during a task, into a single description. For example, a participant described the process of entering all of a new contact's data into his mobile phone as 'Input'. The participant condensed the six consecutive steps he executed when performing the task in to a single word description. It is suggested that this grouping occurs with a high level of familiarity. The participant knows the process so well that, in his mind, the series of steps required to execute that part of the task is only a single action.

The findings show that the 18 - 44 age group has a higher percentage of total steps as groupings compared to the other age groups (Figure 1). This ratio declines with each consecutive age group. This implies that, as age increases, a familiar task with a familiar product is less likey to be described using groupings.

Some possible explanations for these findings include declines in memory and recall functioning, and speech and verbalisation function, as a result of ageing (Gregor, Newell & Zajicek, 2002; Hawthorn, 2000; Klein & Scialfa, 1997). Reductions in memory and recall function could affect the ability of participants to accurately remember the task. Reductions in speech and verbalisation could prevent participants from communicating exactly what they are recalling.

Procedures

Procedures are the integration of a series of disparate steps executed in a task into a single fluid action. Some signs of a procedure displayed by the participant can include: no hesitation when starting a procedure, no or very little verbalisation during the procedure, brief verbalisation once the procedure is complete, fluid or flowing movements, and no pauses in between individual task steps. It is suggested that a procedure is a demonstration of familiarity, as procedures exhibit many of the characteristics of intuitive interaction that Blackler (2008) discusses, and as discussed earlier, familiarity is an important aspect of intuitive interaction.

Figure 2 shows the youngest age group spends the highest amount of time in procedure. It is found that the amount of time spent in procedure declines with each subsequent age group. The 75+ age group spends a mean of 48% less task time in procedure than the 18 – 44 age group. This could also represent a lower level of familiarity amongst older user with familiar tasks and familiar devices.

Some of these findings could be explained by a decrease in motor function (Vercruyssen, 1997) and visual and audio processing, increasing feedback processing time (Hawthorn, 2000), and cognitive load as a result of ageing (Korteling, 1994). It has been reported that delivering concurrent protocol can increase difficulties for older adults when using unfamiliar interfaces (Dickinson, Arnott & Prior, 2007). This could also apply to familiar products.

The Relationship Between Groupings and Procedures

There is a strong relationship between groupings and procedures (Figure 4.). They are very similar, in that they are the integration of steps into a process. The difference is that groupings concern the integration of the description of the steps of a process into a single descriptive word or sentence, while a procedure is the integration of distinct steps of a process into a smooth, flowing action. Groupings are descriptive, and thus they are based on the knowledge that an individual has of a device. This knowledge can be accessed without the device present, and Norman (2002) refers to this as “knowledge in the head”. Procedures, on the other hand, are context based and are always performed with the device. The device provides feedback and prompts, as the users interact with it, enabling easier recall. Norman (2002) refers to this as “knowledge in the world”.

Groupings almost always occur within a procedure. Of the steps that were coded during procedure, 94% were coded as grouped. This may occur as procedures have additional prompts and feedback from the device. This could mean there are more opportunities to recognise the next step. Groupings do not have additional prompts. The only prompt is what participants can recall from memory. Thus it is argued that it may be more difficult to form a grouping than a procedure, as the grouping has less prompts, and relies solely on memory (Norman, 2002). This could explain why groups fall within procedures most of the time.

The data shows that the younger a person is, the more likely a procedure is to have steps described as a group (Figure 4). The youngest age group had groupings in 71% of procedures, while the oldest group had groupings in only 11% of procedures. This shows that, as age increases, an individual is more likely to show familiarity through their actions rather than through the description of process. Thus older adults should not be considered unfamiliar with a particular product or task if they do not group the task description. This has implications for designers performing user research on older adults. This shows that verbal cues for familiarity and experience do not adequately demonstrate actual familiarity that older adults have with products. Observations allow the adequate identification familiarity, which can then contribute to the design of more intuitive interfaces.

Groupings almost always occur within procedures. This suggests that if people use a grouping when describing a task, then they have a high level of familiarity, as the grouping would also suggest a procedure would occur on execution of the task. Using a task description and groupings to identify familiarity is likely to demonstrate more familiarity for younger adults than older adults, as younger adults use groupings more than older adults (Figure 4). As groupings only identified a total of 44% of procedures, it is suggested that such a method is inadequate as a sole measure of familiarity, especially with older adults.

Conclusion and Future Research

The aim of this research was to discover methods that elicit familiarity from individuals regarding contemporary electronic devices. The findings of this research show that familiarity can be identified by determining if a user integrates successive steps of a task into a single step or process. This can occur in terms of both action, and the description of that action. It also shows that familiarity, both in terms of grouping and procedure, declines with age.

The data suggests that a process involving task description could be one possible way to quickly and easily identify familiarity. These findings suggest that if a participant was to use a grouping in the description of a task, it is likely that they would be very familiar with that part of the process. However, the data reveals a method such as this is likely to be less effective with older adults, as the older an individual is, the less likely they are to display their familiarity in the form of a grouping (Figure 4). Also such a method would exclude 66% of procedures, another indicator of familiarity. The analysis suggests that a method that incorporates the evaluation of both task description and task execution is required to get definitive insight into participant familiarity.

This research identifies characteristics of familiarity, such as verbal groupings and smooth interactions flow, that are present in different age groups. It also shows different ways in which individuals express familiarity. This research is significant because it demonstrates the differences in how familiarity is shown by younger and older users. The research techniques used also contribute significantly to the field by demonstrating some potential ways to identify that familiarity.

Further research will attempt to replicate the findings of this study. Additional areas of investigation may include comparing very familiar older adults with very familiar young adults, explorations of possible ways to identify proceduralised steps without the device present, and additional testing around the familiarity of older adults.

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Complexité architecturale et assistance informatique

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Abstract

Depuis plus de trente cinq ans en France, un champ de recherche visant à expliciter la conception architecturale dans sa complexité se développe sous le vocable d' «Architecturologie». Aujourd'hui construit sous forme d'une connaissance scientifique, ce champ présente un langage théorique systémique dont le concept majeur a pour terminologie « *espace de la conception* ». Construit et décrit en tant que «*système complexe*», l'«*espace de la conception*» est posé par l'architecturologie comme lieu mental abstrait et théorique d'intrication de diverses opérations cognitives de la conception.

En tant que méta-savoir fondamental, abstrait de toute réalité concrète, l'architecturologie procède d'une pensée complexe et vise à construire une connaissance complexe de la conception prise comme activité cognitive elle-même complexe. De nos jours, cette connaissance fait l'objet d'une réflexion sur ses possibles applications. Elle est ainsi prise comme modèle pour une approche «clinique» de cas physiques et/ou scientifiques, concernés par la conception, tels que la perception architecturale et la modélisation informatique de l'architecture en projet.

Cette approche « clinique » amène, au regard de la complexité constitutive d'un «*espace de la conception*», à poser une complexité constitutive d'un «*espace de la perception*» et une complexité constitutive d'un «*espace de la modélisation*». Tandis que l' «*espace de la conception*» est descriptible en termes *d'échelles architecturologiques*, l'« *espace de la perception* » l'est en termes de *qualités* et l'« *espace de la modélisation* » le sera en termes d'opérations de modélisation.

La question posée ici, est celle d'un nouvel outil qui vise à produire une nouvelle assistance logique à la complexité de la conception architecturale : ESQUAAS. Produit de deux niveaux de programmation, l'un procédant d'une pensée simplexe et l'autre d'une pensée complexe, ESQUAAS interroge les «*reliances*» indispensables à l'assistance des opérations de la conception architecturale.

Keywords

Architecturologie, conception architecturale complexe, assistance informatique

Abstract

A field of research that aims to explain the architectural design in its complexity develops itself, in France, under the name of "architecturology", for over thirty five years. Now manufactured as scientific knowledge, this field is constituted with a systemic theoretical language whose main concept is "space of conception". Built and described as a "complex system", the "space of conception" is posed as an abstract and theoretical concept which regroups intricacy cognitive operations of conception (design).

As a meta-knowledge, abstracted from any reality, Architecturology proceeds from a thought of complexity and aims to build an intricate knowledge of design posed as a complex cognitive activity. Today, this knowledge is the subject of a research on its possible applications. It is thus considered as a model for a "clinical" point of view that helps to approach physical and / or scientific cases, concerned by design, such as architectural perception and computer modeling of architectural project.

With this "clinical" approach, like the complexity that constitutes the "space of conception", it is possible to build other scientific concepts to describe the complexity of the cognitive mechanisms of architectural perception and computer modelling: a "space of perception" and a "space of modeling".

The complexity of the “space of conception” is described with the architecturological concept of “architecturological scales”. The complexity of the "space of perception" is described in terms of architectural qualities and, those of the "space of modeling" will be described in terms of modelling operations.

This article deals with a new computer tool that aims to support the complexity of architectural design: ESQUAAS. Proceeding from two levels of programming, one carrying a thought of simplexity and the other a thought of complexity, ESQUAAS conducts to question the necessary "reliance" to support the cognitive operations of architectural conception.

Keywords

Architecturology, complexity of architectural conception (design), computer aided

> « La *vérité scientifique n'est pas dans la certitude théorique. Une théorie est scientifique non pas parce qu'elle est certaine mais parce qu'elle accepte de se faire réfuter soit par des raisons logiques, soit par des raisons expérimentales ou d'observations.* »
>
> (Morin et Le Moigne 1999 : 37)

En France, un champ de recherche nommé « Architecturologie » - champ auquel j'appartiens depuis plus de dix ans - se développe depuis plus de trente cinq ans en vue d'expliciter au mieux la conception architecturale dans sa complexité. Ce champ a été proposé et « *structuralisé* » par Ph. Boudon et son équipe du Laboratoire d'Architecturologie et de Recherches Epistémologiques sur l'Architecture (LAREA), à partir de l'idée de constituer un *logos* de l'Architecture c'est-à-dire, un savoir universitaire qui soit propre à l'architecture. Posant à cet effet que ce qui caractérise l'architecture est d'être pensée, conçue et *mesurée,* ce champ de recherche produit, depuis les années 70, des connaissances scientifiques focalisées sur les opérations cognitives de la conception architecturale (Boudon et al. 1994).

Un des concepts majeurs de cette connaissance scientifique a pour terminologie «*espace de la conception*». L' «*espace de la conception*» est l'objet scientifique même que l'architecturologie se donne d'expliciter. Construit et décrit en tant que « *système complexe* », il est posé comme lieu mental abstrait et théorique d'intrication de diverses opérations cognitives de la conception. Ces opérations cognitives de la conception architecturale sont celles par lesquelles sont données formes et mesures au projet. Elles constituent une liste de vingt-et-une classes de manières de faire référence à un domaine particulier pour penser les mesures du projet. Ces manières sont conceptualisées sous le vocable de pertinences et ces classes sous celui d'« *échelles architecturologiques* ».

Chaque classe, chaque échelle se présente comme un micro-*système* complexe opératoire de possible description de cet « *espace de la conception* ». Elle renvoie à l'activité mentale du concepteur qui consiste, de quelques manières, à attribuer des échelles – au sens architectural du terme, c'est-à-dire de tailles relatives - au futur édifice ou espace.

Cette communication a pour objet d'expliciter la complexité que construit l'architecturologie de la conception architecturale. Interrogeant l'activité cognitive complexe de la conception, cette connaissance se développe sur le paradigme de « la pensée complexe ». Introduisant ainsi, de fait, un double jeu de la complexité, cette communication amène à questionner la complexité sous deux formes, une complexité théorique et une complexité empirique et, à investiguer les résistances de la dernière à être décrite par la première (Le Moigne 2007).

La première partie présente ce champ scientifique qu'est l'architecturologie en vue de préciser son potentiel à être « *mis en application* » pour l'étude d'une complexité de l'activité de conception architecturale que renouvellent les usages des outils informatiques. La deuxième partie présente une réflexion que nous avons en cours à l'ARIAM-LAREA et qui concerne un nouvel outil d'assistance informatique à la conception architecturale, nommé ESQUAAS : ESQUisse Architecturologiquement Assistée par Ordinateur.

Architecturologie et complexités de l'architecture

L'architecturologie est donc un champ de recherche qui porte sur l'activité cognitive de la conception architecturale. Il offre aujourd'hui un langage théorique *a priori* qui peut servir de grille d'approche de cas particuliers (Lecourtois 2005). La question que cette partie aborde est celle de la complexité que construit ce langage de la conception architecturale.

Complexité / pensée complexe

S'interroger sur la manière dont un champ construit une connaissance « complexe » d'un objet scientifique qu'il se donne, suppose de s'accorder sur ce que ce terme recouvre. Je m'appuierai ici sur E. Morin et J. L. Le Moigne qui proposent d'interroger la complexité non tant comme un phénomène que comme une activité scientifique d'approche qu'ils nomment : « la pensée complexe ».

« La pensée complexe » selon ces auteurs, consiste à s'interroger sur les relations entre le tout et les parties d'un objet, posant que la somme de ces dernières ne correspondrait aucunement au tout de l'objet. Autrement dit, « la pensée complexe » interroge les « *reliances* » au sens d'activation de liens (Le Moigne 2008) plutôt que les parties. La pensée complexe s'opposerait par conséquent à la pensée classique qui discrétise le savoir, en créant ou recréant des relations bref, en reliant.

Cette modélisation de la complexité s'appuie sur la célèbre phrase de B. Pascal - « *je tiens impossible de connaître les parties sans connaître le tout non plus que de connaître le tout sans connaître particulièrement les parties* » - ainsi que sur l'étymologie du mot complexité - "Complexus" - qui désigne le produit de ce qui est tissé ensemble. La pensée complexe a pour objectif de considérer les diverses interactions qui participent de la construction d'une contingence. E. Morin prend l'exemple du mot et de la phrase pour expliciter l'objet de « la pensée complexe », un mot ne prenant sens qu'au sein de son contexte syntaxique.

Penser complexe c'est, autrement dit, interroger les relations entre les objets et leurs contextes en vue d'en saisir le sens. La sémiotique Peircienne en serait un exemple. Penser le signe par un modèle triadique reliant un Representamen, un Objet et un Interprétant témoigne, en effet, d'une pensée complexe du signe (Peirce 1978).

Cette acception de la complexité se disjoint, me semble t-il, de l'approche essentialiste de la complexité que développe D. G. Emmerich : « *Aussi riche ou compliqué que soit, en apparence, une composition, le fait qu'elle possède un grand nombre d'articulations en soi ne permet pas de l'appeler complexe, car il est nécessaire que la structure soit décomposable en parties caractéristiques de sa constitution, autrement dit en sous-ensembles. Et si la structure de ces sous-ensembles est à son tour décomposable en d'autres groupes caractéristiques et ainsi de suite, on peut alors parler d'une complexité de plusieurs degrés*. » (Emmerich 1966-1967)

D. G. Emmerich pose la complexité comme un tout susceptible de faire l'objet d'une décomposition en sous-parties identifiables. « La pensée complexe » portée par H. Simon, E. Morin et J.L. Le Moigne se pose, quant à elle, comme une approche épistémologique, heuristique et logique dont l'objet scientifique est le principe d'organisation de « *reliances* » participant de la composition. D. G. Emmerich définit la complexité par la décomposition, les auteurs de « la pensée complexe » l'interrogent en termes de « *reliances* » écartant, de fait, de leur réflexion, l'identification et la nature mêmes des entités reliées.

Le point de vue de D. G. Emmerich se rapproche davantage de celui d'A. Berthoz, physiologue de la perception et de l'action, qui propose de s'interroger sur un phénomène d'adaptation qu'il propose de nommer *simplexité*. A. Berthoz (2009) distingue la *simplexité* de la simplification et place sous le concept de *simplexité* un mécanisme cognitif par lequel le cerveau traiterait des situations complexes suivant des principes simplificateurs. La *simplexité* serait un phénomène physiologique d'adaptation de l'être à la complexité de son environnement.

Ce concept permet, me semble-t-il, de poser une distinction entre complexité empirique et complexité théorique. A. Berthoz pose la complexité du côté de l'empirie et la simplexification comme mécanisme mental nécessaire à sa gestion. Dans son ouvrage "la simplexité", A. Bertoz critique l'architecture qu'il pose comme produit d'une réflexion simple et non simplexe. Cette critique amène à pointer une évidence pour les architectes : la complexité architecturale ne se voit pas tandis qu'elle participe des mécanismes de la conception qui la précèdent.

Conception / conception architecturale / espace de la conception

Revenons ici sur le terme conception qui peut porter à confusion lorsqu'on l'approche à partir de deux domaines franchement différents comme ici, la production de connaissances scientifiques et, la production de l'architecture.

J'ai, plus haut, fait référence à J. L. Le Moigne. J.L. Le Moigne est un scientifique qui a pour objectif de construire des connaissances épistémologiques faisant une disjonction majeure entre les sciences d'analyse et les sciences de conception. Il définit son activité comme suit : « *Modéliser pour comprendre et concevoir pour faire, voilà à peu près les deux devises qui jalonnent* *notre activité cognitive* » (Le Moigne 2007 : 343). Dans cette citation, l'expression « *concevoir pour faire* » ne concerne pas l'architecture tandis qu'elle concerne la science.

Par « *concevoir pour faire* » est ici entendue une activité cognitive par laquelle raisonner sur les modèles produits de l'activité de modélisation scientifique et, visant à *faire* de la science. Cette acception se distingue de la notion de "conception" posée par l'architecturologie en tant qu'activité cognitive visant à produire un nouveau projet (par la précision ses formes et mesures architecturales) en passant par la réalisation de modèles de représentation de ce dernier, qui , lui, n'existe pas encore.

Dans le cas de l'architecture, les modèles produits par les architectes, sont des artefacts, des faits de l'art qui ont pour objectif de simuler des objets qui n'existent pas encore. Si l'architecte comme le scientifique raisonne sur et à partir de modèles, ils ne le font pas de la même façon ni dans le même objectif. L'expression "observateur-descripteur-concepteur" forgée par E. Morin pour désigner le praticien en sciences, sied ainsi à l'architecturologue mais non à l'architecte. L'architecturologue vise la production de connaissances sur l'activité cognitive de la conception architecturale. Il en construit une description qui participe de la conception de son champ scientifique. L'architecte, quant à lui, conçoit de futurs artefacts. Si, en en prenant connaissance, l'architecturologie peut l'aider à comprendre l'architecture pour la faire, elle, ne fait pas d'architecture pour la comprendre. Son activité est autre, elle est de modéliser la conception de manière *a priori* pour la rendre intelligible, et non pour en faire.

Plus précisément et suivant Ph. Boudon, « l*'architecturologue ne se propose pas de connaître l'espace architectural, mais l'espace de la conception qui a présidé à sa « conception »* » (Ph. Boudon *in* Demailly A. et Le Moigne J.L. (dir.) 1986 :440). Autrement dit, l'objet scientifique de l'architecturologie est représenté par son concept premier : « espace de la conception ». L'activité architecturologique consiste alors à construire d'autres concepts élémentaires (seconds) en vue de décrire et/ou expliciter cet « espace de la conception ». « Echelle architecturologique », « propriété d'échelle » et « relation d'échelles » sont de ceux-là. Il s'agit donc de modéliser la conception, dans sa plus grande généralité, en désignant l'ensemble des opérations possibles de la conception, de manière *a priori*, et, en s'écartant d'une démarche d'observation de cas.

Pour préciser cette posture, Ph. Boudon s'appuie sur la distinction posée par H. Simon entre état et processus et, pose l'objet de l'architecturologie du côté du processus et non de celui de l'état. L'architecturologie n'a pas pour autant pour objet de décrire (ou construire) le processus de la conception architecturale ni d'en expliciter des diachronies processuelles. Le temps ou la description chronologique de la genèse de l'architecture résiste en effet au principe de l'architecturologie qui est de produire une connaissance générale valable quelque soit le projet. Le processus de la conception architecturale n'existe pas en soi tandis que des processus de la conception architecturale procèdent de contingences singulières et, de fait, participent d'expériences dont on ne peut construire de manière *a priori* (principe de l'architecturologie), une théorie.

L'« *espace de la conception* » constitué par l'architecturologie s'exprime donc en termes d'opérations de conception posées comme systèmes unitaires de l'activité de conception. La succession empirique des opérations en est volontairement écartée.

La modélisation architecturologique procède par ailleurs d'une *réduction* de l'architecture à l'activité cognitive qui la génère et qui est posée comme distincte (bien qu'y participant) des mécanismes du projet architectural. Cette réduction, qui peut paraître néfaste pour la connaissance complexe, permet d'éclairer et/ou de constituer des complexités opératoires intéressantes et riches d'enseignement.

Cette remarque peut choquer au regard des propos d'E. Morin : « *la complexité est invisible dans le découpage disciplinaire du réel. En effet, le sens premier du mot, qui vient du complexus latin, signifie : ce qui est tissé ensemble. Le propre, non pas de la discipline en soi, mais de la discipline telle qu'elle est conçue, non communicante avec les autres disciplines, fermée sur elle-même, désintègre naturellement la complexité.* » (Morin 2007 :29)

Il est un fait, l'architecturologie ne porte pas sur l'architecture en général. Elle se concentre sur un objet scientifique qu'elle construit en s'abstrayant de cet objet empirique. Pourtant, son objet n'est pas de simplifier mais de construire un objet scientifique, suivant les principes de la pensée complexe, en termes de « reliances ». Elle sépare son objet de l'empirie pour construire une complexité théorique de la complexité empirique de la conception architecturale, qu'elle nomme « espace de la conception ».

L'« *espace de la conception* » architecturologique est explicité par vingt-et-une échelles architecturologiques qui, chacune, représente une classe d'opérations de conception de formes et de mesures architecturales. Chacune de ces échelles représente, autrement dit, une complexité opératoire relative à un domaine de références. Par exemple, l' « *échelle parcellaire* » désigne l'ensemble des opérations de conception que l'architecte est susceptible de mettre en œuvre relativement à la prise en compte de la parcelle du projet. Une parcelle peut être caractérisée par ses limites, sa forme, sa surface, son orientation et sa topologie. Chacune de ces propriétés peut entrer en jeu dans la pensée de l'architecture. L'architecte peut s'y référer pour choisir la forme de son projet, positionner son projet, le découper, l'orienter et /ou le dimensionner. Positionner, se référer, découper, dimensionner, orienter, choisir une forme sont diverses opérations de la conception (autrement nommées « *scalèmes* » en architecturologie) qui peuvent être combinées pour penser le projet. J'ai ailleurs, à l'occasion d'un travail sur la collaboration en conception architecturale (projet Cocréa financé par l'ANR), mis en évidence dix opérations élémentaires de collaborations possibles qui peuvent également constituer des complexités opératoires pour la conception : 1) établir les propriétés d'un domaine de référence, 2) positionner le projet, 3) découper le projet, 4) établir des références architecturales, 5) énoncer des précisions programmatiques, 6) se référer, 7) hiérarchiser les domaines de référence, 8) orienter le projet, 9) Dimensionner le projet, 10) évaluer le projet.

Les « *échelles architecturologiques* » discrétisent donc la conception architecturale en domaines de références mis en œuvre par des opérations d'attribution de formes et de mesures à l'architecture. Des « reliances » de cette discrétisation sont pensées sous les vocables de « *propriétés d'échelle* » et « *relations d'échelles* ».

Les « *propriétés d'échelle* » (être initialisante, structurante, principale ou dominante par rapport au processus) spécifient les places et rôles des échelles relativement à l'ensemble du processus de la conception. Elles établissent des relations entre une classe d'opérations de conception et la conception dans sa globalité.

Les « *relations d'échelles* » (être surdéterminantes, co-déterminantes, juxtaposées, successives en cascade ou en relais), quant à elles, spécifient les relations temporelles et/ou spatiales des échelles entre elles. Ces propriétés et relations sont posées de manière *a priori,* au sens Kantien du terme*,* comme des concepts vides, qui ne prennent valeur que dans l'expérience de cas concrets.

L'architecturologie est donc une structure conceptuelle complexe qui prend la forme d'une modélisation systémique de la conception visant à expliciter la complexité de l'activité cognitive de la conception. Elle est une méta-connaissance (et un méta-langage) fondamentale et abstraite de toute réalité concrète.

Ainsi constituée, elle fait l'objet d'une réflexion sur ses possibles applications (Lecourtois depuis 2004). Cette réflexion amène à la prendre comme modèle pour une approche « clinique » de cas. Ces cas sont tant physiques que scientifiques. Le premier d'entre eux est la perception architecturale, le deuxième, la modélisation informatique de l'architecture en projet.

Espace de la perception

Cette partie fait état d'une réflexion menée à partir de l'architecturologie en vue de l'étendre à un autre domaine : la perception architecturale posée comme deuxième moment cognitif de l'architecture (le premier étant, bien évidemment, la conception).

L'objectif affiché par Ph. Boudon, dès les prémisses de l'architecturologie (Boudon 1971), est de construire une connaissance qui s'écarte de la description des édifices, pour spécifier une activité propre à l'architecture, la conception. Dans (Boudon 1990), il part de deux dessins de Steinberg représentant deux édifices aux aspects franchement différents (l'un semblant complexe ou compliqué et l'autre simple), pour marquer l'orientation de cette posture sur le phénomène complexe de la conception. Il s'aide par ailleurs de la fameuse planche aux quatre croquis de Le Corbusier pour pointer le caractère *invisible* de ce phénomène.

Dans cet article (Boudon 1990), Ph. Boudon situe la complexité de l'architecture à l'endroit de l'embrayage, action par laquelle un concepteur rend réalisable son projet. Poser ainsi l'embrayage comme lieu de complexité architecturale, consiste à penser cette action, l'embrayage, en tant qu'acte de « reliance » (Morin et L Moigne 1999) entre le projet et son contexte. L'embrayage serait ainsi un acte par lequel relier le projet à *la* réalité, en vue de rendre ce projet réalisable.

A cette complexité constitutive de l'embrayage, c'est-à-dire de « *espace de la conception* », répond, selon moi, une complexité constitutive d'un « *espace de la perception* ». La conception et la perception architecturales sont ici posées comme deux activités cognitives dont l'une vise à penser un futur espace ou objet architectural, et l'autre, un espace ou objet existant. On la vu ci-avant, l' « *espace de la conception* » est descriptible en termes *d' « échelles architecturologiques »*. L'« *espace de la perception* », quant à lui, l'est en termes de « *qualités* » (Lecourtois 2007). A l'instar des « *échelles architecturologiques* », les « *qualités* », perçues par les usagers, sont posées comme classes d'opérations de perception relatives à des domaines de références, propres aux usagers. Ce sont des classes d'opérations de perception par lesquelles sont attribuées à l'architecture, des qualités positives ou négatives.

Les études de cas menées sur la conception et la perception d'édifices, pointent la non-correspondance entre les *échelles* de la conception et les *qualités* de la perception. Prenons l'exemple d'un édifice qui fît l'objet de nombreuses controverses en France, le nouveau Palais de Justice de Caen. Du point de vue de la conception, les architectes ont particulièrement pensé les aspects de l'édifice suivant ce que l'on nomme en architecturologie, une « *échelle optique* ». Une complexité optique devait s'y établir : l'édifice devait être perçu comme intégré à son environnement et d'aspect clair dans une vision proche et, autonome, monumental et d'aspect sombre, dans une vision lointaine. Par ailleurs, l'édifice devait affirmer son unité le jour et sa discrétisation la nuit, par des jeux de lumière nocturne.

Figure 1: palais de Justice de Caen Photo C. Lecourtois 2002

Dans les faits, les citoyens et usagers ne perçoivent pas ce travail de conception. Une « *qualité optique »* négative est attribuée à cet édifice qui paraît noir, trop noir et non intégré dans sa ville. La vision de nuit est parfois appréciée mais rarement évoquée. Conception et perception s'affrontent donc, ici comme ailleurs, et créent des disjonctions entre leurs complexités constructives et/ou constitutives.

Espace de la modélisation

Le deuxième domaine d'application de l'architecturologique actuellement à l'étude est l'assistance informatique à la conception architecturale (Lecourtois 2008). De nos jours, les agences d'architecture ont quasiment toutes intégré de nouveaux outils, ordinateurs et logiciels, pour produire voire penser leurs projets. Ces outils informatiques sont divers et offrent des potentialités distinctes suivant les usages qu'en développent les agences. Le terrain privilégié par nos approches actuelles est celui des logiciels *dits* de CAO : autocad, archicad, allplan, Sketchup, Digital Project, Generative Components, Rhinoceros et son plugin Grasshoper, Cobald, etc. (Les logiciels d'évaluations techniques feront l'objet d'une deuxième phase de recherche).

Les usages de ces logiciels - de dessin, de modélisation surfacique et volumique et, de modélisation paramétrique - induisent une modification des habitudes de la conception et, par conséquent, un renouvellement des opérations et/ou fonctionnalités de la conception. La question qui occupe nos études consiste à identifier les relais entre les opérations cognitives de la conception architecturale et les opérations de modélisation informatique, en vue de savoir si la complexité de la conception architecturale en tant qu'activité cognitive est réellement assistée.

Il s'agit pour nous de développer une pensée complexe de l'assistance informatique en visant à identifier des liens existants ou à produire entre les opérations de la conception et les opérations de la modélisation informatique. Deux niveaux participent de ce développement : celui de l'interface et celui du mécanisme de l'assistance. Du point de vue de l'interface des outils ci-dessus évoqués, les menus présentent une hiérarchisation et un découpage des objets et fonctionnalités qui conduisent à penser qu'ils procèderaient d'une théorie de la simplexification plutôt que d'une théorie de la complexité. Les utilisateurs sont en effet guidés dans leurs usages par des déploiements diachroniques de menus qui ne laissent aucune place à une visibilité globale du système.

Mais là n'est pas l'objet majeur de notre interrogation. L'objet majeur de notre approche est de constituer un nouveau concept, celui d'« *espace de la modélisation* » que des classes d'opérations de la modélisation expliciteraient. La modélisation est ici entendue comme activité cognitive par laquelle penser et construire des modèles informatiques. Comment conçoit-on un modèle informatique qui puisse représenter et assister la conception d'un objet architectural en cours de conception ? en est la question principale.

Les opérations de modélisation développées par les utilisateurs dépendent, bien évidemment, des visées opératoires des logiciels empruntés. Les logiciels de dessin et/ou logiciels métiers conduisent les usagers à penser un découpage des éléments constitutifs des représentations en plan de l'objet. Ce découpage concerne les objets de la scène (murs, fenêtres, portes, etc.), des formes géométriques (rectangle, cercle, etc.) ou des textures d'objets à appliquer. Ces systèmes sont aujourd'hui capables d'interpréter ces éléments qui participent d'un modèle numérique souvent en 3D, pour produire une vue perspective ou axonométrique *dite* réaliste de cette scène. L'utilisateur doit, pour ce faire, indiquer l'emplacement du spectateur, l'emplacement du projet relativement à un système de repères géographiques et, éventuellement, préciser quelques informations sur des lumières artificielles et les qualités de certains matériaux.

Les opérations de modélisation de ces systèmes se disjoignent des opérations de la conception. Elles sont opérations de réinterprétation du projet suivant le découpage ci-dessus évoqué et, permettent de produire des modèles informatiques (souvent en 3D) à partir de modèles « *manuels* » d'objets nécessairement, au moins en partie, conçus au préalable. Choisir des objets, découper la représentation du projet en objets disponibles de l'outil, situer le modèle dans un système géographique, indiquer et préciser un système d'éclairage, situer l'observateur de la scène, choisir et qualifier des textures sont les opérations majeures induites par l'usage de ces systèmes. Force est de constater que les opérations de la conception architecturale mêmes s'en trouvent écartées et la complexité architecturale réduite.

Les systèmes qui aujourd'hui nous paraissent induire de la complexité entre l'activité cognitive de la conception architecturale et l'activité cognitive de la modélisation informatique sont, nous semble-t-il, les systèmes de modélisation surfacique et volumique qui passent par de la modélisation paramétrique. La modélisation numérique surfacique et volumique induit un renouvellement de la pensée des formes architecturales en offrant de nouvelles façons de les construire. La modélisation paramétrique offre des possibilités de programmation et incite à penser des relations entre des propriétés géométriques déterminantes de formes et, des variables indépendantes.

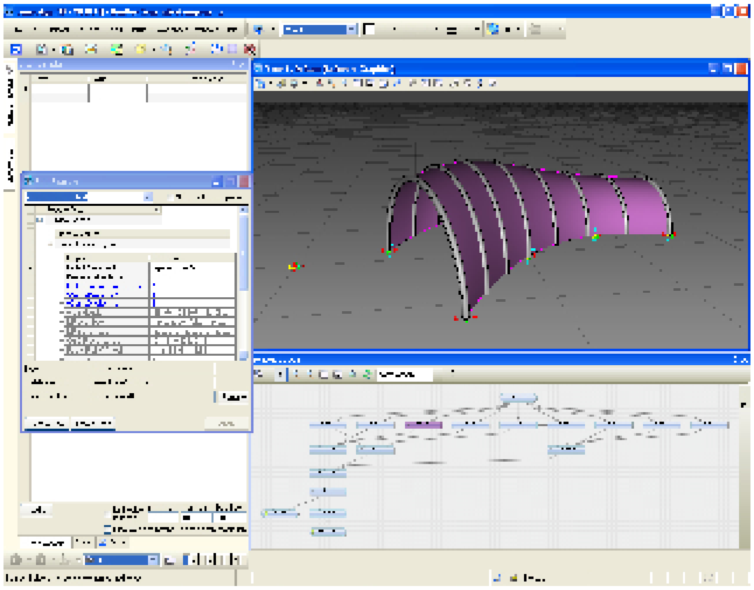

Figure 2 : image réalisée par F. Guéna avec Generative Components

L'image ci-dessus est un exemple des usages possibles d'un outil de modélisation paramétrique qui, ici, est Generative Components. L'opération de modélisation majeure, liée à l'usage de ce genre de système, peut, me semble-t-il, être posée en terme de « *reliance* » : penser le projet comme conjonction de relations participatives de la pensée des formes et mesures de l'architecture en conception.

L'expérience développée par Greg Lynn sous l'appellation d'Embryological House est emblématique du nouveau paradigme induit du recours à ces systèmes. A partir d'un modèle numérique unique, l'architecte propose une multiplicité de spécimens pour sa maison. Ces spécimens procèdent de la variation d'une valeur attachée à une dimension (propriété géométrique du modèle), elle-même liée à d'autres. Par prolifération, les valeurs des autres dimensions sont automatiquement mises à jour.

Greg Lynn lui-même identifie ce nouveau paradigme en termes d'intrication :

« *depuis deux ans, je tourne davantage autour de la notion d'"intrication".(…) Une structure intriquée ne comporte pas de détail. Ce n'est pas une forme faite de détails, mais un ensemble de composantes qui communiquent les unes avec les autres et évoluent en même temps. (…) Sans ordinateur permettant d'exploiter dès la phase de conception le calcul mathématique à un certain niveau créatif et intuitif, on ne peut obtenir l'interaction et la précision nécessaire. (…) L'ordinateur permet de concevoir des projets complexes, dans lequel le moindre détail est relié à l'ensemble, dans un dialogue continu et non discret.*»

G. Lynn (AA p. 104-106)

Il reste à étudier plus avant ces systèmes à l'aide de l'architecturologie en vue de préciser les opérations de conception qu'ils assistent ou induisent. Ce travail en cours permettra d'expliciter ce que nous nommons « *espace de la modélisation* »…

En parallèle à ce travail est actuellement à l'étude un système d'assistance informatique à la conception architecturale que nous avons nommé ESQUAAS (ESQUisse Architecturologiquement ASsistée), et qui participe de la réflexion que nous développons sur la complexité architecturale.

ESQUAAS :

En conséquence de ce qui précède, la modélisation paramétrique paraît être particulièrement intéressante pour penser des outils d'assistance à la conception architecturale et qui prennent en charge la complexité même du mécanisme cognitif de la conception. Le modèle de ce système nous aide à imaginer la poursuite d'un outil dont nous avons initié le développement, F. Guéna et moi-même, au sein de notre laboratoire l'ARIAM-LAREA. Cet outil a pour nom ESQUAAS et vise à assister les concepteurs par la création d'un modèle numérique transformable sous l'action d'opérations de conception identifiées par l'architecturologie (Lecourtois et Guéna, 2009 et, Guéna et Lecourtois 2009b).

Esquaas s'appuie sur le principe Simonien selon lequel il est préférable de viser la satisfaction plutôt que l'optimisation. Il se présente comme un outil visant à faciliter la proposition de solutions satisfaisantes plutôt que d'une solution optimale. Ainsi, cet outil n'est pas pensé comme un système algorithmique qui donnerait une solution unique mais comme un système d'assistance à la réflexion par des propositions possibles.

Deux phases de programmation composent le développement de cet outil encore en cours de réflexion. La première phase concerne la reconnaissance de traces graphiques. La deuxième concerne la signification et la transformation des traces relativement à des classes d'opérations de conception.

Reconnaissance de traces : simplexité

La première phase de programmation a consisté à produire un système qui permette de reconnaître des traces en vue d'interpréter une scène graphique. A partir du Modèle des Chaines de Markov a été mis en place un programme qui identifie des relations entre des traces graphiques.

Ce système analyse des relations entre des points en cours de tracé relativement à des points de la scène déjà inscrits. Il est capable de reconnaitre leurs propriétés - être proche de l'extrémité, être sur, être proche du milieu, être loin de, etc. - et de calculer les probabilités pour les traces de correspondre à des classes identifiées.

Cet outil s'appuie sur une classification des rapports binaires de traces graphiques identifiés par l'architecturologie sous le vocable de dromies. La figure 3 qui suit présente ces rapports de traces.

Nos hypothèses de départ sont :1) la représentation graphique est instrument de conception pour l'architecte et, 2) la trace graphique est porteuse de signification pour le projet. Le dessin est donc ici pris comme moyen de modélisation d'un objet ou espace qui n'existe pas encore. Aussi le modèle produit par le ou les concepteurs a-t-il pour visée d'assister la conception du projet par sa représentation. Il est ainsi d'une nature qui se rapproche, d'un certain point de vue et bien que son objet soit à produire, de la visée des dessins d'un Léonard de Vinci (*les carnets de Léonard de Vinci* ou P. Valéry, *introduction à la méthode de Léonard de Vinci*) c'est-à-dire, la compréhension, la représentation pour la compréhension et la conception. C'est une simulation pour la compréhension d'un existant anticipé….

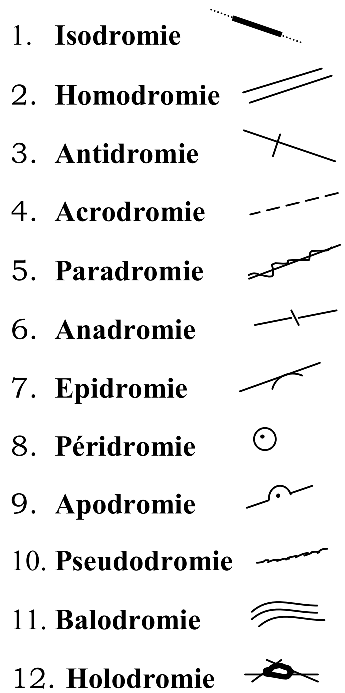

Figure 3 : liste des méta-dromies

Cette première phase de programmation procède d'un mécanisme de la pensée qui se rapproche de celui que décrit A. Berthoz par son concept de *simplexité*. Nous avons simplexifié la conception en en disjoignant deux constituants : des signes indiciels (traces graphiques témoins) et des opérations de conception (génitrices des traces). Cette posture s'appuie sur le modèle des systèmes informatiques experts qui impliquent deux types de modélisation de la connaissance : les connaissances énonciatives exprimées par un réseau sémantique, les connaissances procédurales exprimées par des règles de production. (Mathieu J. in Demailly A. et Le Moigne J.L. (dir.) 1986 : 75)

Cette première phase de programmation renvoie donc à une modélisation des connaissances énonciatives. La deuxième phase de développement d'ESQUAAS s'inscrit comme travail de modélisation des connaissances procédurales, qui implique la mise en œuvre de schémas de raisonnement (règles de processus de conception).

Opérations de conception assistées : complexité

Cette deuxième phase de programmation vise à constituer des « *reliances* » dynamiques entre les dromies et les classes d'opérations de la conception (autrement nommées « *échelles architecturologiques* »).

La trace graphique (décomposable pour partie en dromies) est ici considérée comme représentation ou témoignage d'un moment de conception procédant de la mise en œuvre de diverses « *échelles architecturologiques* ». Elle est un ensemble de signes indiciels de la mise en œuvre d' « *échelles architecturologiques* ».

La dromie (rapport élémentaire entre deux traces), en soi, ne possède aucune signification architecturale propre. Elle est en soi oppositive et acquière des significations suivant deux ordres : un ordre scénographique et un ordre indiciel (ou énonciatif). Du point de vue de l'ordre scénographique, la dromie acquière son sens par les relations qu'elle entretient avec les autres dromies de la scène graphique, autrement nommée trace. Cette signification de l'ordre scénographique peut être iconique et/ou métaphorique. Du point de vue de l'ordre indiciel (ou énonciatif), la dromie acquière son sens relativement à l'objet architectural qu'elle aide à concevoir. Elle procède alors tant d'opérations de la conception architecturale que d'opérations de la conception graphique. Ces opérations de la conception constituent, pour nous, le sens indiciel des dromies.

La trace est donc pour nous outil de conception qui relie un processus passé (1) à un processus potentiel (2) : processus 1) celui dont elle procède et pour lequel elle est modèle résultant, processus 2) celui pour lequel elle est modèle substrat et à partir duquel appliquer diverses transformations pour engager ou poursuivre le processus de la conception.

Dans ce cadre, chaque dromie est à étudier de manière à déterminer les possibilités pour elle de procéder d'une ou plusieurs classe(s) d'opérations de conception. Prenons le cas de l'homodromie en exemple. La question qui nous occupe est celle de savoir ce qu'elle pourrait représenter dans un croquis d'architecte. Interrogeons-nous à partir de la liste des vingt et une échelles architecturologiques : parcellaire, symbolique formelle, géométrique, de voisinage, géographique, de modèle, socioculturelle, d'extension, de représentation, cartographique, symbolique dimensionnelle, humaine, technique, de voisinage, optique, d'intégration, de visibilité, globale, de niveaux de conception, économique, sémantique.

Dans un croquis, l'homodromie désigne le phénomène selon lequel deux lignes se suivent, de tout leur long, selon des relations de voisinage quasi équivalentes. Dans le cadre d'une « *échelle parcellaire* », l'une de ces lignes pourrait représenter le contour de la parcelle et l'autre la volonté de suivre cette limite pour décider de la forme du projet. Dans le cadre d'une « *échelle géométrique* », l'homodromie pourrait manifester la volonté de créer des règles géométriques particulières entre deux éléments du projet. Dans le cadre d'une « *échelle de voisinage* », l'homodromie manifesterait la mise en oeuvre d'un lien entre un élément du voisinage, une hauteur, une limite, une direction et les mesures du projet à venir. Dans le cadre d'une « *échelle géographique* », l'homodromie jouerait un rôle similaire mais, dans ce cas, l'une des traces représenterait la topographie du terrain prise comme référence de pensée. Etc.,etc.

Ainsi, chaque dromie prend sens relativement à un domaine de références mis en œuvre dans la conception. Pour notre système ESQUAAS, chacun de ces domaines est pensé comme un contexte multi-agents déterminé par : 1) des propriétés (éléments déterminants le domaine de références impliqué, tels que, par exemple, la situation géographique, la topographie du terrain, l'orientation de la parcelle dans le cas de l'« *échelle géographique* »), 2) des variables dépendantes (éléments calculés par la machine relativement aux propriétés, tels que, par exemple, la course du soleil et la course des vents dominants dans le cas d'une « *échelle géographique* ») et, 3) des scalèmes (opérations élémentaires de la conception, telles que, par exemple, orienter, situer, découper, dimensionner dans le cas d'une « *échelle géographique* »). (Lecourtois et Guéna 2009)

Le développement informatique de ces contextes est pensé de manière à reconnaître le sens des traces d'une part et à permettre des opérations de transformations de celles-ci d'autre part. Il implique une pensée complexe à deux niveaux : 1) relative à la complexité opératoire des scalèmes des domaines engagés par le contexte concerné, 2) relative à la complexité opératoire entre les contextes eux-mêmes (« *relations d'échelles* » et « *propriétés d'échelle* »). Ainsi impose-t-il de penser un système opératoire de hiérarchisation des opérations de conception et de leur résultat qui ne pourra se faire indépendamment d'une pensée simplexe…

La conception de ce nouveau système d'assistance à la conception architecturale impose de revisiter la structure du langage de l'architecturologie. Elle conduit à poser l'action des « *échelles architecturologiques »* en termes d'hypertexte (Mahoudeau 2006 :40) par lequel sont créés des liens non linéaires entre les scalèmes des échelles mais également entre les échelles elles-mêmes, en vue de faire de cet outil une aide logique plutôt qu'une aide pratique qui prendrait en charge le mécanisme cognitif non-inférentiel (l'inférence pouvant par ailleurs être prise en charge par des systèmes bayésiens) des architectes….

En guise de conclusion

Cet article pose deux distinctions majeures entre : 1) complexité théorique et complexité empirique et 2) la « pensée complexe » et la simplexité. Partant de ces disjonctions, il développe une réflexion sur le statut du savoir constitué par l'architecturologie sur l'activité cognitive de la conception architecturale.

L'architecturologie est ici interrogée dans sa potentialité à s'offrir comme base de connaissance structurée à partir de laquelle développer des applications sur des domaines de l'architecture concernés par la conception, pour en constituer des complexités théoriques : 1) la perception architecturale posée comme deuxième moment cognitif constitutif de celle-ci et, 2) l'assistance informatique à la pensée et à la production de l'architecture contemporaine, posée comme lieu de nouvelles complexités opératoires empiriques.

La deuxième partie de cet article présente une réflexion en cours dans notre laboratoire et qui vise à produire une nouvelle assistance informatique portée sur la gestion de la complexité des mécanismes opératoires de la conception architecturale. Cette réflexion amène à ré-investiguer la structure complexe de l'architecturologie posée alors comme méta-connaissance de l'architecture. Ce système en cours de développement nécessite de développer puis de constituer des « *reliances* » entre des pensées complexes et des pensées simplexes…

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Author Biography

Caroline Lecourtois

Architecte DPLG et Docteur en Urbanisme et Aménagement de l'espace (spécialité architecturologie), Caroline Lecourtois développe, depuis 1998, ses recherches au sein du LAREA (Laboratoire d'Architecturologie et de Recherches Epistémologiques sur Architecture) devenu, en 2005, ARIAM-LAREA (Atelier de Recherche en Informatique Architecture et Modélisation – LAREA). Elle a travaillé pendant près de dix ans sous la direction de Philippe Boudon. Elle est aujourd'hui également Maître-assistante des écoles d'architecture Françaises et co-dirige les thèses des doctorants de son laboratoire. Ses objets de recherche portent sur les opérations cognitives de la conception architecturale et leur assistance informatique. Ses travaux nourrissent deux des quatre axes du laboratoire : 1) activités de conception assistée par ordinateur et 2) modélisations précoces. (http://www.ariam-larea.archi.fr/index.php?page=presentation)

Transformative Design: From Consultant to Clinician

Robert Lederer, University of Alberta

Ben King, Institute for Reconstructive Sciences in Medicine, University of Alberta

Heather Logan, University of Alberta

Abstract

The paper will describe how digital information gathered in medical diagnostic practices has been utilized in an area traditionally reliant on manual medical sculpting techniques. Working in conjunction with iRSM (Institute for Reconstructive Sciences in Medicine), the authors have participated in the development of systems and processes that have resulted in: enhanced surgical planning, elimination of surgeries and improved accuracy of prosthetics. As iRSM is the only centre in Canada to provide these services, it has attracted many international medical facilities and practitioners to use these digital workflows in their own practice.

Industrial Designers were originally consulted by iRSM on a project-by-project basis, consistently demonstrating the value of design research strategies. This demonstration of value resulted in the demand for a full-time designer within iRSM's interdisciplinary team, opening new insights and opportunities within the clinical environment. The integration of design into this area of medicine resulted in the development of a new field of design interaction, education and research. The collection of numerous case studies over an eight-year period provided the background for the development of a graduate program of study dedicated to this new field. The result of this work has been presented exclusively within the medical arena both at conferences and workshops. This academic year, the first student to be enrolled in a Master of Science in Rehabilitation Medicine with a specialization in Surgical Design and Simulation came to fruition. The creation of this new field of study is a continuation of this relationship, as the first candidate has a degree in Industrial Design, but will gain the necessary skills to become a clinician and researcher within a clinical practice. This new "species" of designer is at the forefront of new opportunities for design education and research with a focus on patient-centered health care delivery.

Keywords

Health care; Industrial Design; Computer Aided Design; Reflective practices; Visualization; Rapid prototyping.

Like many interesting research projects, the collaboration between the ID (Industrial Design) Program at the University of Alberta and the medical unit iRSM (Institute for Reconstructive Sciences in Medicine, formerly known as COMPRU - Craniofacial Osseointegration and Maxillofacial Prosthetic Rehabilitation Unit) arose from a series of unplanned coincidences. This paper will discuss the involvement of Robert Lederer as consultant; Ben King as a full-time member of the interdisciplinary team and the transition of Heather Logan from design student to clinician. Based upon the authors experiences' and observations, there is an increasing opportunity within health care for designers to define new roles that will have a significant impact on patient care.

Beginnings

In early 2000, Robert Lederer was appointed the coordinator of the ID program at the University of Alberta and sought to introduce various rapid prototyping (RP) systems into the undergraduate program. During the time Robert was investigating different systems, Rosemary Seelaus, an Anaplastolgist with iRSM, was also researching the integration of various technologies into her profession. Anaplastology (Fig. 1) is defined by the IAA (International Anaplastology Association) as a branch of medicine dealing with the creation of prosthetics to rehabilitate an absent, disfigured, or malformed portion of the face or body, typically caused by cancer, trauma or a birth defect. Anaplastology techniques traditionally rely on labor-intensive hand sculpting, physical impressions and mold making with very limited use of computer software of digital planning. Rosemary and Robert were introduced by a sales representative from a 3D printing company, as he felt the common interest in prototyping applications may benefit both parties. After discussing a potential collaboration with Rosemary, it became apparent that the opportunity to inject new technology driven techniques into the field of Anaplastology seemed plausible, but further expertise in Computing Science and a source of funding were major hurdles.

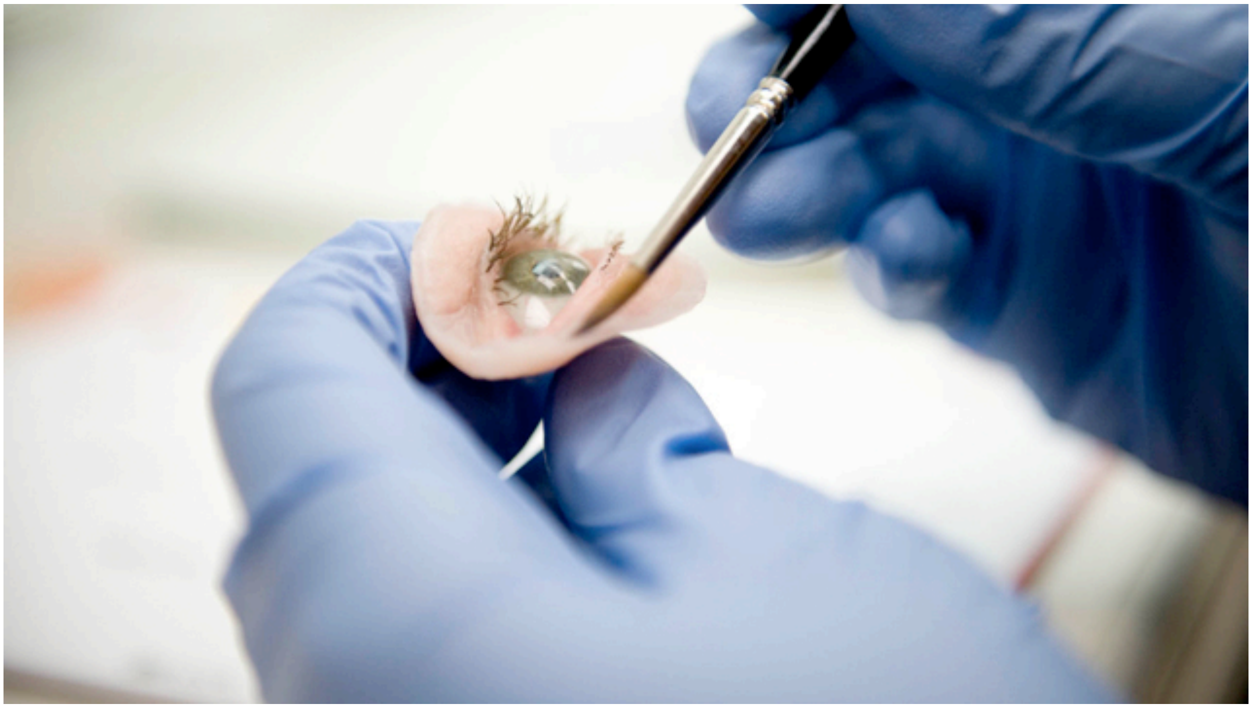

Fig. 1 Example of an Anaplastologist colouring a prosthetic eye

These hurdles quickly dissipated thanks to the involvement of Jonathan Schaeffer from Computing Sciences at the University of Alberta. Dr. Schaeffer received a large grant ($20 million MACI-Multimedia Advanced Computational Infrastructure) to develop digital data processing systems by linking PCs across Canada; it became apparent that a small part of the MACI grant was devoted to visualization. This potential funding source instigated research into various programs and input data from MRI (Magnetic Resonance Imaging), X-ray and CT (Computed Tomography) to comparatively assess the best means of acquisition, output and visualization for clinical applications. Once it became evident that CT could produce accurate and reliable scans that could be translated into 3D (three-dimensional) prints, an initial attempt at establishing a medical modeling process was formulated. As Bibb (2006) explains, medical modeling originates from the 1990s when it was realized that RP machines could potentially use a variety of 3D computer data, which included formats from medical scanners. Computer-Aided-Design (CAD) software served as the basis for medical modeling software, which can be used to translate and manipulate medical data and communicate with RP devices to print highly accurate medical 3D models (Fig. 2).

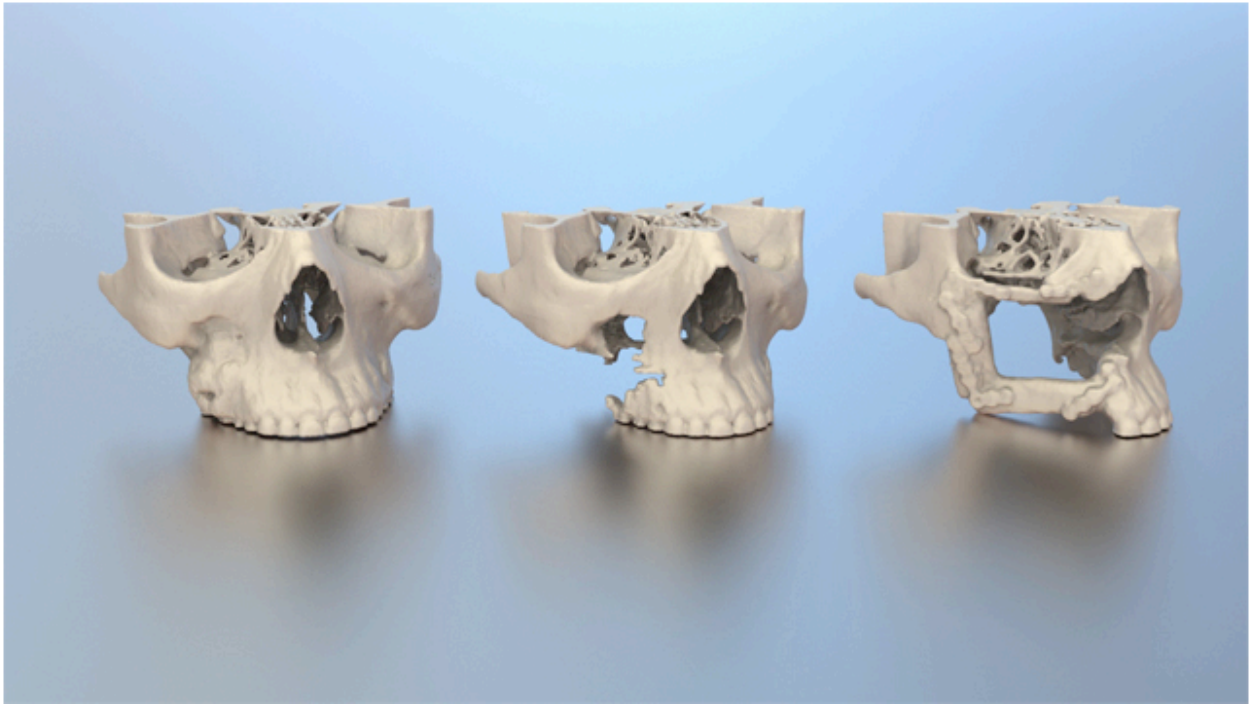

Fig. 2 Example of medical models used to identify, remove and reconstruct a maxillary cancerous tumor

The first 3D print generated was to be used as a surgical guide to reconstruct a patient's outer ear. The patient was born with microtia, which Medline defines as a congenital condition that causes an underdeveloped outer ear. The patient was going to have autogenous ear reconstruction, which is defined as the procedure of sculpting a new ear from the patient's own rib cartilage. Using a 3D laser scanner, the patient's fully formed left ear was scanned and a digital mirror image was produced to act as a template for the microtia affected right side. A 3D print was produced from this replicated ear as a guide for the surgeon in planning the shaping of rib cartilage as well as epidermis trimming and stitching. This visualization of digital information fit within the parameters of the MACI grant and funding was allocated to enable the purchase of a 3D printer.

The luxury of having a 3D printer and the freedom to experiment with limited parameters provided Rosemary and Robert the chance to explore numerous medical procedures. The first major project came after 6 months of exploring various medical modeling software and 3D printer applications and unraveling the true depth of change digital technologies could inject into the medical field. This first significant project dealt with a patient that had recently had a brain tumor removed; in order to access the tumor, a portion of the patient's skull had to be temporarily removed. Unfortunately, this section of skull incurred postoperative infection, resulting in permanent removal. The patient had undergone two previous operations to remove infected regions of bone and now required a prosthetic implant to cover the missing portion of skull to protect the brain. The medical procedure that was in place at the time required two operations; the first operation involved peeling the skin away from the affected area which exposed the skull. The use of a non-sterile molding material similar to putty was pressed into the cavity to form an impression of the defect. The incision was then stitched and the patient was provided with a protective helmet to wear while the impression was sent to a lab to be converted into a custom prosthesis for implantation during the next surgery. The second surgery, which normally occurs 2 weeks after the first, began the same way as the first surgery: by peeling back the patient's skin to access the cavity. The surgeon cut and cleaned the areas of both the patient's skull and the prosthesis to ensure a proper fit. The surgeon then had to decide where to place titanium attachment screws for securing the prosthesis to the skull while relying on the two-dimensional imagery provided by X-ray and CT scans to analyze the quality and thickness of bone. Unbelievably, all this work and decision making was being done while the patient was in surgery.

The challenge presented by Dr. John Wolfaardt (one of the co-founders of iRSM) was to find a means of improving this procedure using a digital workflow. Part of the earlier experimentation involved working with tolerances and accuracy related to processing digital medical information and 3D printing outcomes. With the knowledge accumulated from various experiments, there was confidence that the surgeon could be provided with a 3D print of the defect area. This model would presumably allow the surgeon to pre-operatively examine the bone structure around the defect and pre-plan where he would trim bone to allow a better fitting prosthesis. With input from the surgeon, alterations were made to ensure the prosthesis fit the defect area based on proposed surgical changes; the model also allowed the surgeon to examine areas for attachment and select the best sites. The 3D model and prosthesis were sterilized and brought into the surgical field for referencing and installation. To the relief of everyone involved, the procedure went incredibly smooth and the surgeon was able to install the prosthesis during one operation in significantly less time than it typically took for the traditional two-operation process. More importantly, the entire first invasive operation where impressions were made was eliminated. This resulted in less chance of infection for the patient as well as less operating time for the surgeon. The result was clearly an improvement in the quality of patient care and procedural outcomes as well as a reduction in operating time and costs. These models continued to be provided as visual aids for the next twelve months, while the 3D techniques continued to be refined. This case demonstrated incredible potential, which resulted in other researchers investigating the use of 3D modeling in surgical planning in areas such as: Maxillofacial Surgery, ENT (Ear, Nose and Throat) Surgery, Plastic Surgery, Prosthodontics, Pediatric Cardiology, Pediatric Surgery, Neurosurgery and Orthopedic Surgery.

Due to these successes, iRSM received a grant of $1 million dollars in 2005 from Western Economic Diversification Canada, which was supplemented by Caritas Health to setup the first Medical Modeling Research Laboratory (MMRL) in Canada at the Misericordia Hospital in Edmonton. It was outfitted with surface laser and probe scanning, a variety of CAD software, haptic stations (Fig. 3), Stereolithography prototyping, 3D Multi-jet Modelers in Acrylic and Wax, as well as CNC (Computer Numerically Controlled) milling. Previous to the setup of this lab, work was split between the prosthesis lab in iRSM and the ID studio; now everything was in one location. This consolidation also facilitated the ability to have graduate students work, learn and develop their thesis projects. Similarly, this enabled undergraduate students to take practicum courses to assist on various tasks and projects. This has led to a variety of results from tactile models for teaching plastic surgeons rhinoplasty surgery (Zabaneh, 2009), to developing and evaluating new digital workflows for a variety of medical processes such as mandibular reconstruction (Dziegielewski, 2010). The facility has also enabled a variety of medical product based projects such as concept designs for bone anchored hearing aids and otoscopes. Like the playful experimentation in the early stages of this collaboration, ID students at the University of Alberta will continue evolving and discovering while facilitating this beneficial relationship between medicine and design.

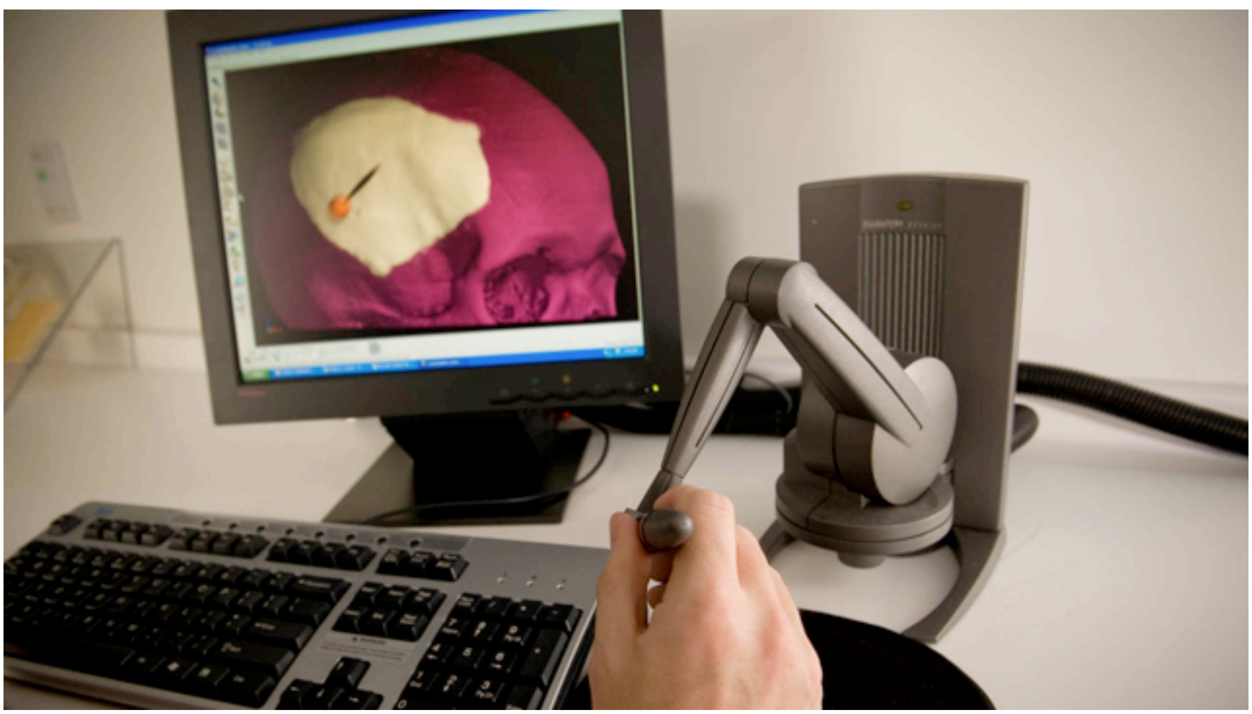

Fig. 3 Example of the use of a SensAble haptic device and Freeform software to virtually sculpt a cranioplasty implant

Infiltration

Ben King was one of the first students to take a semester long practicum in the MMRL, and was a willing guinea pig in deciphering potential future collaborations between ID and iRSM. His first visit to the MMRL was swiftly met with panic, as the clinician that was meant to introduce the practicum project had double-booked their first meeting with a patient consultation. Needless to say, the patient consultation was prioritized in this scheduling showdown and Ben was left alone in this newly assemble million dollar laboratory surrounded by shiny, futuristic devices. The clinician made the assurance that there "were instructions around somewhere" and that designers were perfectly capable of "figuring these kinds of things out". Instead of disintegrating into panic and frustration, this situation quickly revealed itself as a tremendous opportunity. Not many students are fortunate enough to stumble upon the design equivalent of Willy Wonka's Chocolate Factory.

The practicum project that was presented involved finding a way to measure facial volume changes in a patient pre/post surgery to aid in assessing facial reconstruction outcomes. Being able to reference quantifiable numbers instead of clinical assumptions and arbitrary opinions eliminates egos from this evaluation stage of patient treatment. This information would also improve outcomes of future surgeries by providing tangible reference material, as opposed to simply referencing anecdotal evidence from someone's surgical experience. Other than using a 3D scanner and a digital workflow, there was no structured handout or rules to follow. The clinical staff had all but abandoned this project and seemed amused that a student would be willing to spend the required time to repeat their missteps.

Like many challenges, this was a problem of process. Industrial designers are generally well-versed in the development of process and its application across multiple platforms. Once the medical jargon was deciphered, the project became a simple case of data acquisition, manipulation and output. Using available software and open-source programs, a set of work instructions were created that outlined a simple clinical workflow that would eventually be used in several clinical evaluative studies. These studies included titles such as "A Comparison Study: 'Proposed Digital Position' of Auricular Implant Retained Prostheses Using Computer Aided Design Versus the 'Final Position' of Fitted Prostheses" and "Free Tissue Transfer Flap Reconstruction of Parotidectomy Defects; A Paired Outcomes Analysis Using Three Dimensional Laser Surface Scans". These studies were presented at the 2008 Advanced Digital Technology Conference in Head and Neck Reconstruction in Cardiff, Wales; although the wording is complicated, the ability to perform these studies evolved from the willingness to ask seemingly simple questions. That is where designers hold a competitive advantage over many professions, both artistic and pragmatic: designers are often required to step outside of comfort zones to ensure a fundamental understanding of users, projects or processes.

By asking simple questions and providing not so simple results, iRSM was impressed enough with the potential of integrating designers into a clinical environment to offer a one year full-time Industrial Design position. During the interview process, Mr. King asked what the expectations were of the position, and was promptly told, "You tell us". Not very many clinical facilities have the fortitude to take risks and place such a large amount of trust into a young professional with no formal training in the medical field, but proof of concept resonates through all fields. A one year contract is a relatively small risk, but the reward of new collaborations can perpetuate for many years. In recognizing that creative professionals can blossom under less defined structures, iRSM has benefited from the eclectic array of designer skills. Industrial design has played a vital role in iRSM projects ranging from product development, branding and marketing, visualization, surgical planning, medical model production and surgical workshop development.

iRSM intentionally provided minimal training, and instead emphasized exploration. This puts the pressure on the designer but also allows for flexibility not typically found in the structured positions occupied by medical professionals. In fostering new ideas and skill sets, it became apparent that "we all have a creative side, and it can flourish if you spawn a culture to encourage it, one that embraces risks and wild ideas and tolerates the occasional failure” (Kelley, 2001, p.13). In addition to this creative freedom, the emphasis on interdisciplinary teamwork facilitated jargon related stumbling blocks. Individuals such as Andrew Grosvenor, a Maxillofacial Prosthetisist, acted as an invaluable resource in breaking down clinical jargon and explaining medical concepts and procedures. As Andrew recalls, once Ben understood the principles of medical modeling “he promptly tore up the instructions” and began writing new information so that it would be both usable and easier to learn. Medical modeling software is derived from Computer-Aided-Design, and like CAD software, desired results can be achieved from many combinations of steps and toolsets. A workflow was designed that would introduce new users to a variety of functions, and encourage non-linear thinking when using the software. This was intended to persuade the users to work around problems, as opposed to quitting when the established method did not work. The instructions were written in plain language to encourage researchers from a variety of backgrounds to learn how to use the software and hardware. Technology can be daunting, and if it is presented as exclusive and impossible to learn, an unnecessary hurdle has already been put in place. These instructions were used internally and later as the basis for a series of ongoing training seminars (Fig. 4) for both established clinicians and medical residents.

Fig. 4 Example of a web advertisement for one of a series of 3D modeling workshops

The dichotomy that occurs in these two groups is that medical residents express their lament that digital technologies were not introduced earlier in their education, and the established clinicians insist that although useful and interesting, technologies are too complicated to incorporate into everyday workflows. The simple deduction that can be derived from these two groups is that technologies that have proven to benefit patient care should be introduced much earlier in the education process for medical practitioners. Any new skill requires time and dedication; two ingredients that are particularly challenging when an individual has a full clinical workload. This leads clinicians to either plateau at an early stage of their career, or become reliant on information and training from workshops and conferences. This can work if an individual’s peer network is strong enough in technology research, development and communication, but clinicians are generally focused on addressing the sheer number of patient cases and not necessarily the process of their treatment. An unfortunate scenario involves clinical professionals attending conferences and being swayed by new technologies without realizing the associated costs and learning curve, all with the risk of the technology not addressing their needs. Simply put: medical professionals need a guiding hand with a deep-rooted understanding of technology that can interpret their needs.

Unfortunately, medicine is often guilty of projecting complication and red tape, which does not necessarily entice other professionals. Industries such as film and video games set the bar both creatively and technically for technological applications, and much can be learned or adopted by medical facilities. As Robert Lederer demonstrated in his early exploration, by researching RP for medical applications, surgeries have been eliminated, dollars have been saved, and patients receive safer treatments. The struggle is in promoting change and teaching medical professionals that it is both acceptable and encouraged to learn from professionals outside of their expertise, even though they may be from the ‘creative’ world.

Although the initial Industrial Design position held by Ben King with iRSM was upgraded from a one-year contract to full-time permanent (a first for an Industrial Designer in our Health Region), there will continue to be areas that are near impenetrable for designers. It seems that combining the inquisitive nature and technological savvy of designers with medical knowledge and clinical skills may result in a hybrid that will truly address the needs of patients. Dr. John Wolfaardt also recognized this potential value of design within a clinical environment and in conjunction with the faculties of Rehabilitation Medicine and Industrial Design at the University of Alberta initiated a new field of study to address these needs in 2009. Dr. Wolfaardt sees in designers what Pink (2005) details as the ability to empathize to ensure the patient is at the focus of care. Medicine has largely been “standardized – reduced to a set of repeatable formulas for diagnosing and treating various ailments” (Pink, 2005, p. 168). As Pink further details, this is reminiscent of a computer, but computers are essentially emotionally autistic. This has triggered changes at places such as the Yale School of Medicine, where medical students “are honing their powers of observation at the Yale Center for British Art, because students who study painting excel at noticing subtle details about a patient’s condition” (Pink, 2005, p.52). There is value in established rules and processes, but equally important is the recognition that human emotions play an integral part in the health care environment; patient-centered design and delivery of care will be instrumental considerations for the next (and current) generation of clinicians. An Industrial Designer can infiltrate quite far in the medical realm, but a clinician with the skills and empathy of a designer presents a tremendous amount of possibilities for new conversations, research and change.

Transformation

As an ID undergraduate student at the University of Alberta completing the last year of her program, Heather Logan was interested in gaining experience in the medical field. Heather has always had a strong interest in finding educational and professional opportunities that involved helping people. After speaking with several professors and peers about her interests, Heather was directed to contact Ben King at iRSM. A four-month practicum and design project ensued, with the task of redesigning a Bone Anchored Hearing Aid (an implantable hearing device). During this practicum valuable experience was gained in the clinical world while interacting with professionals of various backgrounds and learning about and interviewing patients with various conditions. Heather was also able to gain knowledge and insight into a new application of digital design and rapid prototyping. The experience inspired her to pursue a career in a clinical environment, which fortunately coincided with the opportunity to apply for a Masters of Science in Rehabilitation Medicine with a specialization in Surgical Design and Simulation. The program began in September, 2009 and Heather affectionately became known as the “new species”.

Program

The Masters of Science in Rehabilitation Medicine with a specialization in Surgical Design and Simulation program is designed to teach the necessary skills to become a clinician and a researcher within a clinical practice. It is composed of three main areas of learning: course work, clinical training and independent research. The course work is completed at the University of Alberta and includes advanced digital technology training, anatomy and physiology of the head and neck, issues in rehabilitation science and conducting rehabilitation research. The second area of learning is clinical teaching and training at iRSM. This section includes learning from a team of interdisciplinary health care professionals with a focus on surgical prosthetic care, research and advanced digital technologies. It is composed of clinical training, laboratory exercises and seminars. The final component involves independent research and completion of a thesis. Heather will be conducting research that will focus on advanced digital technology, and the value the technology brings to surgeons, their process and patient outcomes. There is a substantial array of research (Eggbeer, 2005) that discusses and describes advanced digital technology, including its accuracy and applications, but there is limited hard evidence that scientifically evaluates the surgical or patient specific outcomes. This type of evidence is what is needed to convince more medical professionals and health authorities of the benefits of incorporating new technologies. Unfortunately, most facilities do not have direct access to facilities such as iRSM, but with hard empirical evidence, this could change quite drastically.

Challenges

Although this new field of study was thoroughly planned, challenges developed in the early stages; it was obviously a shocking transition from an ID workshop to a clinical environment. Clinical environments are fast paced, continuously busy and people within that environment have strict methods to which they adhere to ensure team members can work in a smooth flow for optimal patient care. Injecting a student that requires frequent explanations slows down the intricacies of the activities going on in the clinical setting. It can be challenging for a student to feel comfortable asking questions and feel relaxed in a patient care environment. An expected, although none the less monumental challenge, has been absorbing and retaining medical terminology and vocabulary. Often designers have very little background in medicine and learning medical terminology, anatomy and physiology can be a tremendous learning curve. The course work that was initially planned to cover this material was joining a head and neck anatomy and physiology class with speech and language pathology students. Although this course presented important material that was of great value, there were areas of relevance that were not covered in the course. In order to acquire pertinent information, added readings, questions and an oral exam have been used as a supplement. The anatomy and physiology course work is essential to understanding and communicating with medical professionals and clinicians; an in-depth knowledge of these areas is critical for understanding and exchanging information.

Transferring from an art and design world, which is often qualitative and descriptive, to a scientific world that is more quantitative and evidence based presents a unique challenge for designers. Rehabilitation medicine and science has a strong relationship with empirical based research and methods; there are many strict methodologies that scientific research follows in comparison to design research. Scientific research focuses on experimental design, testing hypotheses and quantitative research; design research involves elements of scientific research, but it has a much greater focus on the user, user observation, user experiences, thoughts and relationships. Rehabilitation medicine has only recently begun to focus on quality of life and user experience. As troubling as it is, “current healthcare tends to be organized for the convenience of the organization and the clinical staff and most solutions are geared to the needs of these two stake holders” (Macdonald, 2007, p.27). The challenge as a designer is to explore new ways to implement design research skills and processes. Macdonald (2007) further discusses that clinical professionals often struggle to understand the role of design in health care, but eventually come to acknowledge the boundary-less approach of design as yielding incredible clarity to medical environments. As a designer, the understanding of human activity and human experience is an important focus, and can bring strong contributions to the clinical field. It is critical to bring new skills to a team and to add a new dynamic and perspective to clinical care. Advanced digital technologies have brought positive benefits to the design process and the design field. Exploring the benefits and applications of these technologies in surgical design and simulation as well as in patient experience and patient care is an intriguing area for future exploration. Rehabilitation Sciences is evolving and a fresh perspective adds a unique dynamic to established methods related to clinical care.

This journey as a designer transitioning into the medical world has brought positive and exciting experiences as well. There is a strong interest from medical professionals wanting to know more about the design world and what designers have to offer to the medical world, which has already stimulated greater understanding, learning and collaboration. There has been exposure to innovative and exciting ways in which the medical world has applied advanced digital technology and made great contributions to medical procedures and patient outcomes. Areas that Ben King mentioned in the previous section, such as head and neck cancer patients, craniofacial, orthopedics and cardiovascular surgery as well as preoperative and operative planning are greatly assisted using surgical design and simulation. Simultaneously, there is a lingering need for a greater universal understanding and awareness of technologies across all areas in the medical field. It has become evident that technology is a necessary and useful tool and in order to discover new areas and applications we must have a deeper and stronger evidence based understanding of its potential.

Conclusion

The roles of designers and the level of understanding regarding design from professionals outside of the field strengthens through collaborative efforts; the authors have experienced the benefits of such endeavors and the mutual value that medicine and design can enjoy. The current developments, advancements and growing collaborative potential between industrial designers and medical professionals at iRSM reflects a widening window of opportunity for aspiring designers interested in the medical realm. Whether industrial designers utilize their skills as consultants, members of staff, or clinicians, a beneficial relationship between medicine and design has created new opportunities of knowledge growth, research and collaboration within the two fields. As medicine continues to shift to technology driven workflows, there will be increased demand in a variety of areas such as user-centered approaches, interaction design and user interface design. New collaborations may arise from coincidence, but the hope of the authors is that medicine and design will work together based on a growing resume of results driven by patient outcomes.

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Author Biographies

Robert Lederer

Has practiced as an Industrial Designer both as a staff designer and a freelance consultant in Australia and in Canada. He joined the University of Alberta as a sessional instructor in 1986 and as Assistant Professor and Program Coordinator in 1999. He is currently Associate Professor of Industrial Design. His research at present consists of a collaborative venture with the Steadward Center at the U of A developing exercise equipment for spinal cord injured persons, and more recently along with researchers at IRSM (Institute for Reconstructive Sciences in Medicine, Misericordia Hospital), examining “seamless technological interface” in patient treatment systems utilizing rapid–prototyping 3D imagery and other digital formats. A long term collaboration project with the Faculty of Rehabilitation Medicine in the development of student projects in the utilization of Universal design methodology and principles for the design of products for an aging population received a commendation by the American Society on Aging for Exemplary Program in Industrial Design (2002). Robert teaches classes in design principles, advanced industrial design practice and human factors.

Ben King

Is an Industrial Designer with iRSM (Institute for Reconstructive Sciences in Medicine, Misericordia Hospital) and a Master of Design candidate at the University of Alberta. He has extensive experience with Computer Aided Design and Rapid Prototyping for surgical planning as well as product visualization and development. Ben incorporates user-centered and participatory design strategies to achieve innovative approaches within interdisciplinary projects, which have included products and services for rehabilitation medicine, otolaryngology-head and neck surgery, audiology and pediatric medicine. Ben has experience designing and teaching courses on 3D modeling, and is dedicated to improving patient health care experiences and enhancing the abilities of health professionals while promoting the value of design within health care environments.

Heather Logan

Is a graduate from the University of Alberta Industrial Design Program in Edmonton, where she specialized in psychology and sociology. Heather is currently pursuing graduate studies at the University of Alberta and will be completing a Master of Science in Rehabilitation Science specializing in Surgical Design and Simulation. Heather will be conducting research that will focus on advanced digital technology, and the value the technology brings to surgeons, their process and patient outcomes. She has a strong passion to work with people and believes that the understanding of human activity and human experience is essential to design. Her seven years of experience working with people with disabilities and growing up in a family with a physically and mentally impaired brother has given her the knowledge and motivation to work as a successful and innovative cross-disciplinary designer. Her passion to work with people, learn from people and interact with people, joined with her knowledge and skills from her education gives her the greatest inspiration to design.

A Comparison and Analysis of Usability Methods for Web Evaluation: The Relationship Between Typical Usability Test and Bio-Signals Characteristics (EEG, ECG)

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Abstract

A usability assessment is now widely recognized as critical to the success of interactive interface design including web design. In this paper, our research team used a variety of different bio-signals such as Electroencephalogram (EEG), Electrocardiogram (ECG), and Electromyogram (EMG) to evaluate individuals' emotional reactions to different web interface designs. At the same time, we conducted typical usability testing of the same web interface design to compare the results of these two methods, and conclude whether usability testing using bio-signals is a good method to use for web evaluation.

Keywords

Web Interface Design; Usability Test and Method; EEG; ECG; ERP; Human Bio Signals; Visual Brainwork

On the web, usability plays a crucial role in user experience and is emphasized above anything else. It is an inherent design character and requirement, and closely related to various user errors (Rexfelt and Rosenblad, 2006; Latorella and Prabhu, 2000; Gramopadhye and Drury, 2000). Thus, usability testing is essential to create a well-designed web site that is highly usable, and measures a person's individual feeling and emotional satisfaction. Different usability evaluation techniques have been developed and incorporated into the design and development of web sites. Continuing study in this area, this paper shows a new and innovative method for usability testing, which classifies the emotional satisfaction of web interface design.

Typical user-based usability test and new method using bio-signals

Typical user-based usability test

Recently, it has been found that user-based testing is recommended to be the primary method in usability evaluations. The purpose of a usability test is to investigate whether a web interface design meets its usability requirements and problems it is addressing. Evaluating a web interface design helps to find out how successfully the design works, and what kinds of problems users have while using the interface design (Lee, 2006). This method is usually conducted in a scenario-based environment and includes user performance measurements, satisfaction questionnaires, interviews, and participator evaluations (Maguire, 2001; Gray and Salzman, 1998; Nielsen, 1993). With this method, the measures are easily obtained and can be used to infer problem areas in an interface design. This method, however, is too subjective and does not give any clear indication why a certain interface aspect poses a problem to a user or how to improve it (Jaspers, 2009). Therefore we focus on the strengths and weaknesses of typical user-based usability test.

New method of usability testing using bio-signals (EEG, ECG)

With advances in computer video display technologies, such as EEG, fMRI, PET, and SPECT, brain research has become a contemporary issue. Based on this issue, many different major areas, such as Medical Science, Engineering, Psychology, Biotechnology, Linguistics, Economics and Music explore diverse aspects of brain research. Hence, there should be many opportunities to study brain research relative to Art and Design.

When one makes the decision that something is good or bad, his or her decision is a result of the human thinking process. The brain works differently depending on a positive feeling or a negative feeling. In other words, the brain will answer in different ways when people look at effective designs or ineffective designs. One of my previous studies clarifies how the brain works when people look at good and bad design; it also comes up with an objective evaluation of how to judge the design value. Continuing this research, we are evaluating a person's emotion, mainly positive and negative feelings, by using a variety of different bio-signals such as EEG, and ECG.

Electroencephalogram (EEG): Many of the recent advances in understanding the brain are due to the development of techniques that allow scientists to directly monitor neurons throughout the body. EEG is the recording of electrical activity along the scalp produced by the firing of neurons within the brain (Society for Neuroscience, 2005). EEG has several strong components as a tool of exploring brain activity; for example, its time resolution is very high (on the level of a single millisecond).

Electrocardiogram (ECG): ECG is a transthoracic interpretation of the electrical activity of the heart over time captured and externally recorded by skin electrodes (Kumar). Electrical impulses in the heart originate in the sinoatrial node and travel through the intimate conducting system to the heart muscle. The electrical waves can be measured by electrodes placed at specific points on the skin. Electrodes on different sides of the heart measure the activity of different parts of the heart muscle. An ECG displays the voltage between pairs of these electrodes, and the muscle activity that they measure from different directions can also be understood as vectors. This display indicates the overall rhythm of the heart and weaknesses in different parts of the heart muscle. It is the best way to measure and diagnose abnormal rhythms of the heart (Braunwaid, 1997).

At the same time, we conducted a typical usability testing of the same web interface design to compare the results of these two methods, and concluded whether usability testing using bio-signals is a good method to use for web evaluation.

Methods

Participants and decision of web interface design

Ten healthy male college students in their twenties were selected for this experiment. After they agreed to the experiment, they completed questionnaires and we measured their brain waves and the electronic activity of the heart. The participants all consisted of persons who were right-handed and without brain-related diseases.

The websites evaluated were four different car companies' websites. Because of the subject issue, our research team chose all male participants who were interested in buying a car. In order to focus on design issues of web interface, the four websites chosen had brands of equal value and attractive design, but layout designs, navigation methods, and graphic elements were used in different ways. After the participants navigated the four websites, the preferred website was selected from the questionnaires given, and we compared them with the results of brain waves and electronic activity of the heart.

Usability testing procedure

The experiment included three main sessions: the user-based usability test, the EEG measurement, and the ECG measurement. Completing the usability test required approximately 60 minutes. All participants were involved in this research, and the scenario of the experiment is as follows:

1. Attach electrodes for EEG and ECG measurement
2. Show "+" on a computer screen for 4minute to ensure a steady state of participant's brain waves
3. Navigate Samsung SM5 web interface design and complete each task from the questionnaire during the next 10minutes
4. Show "+" on a computer screen for 1minute to ensure a steady state of participant's brain waves again.

5. Navigate GM Daewoo Tosca web interface design and complete each task from the questionnaire during the next 10minutes.
6. Show “+” on a computer screen for 1minute to ensure a steady state of participant’s brain waves again.
7. Navigate KIA Loche web interface design and complete each task from the questionnaire during the next 10minutes
8. Show “+” on a computer screen for 1minute to ensure a steady state of participant’s brain waves again.
9. Navigate Hyundai Sonata web interface design and complete each task from the questionnaire during the next 10minutes.
10. Show “+” on a computer screen for 1minute to ensure a steady state of participant’s brain waves again.
11. Participant chooses a mouse button (Yes: right button, No: left button) to decide whether he buys a Samsung SM5 car and we check event-related brain potentials (ERP).
12. Participant chooses a mouse button (Yes: right button, No: left button) to decide whether he buys a GM Daewoo Tosca car and we check event-related brain potentials (ERP).
13. Participant chooses a mouse button (Yes: right button, No: left button) to decide whether he buys a KIA Loche car and we check event-related brain potentials (ERP).
14. Participant chooses a mouse button (Yes: right button, No: left button) to decide whether he buys a Hyundai Sonata car and we check event-related brain potentials (ERP).
15. Participant fills out the user survey form for his preference of web interface design.

Procedure of typical user-based testing method

Usability assessment is now widely recognized as critical to the success of interactive interface design, including web design. Most common and typical usability testing is user-based evaluation that is based on user performance measurements, keystroke analyses, satisfaction questionnaires, and interviews. Using the four different web interface designs chosen, usability testing was conducted to analyze the user’s experience and performance. First, participants were asked for demographic information such as age, occupation, and their computer usage. Second, participants were asked to perform three tasks on the computer, and they had to finish all tasks navigating each car company’s website. Tasks were divided into specific questions such as checking each car’s model, shape, color, safety, performance, and price in order to find more accurate results. To accomplish these tasks, participants would navigate most of the websites. The software ‘Camtasia’ was used to capture a screen record and participants’ voices. Lastly, participants were asked to choose their preference of web interface design.

Procedure of usability testing using bio-signals method (EEG, ECG)

We also conducted usability testing using bio-signals, EEG and ECG, to evaluate individuals’ emotional reaction to different web interface designs in this research. Using the EEG method, electrodes placed on specific parts of the brain, which vary depending on which sensory system is being tested, make recordings that are then processed by a computer.

Our team has used the technique of EEG to address the question of how the brain answers while participants viewed websites. The most difficult decision when using EEG is which part of brain we need to place electrodes to measure the brain waves. Electrode location and names are specified by the 10-20 system for most research applications. This system is an internationally recognized method to describe and apply the location of electrodes in the context of an EEG test (Fig.1).

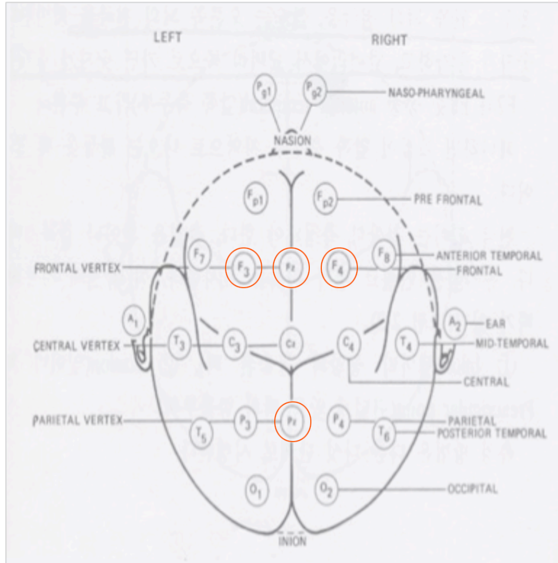

Figure 1 Electrodes location to check the EEG (10-20 System*)*

Brain waves were measured by QEEG-4 (LAXTHA) and 256Hz was selected for a sampling frequency. The position of electrodes went by the international 10-20 electrode arrangement, using the channels of F3 and F4 for emotional control area and Fz and Pz for decision making area. Standard electrodes were applied to Cz. The electrode arrangement plan is shown in Figure 1.

During the experiment, we used event-related brain potentials (ERP), which is a method in checking an electroencephalogram in certain moments when participants received the event, like choosing a mouse button to decide which car to buy. ERP is any measured brain response that is directly the result of a thought or perception. It can be reliably measured using the EEG, a procedure that measures electrical activity of the brain through the skull and scalp (Coles, Michael, and Rugg, 1996). There are four important components in the ERP waveform, which are P300, P600, P800 and N400. The N400 ERP component is described as a negative voltage deflection occurring approximately 400ms after stimulus onset, whereas the P300 component describes as a positive voltage deflection 300ms after stimulus onset. The presence, magnitude, topography and time of this signal are often used as metrics of cognitive function in decision-making processes.

Proper placement of the limb electrodes for ECG measurement is color coded as recommended by the American Health Association (Fig.2). Limb electrodes can be far down on the limbs or close to the hips/shoulders, but they must be even (left vs. right). Our research team attached electrodes like first figure and measured the electric waves of SDNN, the standard deviation of the normal RR intervals, and the ratio of high frequency (HF) and low frequency (LF) to check emotional status.

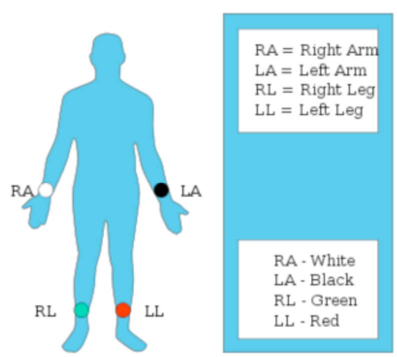

Figure 2 Electrodes location to check the ECG

Results

Analysis of typical user-based usability testing

Typical usability testing was user-based performance that was evaluated based on total time to complete tasks, number of errors, frequency of assists, and the percentage of completed tasks. Table1 shows the result of total time to complete task. The first column shows each participant and the first row shows the each website. Red texts show shortest time that participants had to finish all tasks from the websites.

	1	2	3	4	5	6	7	8	9	10
SM5	8.15	9.26	12.27	11.58	5.54	11.25	11.59	14.24	16.11	13.48
Tosca	6.54	7.37	7.44	8.05	5.54	8.34	8.35	7.13	16.08	12.19
Loche	**4.29**	**5.31**	**5.23**	**5.02**	**4.09**	6.25	**3.60**	**5.30**	**9.00**	**9.07**
Sonata	6.25	5.58	6.15	10.35	4.28	**6.00**	5.19	6.56	9.21	9.39

Table 1 Total time to complete tasks

	1	2	3	4	5	6	7	8	9	10
SM5	2	**0**	4	3	**0**	3	13	**1**	**2**	1
Tosca	2	4	3	**0**	5	8	5	3	5	**0**
Loche	**1**	3	2	**0**	3	**0**	**2**	3	3	5
Sonata	6	3	**1**	2	**0**	**0**	7	2	4	6

Table 2 Number of errors (Red texts show the lowest error)

	1	2	3	4	5	6	7	8	9	10
SM5	1	**0**	1	1	**0**	1	1	**0**	1	**0**
Tosca	1	1	1	**0**	**0**	1	1	**0**	**0**	**0**
Loche	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Sonata	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Table 3 Frequency of assists (Red texts show the lowest assist)

	1	2	3	4	5	6	7	8	9	10
SM5	100	100	100	100	100	100	100	100	100	**67**
Tosca	100	100	100	100	100	100	**67**	100	100	**67**
Loche	100	100	100	100	**67**	**67**	**67**	100	100	100
Sonata	100	100	100	**67**	100	100	100	**67**	100	100

Table 4 Percentage of completed tasks (Red texts show the less than 100%)

After analyzing the user-based usability testing results, we concluded the participant's preference of web interface design (Table5).

1	2	3	4	5	6	7	8	9	10
Loche	Loche & SM5	Loche & Sonata	Loche	Sonata & SM5	Sonata	Loche & Sonata	Loche	Loche	Loche & SM5

Table 5 Estimated participant's preference of web interface design from user-based usability testing

Lastly, Table6 shows the results from the user survey that participants directly answered the one, which they liked most among the four web interface designs. The results of Table 5 and Table 6 are mostly similar with few differences; therefore the user-based usability testing was successful.

1	2	3	4	5	6	7	8	9	10
Loche	SM5	Loche	Loche	Sonata	Sonata	Loche	Loche	Loche	Tosca

Table 6 Participant's preference of web interface design from user survey

Analysis of usability test using bio-signals (EEG, ECG)

First, we analyzed the ECG electric waves of SDNN, the standard deviation of the normal RR intervals, and the ratio of high frequency (HF) and low frequency (LF) to check emotional status. The higher number of SDNN means the participant's emotion is more active and positive. The lower number means there is no emotional feeling change. The higher number of HF means the participant's heartbeat is stronger which shows more active and positive feeling. Therefore, the smaller ratio of LF divided by HF is their preference website.

	A	B	C	D	E	F	G
1	date	subject	task	SDNN	LF	HF	LF/HF
32	06□ 25□	6. □□□	Open	44.8	75.6	24.4	
33			SM5	40.4	78	22	3.545455
34		X	Tosca	55.1	80.1	19.9	4.025126
35			Loche	47.3	81.9	18.1	4.524862
36			Sonata	60	81.1	18.9	4.291005
37							
38	06□ 26□	7. □□□	Open	53.2	77	23	
39			SM5	41.3	50.4	49.6	1.016129
40		X	Tosca	48.1	62.7	37.3	1.680965
41			Loche	31.7	74.8	25.2	2.968254
42			Sonata	33.9	79.4	20.6	3.854369
43							
44	06□ 26□	8. □□□	Open	52.9	40.5	59.5	
45			SM5	74.6	37.1	62.9	0.589825
46			Tosca	64.8	38.7	61.3	0.631321
47			Loche	79.8	51.1	48.9	1.04499
48		X	Sonata	59.5	43.3	56.7	0.763668
49							
50	06□ 26□	9. □□□	Open	52.1	74.5	25.5	
51			SM5	39.7	56.9	43.1	1.320186
52		X	Tosca	41.1	75.1	24.9	3.016064
53			Loche	60.8	73.8	26.2	2.816794
54			Sonata	58.6	72.7	27.3	2.663004
55							
56	06□ 29□	10.□□□	Open	66.3	84.4	15.6	
57			SM5	64.1	69.1	30.9	2.236246
58			Tosca	58.1	78.1	21.9	3.56621

Figure 3 Example of analyzing ECG data

	1	2	3	4	5	6	7	8	9	10
SDNN	Tosca	SM5	Sonata	Loche	Sonata	Sonata	Loche	Loche	Loche	SM5
LF/HF	Sonata	Loche	SM5	SM5	Loche	SM5	SM5	SM5	SM5	SM5

Table 7 Estimated participant's preference of web interface design from ECG

Second, we analyzed the EEG data, which a frequency of 4~30 Hz was selected to remove the noise from raw data, and the values of RPS (relative power spectrum) were found in the frequency band of brain waves, theta (4~8 Hz) and beta (13~30 Hz), using FFT (Fast Fourier Transform). As we mentioned previously, brain waves were measured by QEEG-4 (LAXTHA) and the position of electrodes went by the international 10-20 electrode arrangement, using the channels of F3 and F4 for emotional control areas.

Higher numbers of theta mean that people are a in comfortable and positive status, while higher numbers of beta mean that people are a in nervous and anxious thinking status. Thus, the F3 position is located in the left side of the brain, an area that processes optimistic thinking, and the F4 position is located in the right side of the brain, an area that processes pessimistic thinking. Therefore, we need to focus more on analyzing the F3 area for decision of preference of web interface design.

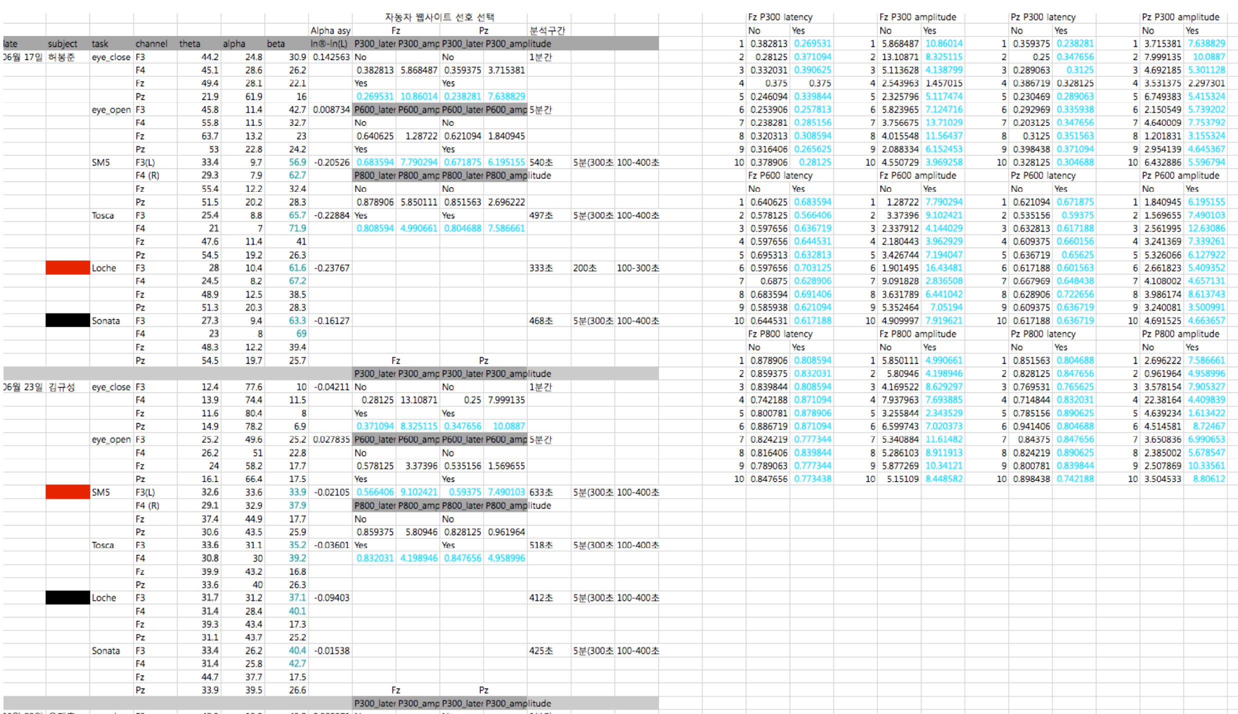

Figure 4 Example of analyzing EEG data

Figure 5 shows the result of beta power of F3 and F4. The red squares are the preference of web interface designs that participants chose from the user survey, and the black squares are the ones that they do not like. According to the figure of beta power of F3, most of their preference websites of beta power are lower than non-preference websites. As we mentioned previously, beta power shows the meaning of nervous and anxious thinking status, so this result is what we anticipated.

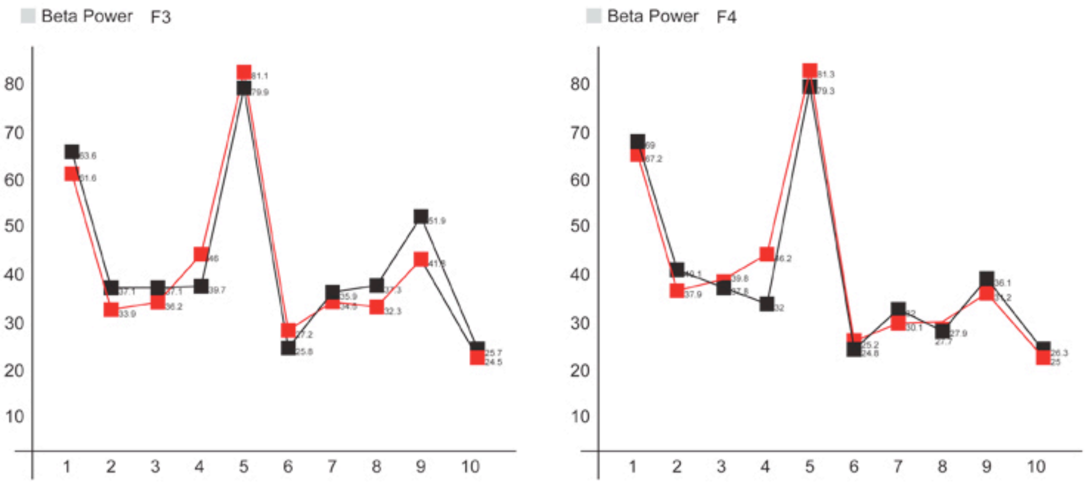

Figure 5 Result of beta power of F3 and F4

Figure 6 shows the result of theta power of F3 and F4. Again, the red squares are the preference of web interface designs that participants chose from the user survey, and the black squares are the ones that they do not like. According to the figure of theta power of F3, most of their preference websites of theta power are higher than non-preference websites. As we mentioned previously, theta power shows the meaning of comfortable status, so this result is what we anticipated.

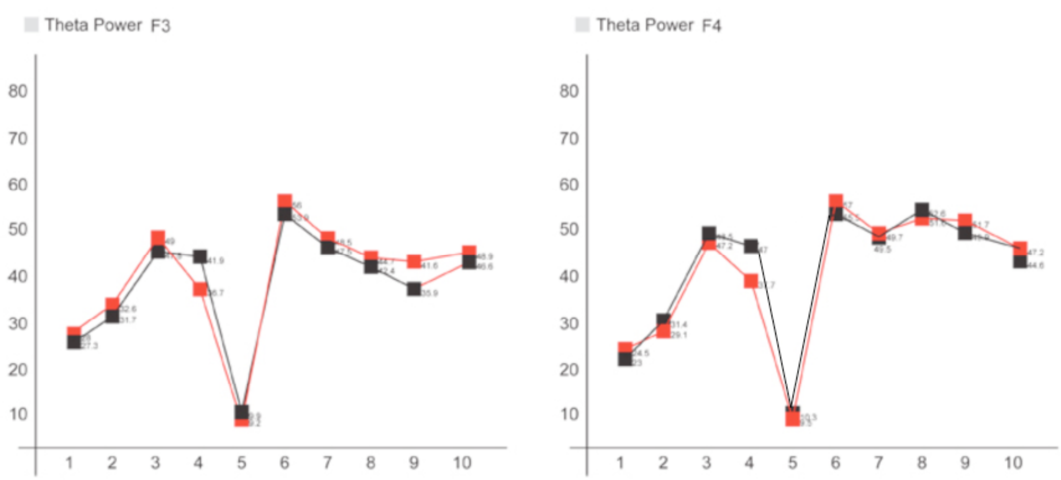

Figure 6 Result of theta power of F3 and F4

Additionally, we used event-related brain potentials (ERP), which is a method in checking an electroencephalogram in certain moments when participants received the event like clicking a mouse button (Yes: right button, No: left button) to decide which car to buy. Our research team attached the electrodes to Fz and Pz, which are areas for decision making.

Figure7 shows the P300, P600, and P800 of ERP results at the moment of participants clicked the preference of car. From the analysis, we concluded the amplitude of P600 shows the highest and strongest reactions when the participants chose preference of car.

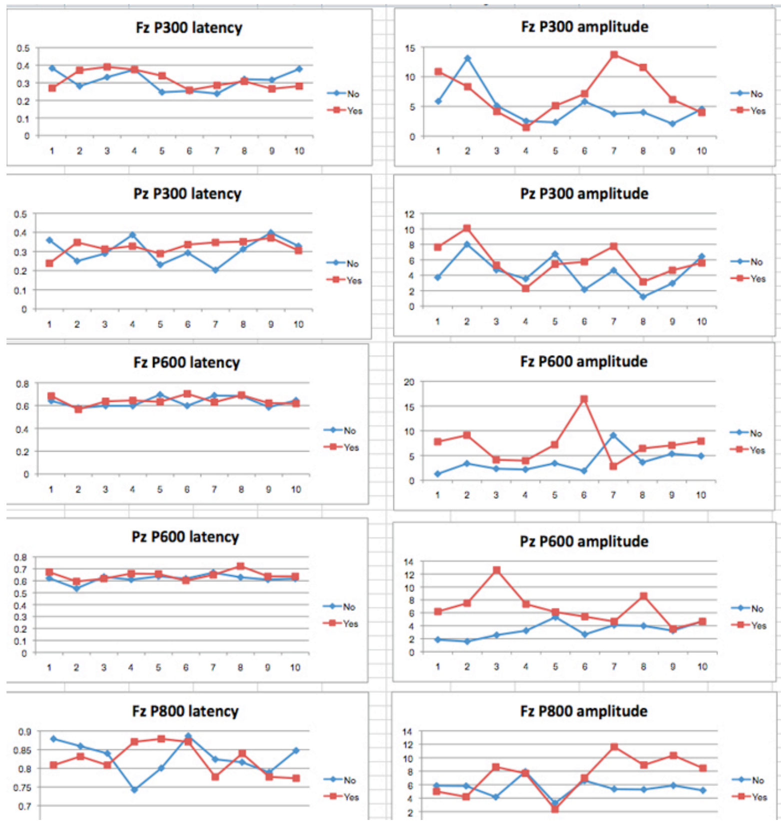

Figure 7 P300, P600, P800 of ERP result

Comparison and relationship of two methods

Table8 shows the results of the comparison between user-based usability testing, including the user survey and new usability testing methods using bio-signals (EEG, ECG). The final results of participants' preferences of car web interfaces consist through all different usability test methods, except the result of ECG (LF/HF). This result shows irregular choice of preference of car websites compared to other methods, and it is reasonable that we can eliminate it as final conclusion.

	1	2	3	4	5	6	7	8	9	10
User Survey	Loche	SM5	Loche	Loche	Sonata	Sonata	Loche	Loche	Loche	Tosca
User-based Usability testing	Loche	Loche & SM5	Loche & Sonata	Loche	Sonata & SM5	Sonata	Loche & Sonata	Loche	Loche	Loche & SM5
EEG:Theta Power	Loche	SM5	Loche	X	Sonata	Sonata	Loche	Loche	Loche	Tosca
EEG:Beta Power	Loche	SM5	Loche	X	X	X	Loche	Loche	Loche	Tosca
ECG: SDNN	Tosca	SM5	Sonata	Loche	Sonata	Sonata	Loche	Loche	Loche	SM5
ECG: LF/HF	Sonata	Loche	SM5	SM5	Loche	SM5	SM5	SM5	SM5	SM5

Table 8 Comparison of all methods

Conclusion

The purpose of a usability test is to investigate whether a web interface design meets its usability requirements and the problem it is addressing. Recently, it has been found that user-based testing is recommended to be the primary method in usability evaluations. With this method, the measures are easily obtained and can be used to infer problem areas in an interface design. However, sometimes it is too subjective and does not give any clear indication why a certain interface aspect poses a problem to a user or how to improve. To make up for this weak point, our research team used bio-signals (EEG, ECG) to evaluate individuals' emotional reactions to different web interface designs in this research.

Based on the result of typical user-based usability testing, we compared the result of new methods using EEG and ECG and it shows similar conclusion. Almost 70% of what participants chose the preference car website from typical-user based usability testing are the same result from the new method using bio-signals (EEG, ECG) which means reasonable and valuable method for web evaluation.

One of the most important issues in web interface design is a usability test to grasp a person's individual feeling and measure the emotional satisfaction. The web interface designs are also objectively assessed by measuring the degree of utilization of the design elements, clarifying how it affects their emotional feelings, and comparing it to the results of frequency from bio-signals. New design methods are required so web designers can grasp the proper emotion, impression, and feeling of a web interface, and reflect these elements to make better web interface design. In the future, the idea of this paper shows an innovative method for usability tests, which can classify emotional satisfaction of web interface design, also linked with ease of use.

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Design Research Methodology

Design research and the complexity encountered in people's critical thoughts

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Abstract

This study focuses on the concept of "Critical Design", which describes the development and use of design objects for the discussion of social and technological problem areas. "Critical Design" provokes or puzzles the consumer. Instead of offering people merely optimized and constraint action patterns, open situations and questions are created. The arising reactions provide valuable insights for innovative product development and basic design research. This paper assesses the potential of "Critical Design" approaches to be utilized as novel research tools for future challenges to design. The main contributions of this paper are threefold. Firstly, it reviews various ways of user engagement to design that reinterprets the conventional relationship of user and designer. Secondly, it selects and evaluates specific qualitative research methodologies that accept and support the active involvement of the researcher as well as the importance of letting theories "emerge" out of data, in order to develop a methodological research framework specific and original to design. Finally, the study offers an assessment of "Critical Design's" potential, to understand and deal with people in a novel and richer way and to test it as a research tool that supports complex approaches. "Critical Design" illustrates the need for design researcher to deal with complexity encountered in the general dynamic of actors and in people's critical thinking.

Keywords

Design and society, Action research, Social and cultural studies, Qualitative research methodology

1. Introduction

Before the consumer takes over possession by means of purchase, every product carries a specifically precast meaning of its own. Part of this meaning is the value model, which is attributed to the artifact by marketing's communication strategy. This model confers the aura of a brand or the corporation and consists of a defined image aimed at the desired target audience. Another part of the meaning is of rather practical nature: It consists of the definition of the intended purpose. It is the manufacturer or producer who determines this purpose of the product, i.e. the functions, which the product must fulfill, and the areas in which it shall be used. The determination of the purpose necessarily follows the needs of the consumer, while it remains to argue how these needs have been proven by empirical studies or rated as "natural" needs. In this condition, the product leaves the producer as an object, which is equipped with a number of invisible values, attributes, and definitions, or in other terms the product is equipped with a story. In recent years, the design industry has recognized these virtual values as a trend and has labeled it with the term "Storytelling" or "Narratives".

With the purchase of the product, the process of the product development could actually be completed. However, this is obviously not the case. Only at this point does the unfolding complexity caused by the design become apparent. As soon as the user unpacks the purchased product, she begins to undermine and manipulate the idea of precast image and purpose: The product generally is not used according to the exact notion of the producer. This disobedience of the user points out the shortcomings of such predefined interpretations and definitions and reveals their arbitrary and “user-unfriendly” nature.

2. Reinterpreting the relationship between user and designer

2.1 Subversion of the function

Brandes et al. coined the term “Non Intentional Design” or NID (Brandes et al. 2000) to describe the aforementioned reinterpretation of product functions. They describe this phenomenon with the “everyday redesign of the designed product”. Thereby, “Non Intentional” does not refer to the purpose, but rather to the process of design. NID in fact has an intentional goal or dedication: by inventing new possible applications and producing new narratives, the user satisfies unmet needs neglected by the original product design. However, it is not a deliberate design activity, since the change of the operation is carried out at a visceral level. More likely, it is a reflex, a reaction to the restrictions, which the object embodies.

“According to the motivation, no design results [...] since the impulse to consciously create design is missing. Non Intentional Design is not characterized or driven by the creative will.” (Brandes et al. 2000)

NID primarily happens in everyday handling of products, anytime the users change the predetermined purpose of an object. Turning a chair into a wardrobe could be one scenario to illustrate such a situation. Instead of using the hooks of a wardrobe, one uses the backrest of a chair to hang up the jacket. At that moment, the real function of the chair is reinterpreted. The chair turns into a wardrobe, because to the user it might appear to be the better satisfier to the need of storing one's clothes. The motives for this repurposing can be versatile and deliver information about the user's complex patterns of requirements: The chair might facilitate a better drying of the jacket, it might be closer to the user giving her a more secure feeling or it might allow the user to faster access things, which are kept in the jacket. Of course, these are only some possibilities motivated by the concept of NID. A deeper understanding of the processes during the use of objects is necessary to achieve a design that better considers the use situation and the complex needs involved. Thus, it is highly relevant to the quality of design outcomes to understand that the user's motives to handle a product in other than the “built-in” or designed ways are an attempt to remedy a situated deficit. The observations of the everyday redesign processes in the context of NID show that there are many deficiencies, which have to be addressed by investigations to inform design about novel necessities and unforeseen requirements.

Unlike NID, the so-called formation of “Beta-Tester” (Dunne, Raby 2001) intentionally confronts themselves with the redesign of objects. The term “beta” thereby is a well-suited metaphor for the processes of hacking and manipulating predetermined design concepts. The Beta as the second character of the Greek alphabet is used as an attribute to describe a second version of a Narrative or product meaning, which is not precast by the designer but interpreted by the user. Analogous, a similar meaning can be found in the field of software: the Beta-version is commonly a preliminary form of newer or advanced software, which is initially tested by the user before its market launch.

Similarly to the users involved in the processes of NID, Beta-Tester as well perform a repurposing. Yet, this misappropriation is conducted within a framework of an intentional design process and therefore it is a planned and conscientious act of designing by the user.

Beta-Tester, in a playful and exploratory way, redesign existing objects in order to utilize them beyond their initial purposes for their individually defined aims. As seen with NID, Beta-Tester also practice reformatting and overwriting existing Narratives by formulating and telling their own stories of use. In addition to this reappropriation, Beta-Testing involves a manipulation of physical forms and surfaces of the object, making it similar to hacking practices.

Fiona Raby and Anthony Dunne exemplify various Beta-Tester in their book “Design Noir”. For instance, they mention the “Anarchist Cookbook”, in which instructions are given to create sophisticated weapons out of everyday objects, or a group of athletes who with the deployment of radio antennas, receivers, and radio direction finders conduct some kind of urban orienteering where they try to recover electronic transmitter that have been hidden in the field. With the latter example, it becomes apparent that this extreme “disobedience” to the prefabricated world of consumption requires a substantial degree of technical knowledge and familiarity with the devices and the tools needed for the production of such equipment.

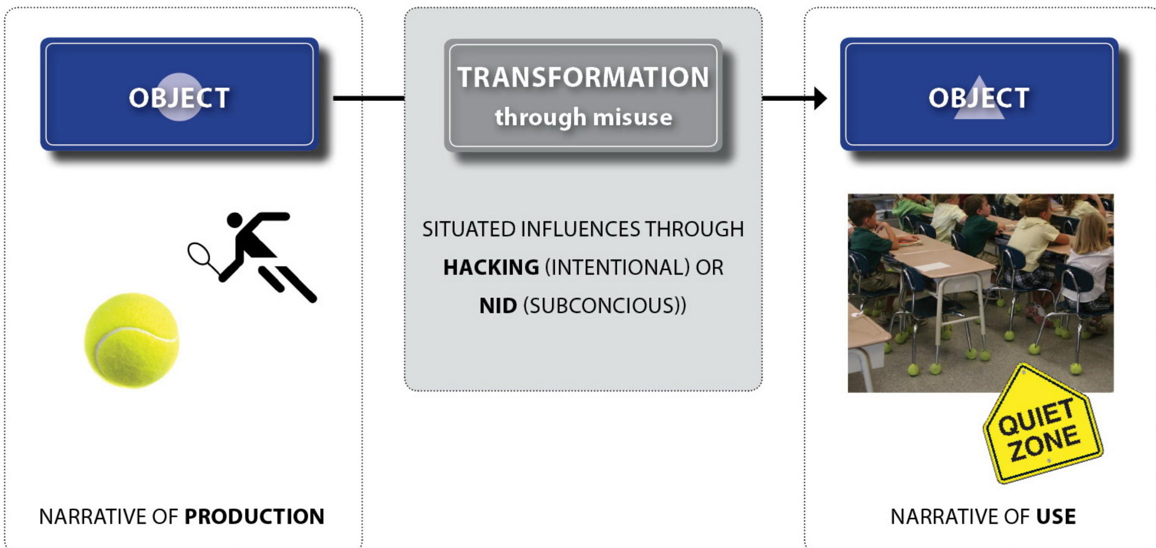

Figure 1 Subversion of the Function. Tennis balls serve as cushion to reduce the noise caused by moving school furniture.

2.2 From Consumer to Prosumer

The aforementioned phenomena emphasize the existence of reappropriation and redesign tendencies with narratives in the use of objects. Thereby, we are dealing with motivations that, driven by product deficiencies or dissatisfactions in the situation of use, aim at overcoming the status quo. Similarly, there are many other modification tactics in the world of consumer products: car-tuning, accessories in fashion, DIY, cooking, case-modding of computer boxes, just to mention a few. In most of the cases, the driving force to redesign is the desire for individuality: modifying, extending, recreating, or redefining oneself.

“Overall, making things is not an end in itself, but has to be regarded as a automatism of an incremental process of identity formation under the constraints of a progressing individualization. When there is an abundance of possibilities, orientation and thus identity can only be constructed piece by piece instead of one big cast.” (Liebl, Düllo, Kiel 2005)

Be it of a purely functional or individualistic nature, the user obviously has a fundamental drive to design. Taking a glance at today's Open Source cultures and noticing the flourish of Blogs, the efforts of autonomous design activities in the digital and virtual world are already highly advanced. In this way the roles of producer and consumer converge to a new role which Alvin

Toffler in his book from 1980, “The Third Wave”, has called the “Prosumer” (Toffler 1984)

The development of consumers actively participating in the design should not frighten the designers. Surely, there is no trend towards a society without designers. It rather shows that the effort is worthwhile to pay more attention to the use-situation. Considering the phenomena of the participating consumer, interesting and useful insights can be collected to inform product development from specific use-situations. It must therefore be the aim to understand the circumstances, mechanisms and goals related to the use-situation to better analyze the underlying psycho-social factors.

“It is astonishing that despite this problem statement, which dates back far into the eighties there is still no qualitative Design Research and the Study of the everyday life in the field of design.” (Brandes et al. 2000)

The aim of this study will thus be to describe the processes involved in the transformation of artifacts, from the designed object to an object of use, and how this alteration or translation process could be specifically utilized in design research, in order to better understand people’s motivations, behaviors, and “Complicated Pleasures”. In the end, this will lead to a qualitative improvement of design outcomes.

In the following, specific qualitative research methodologies that accept and support the active involvement of the researcher are reviewed. Those approaches are crucial to portray people’s motivations and behaviors, and they recognize the importance of letting theories “emerge” out of data to develop methodological research frameworks specific and original to design.

3. Design as a research tool

In his article “Research in Art and Design” (Frayling 1993), Christopher Frayling classifies design research in three distinct directions: research INTO art and design, research FOR art and design, and research THROUGH art and design.

The design aspects within this classification are as follows.

1. Research INTO design: e.g. Design History (operates in a scientific-observing manner, i.e. observing from the distance without influencing the subject.)
2. Research FOR design: e.g. Market Research or Consumer Research (provides necessary insights for the design process. Designers can deliver those results. However, those can be of varying use to others due to the specific constraints applied by the design methodology.)
3. Research THROUGH design: Design Practice as Research (allows the researcher to design the subject of study as well as the study context with all its elements.)

The vast majority of the Anglophone design research emphasizes the two first categories as central part acknowledging design as a scientific discipline. Looking at the slow advancements in higher theoretical design education, the existence of research through design still seems to lack credibility. Yet, possibilities of scientific methodical approaches towards design do exist. They are from the sociology-based area of qualitative research and are already applied in design:

- *Action Research*: as a method for changing the practice
- *Grounded Theory*: as a method to develop a theory
- *Mode*-2 research: as a method with inter-relationships between science and society

These methods accept and support the active involvement of the researcher as well as the importance of letting theories "emerge" out of data. Theories are no longer considered mere verifications of previously stated hypotheses just to affirm existing coherences. Rather, they are understood to openly interact with an instable study area, and always being flexible to change. Immediacy to the subject of study and ways to cope with inexactness and uncertainty are new challenges with this approach. Therefore, when talking about design research it is impossible to reduce its methodologies to the first two categories of researching into and for design. They might offer scientific innocuousness, however they do not lead to what design research could become: a self-contained and original research domain that is closer to the real world. Hence, the challenge is to look for a method specific and original to design, which orients itself to the aforementioned areas of qualitative research and emancipates itself from rigid and traditional Mode-1 research, by introducing new methodologies that are more adaptive to current challenges and problems.

3.1 Action Research

During his time at MIT in 1944, Psychologist Kurt Lewin coined the term "action research". In a paper published in 1946 titled "Action Research and Minority Problems" he described action research as "a comparative research on the conditions and effects of various forms of social action and research leading to social action that uses a spiral of steps, each of which is composed of a circle of planning, action, and fact-finding about the result of the action" (Lewin 1946).

Action research in its origin primarily saw itself as criticism to traditional social research through which it not only made a methodological but also an epistemological contribution. At the level of methodology, Lewin denounced the increasing estrangement between sociological theory and practice. The aim was that science could and should change the field of practice. Therefore, action research was considered a study within the social domain where there should be no more strict separation of the researcher and the participant and where social change as well as the activation of the participant should be the main goal.

At the level of epistemology, Wadsworth considered action or participatory research not only as a method but also as a general paradigm for research. He claimed that action researchers are simply conscious of the unavoidable fact that they influence the object of research by their examinations:

"Action researchers, it seems to me, are really just researchers who have come to understand the practical and ethical implications of the inevitability of the value-driven and action-effects of their inquiry, that is:

- *the effects of raising some questions and not others,*
- *the effects of involving some people in the process and not others,*
- *the effects of observing some phenomena and not others,*
- *the effects of making this sense of it and not alternative senses, and*
- *the effects of deciding to take this action as a result of it rather than any other action." (Wadsworth 1998)*

Through action research, the researcher is intentionally integrated as a stimulating actor.

3.2 Grounded Theory

In Grounded Theory, (Glaser, Strauss 1967) the relationship of theory and empiricism consists of the principle of openness and of the communication. The principle of openness states that the theoretical structuring of the object of research is held back until the structuring of the object by the research subjects has taken shape. To avoid any pre-knowledge and prejudices at the beginning of an examination, a clarifying discussion by the means of brainstorming or analysis is required. The principle of communication refers to a communicative research concept which considers the interaction between researcher and participant and suggests the communication rules and interaction forms.

3.3 Mode 2 Research

Another concept from social studies is the so-called Mode-2 research (Gibbons et al. 1994). Gibbons et al. argued that a new form of knowledge production started emerging from the mid 20th century which is context-driven, problem-focused and interdisciplinary. It is closely related to the methods of qualitative social research, however, seeks for an approach to bridge from classic science methods over to application-oriented methods. Instead of special academic interests, real problem definitions from practice are the motivators of the research. The following table shows a comparison of the research approaches. It summarizes features of the approaches discussed here and mentions possible characteristics of design oriented research, which is transformed from the subject-object relation of conventional social research into a subject-subject relation.

Table 1 Comparison of qualitative research approaches.

	MODE 1	MODE 2
Problem statement/ solution	In the academic community	In the situational context
Aim of research	Fundamental principles and their integration into theories	Contextualized result and their application
Research content	Bound to disciplines	Trans-Disciplinary
Research structure	Hierarchical und homogenous	Transient, heterogeneous
Quality control	Fixed to expert judgment	Multidimensional/use-oriented
Communication	One-way Information transfer from science to society	Diffusion process/interactive relationships between science and society

4. “Critical Design” as a research tool supporting complex approaches

4.1 Conservative Products

In his book “The System of Things” (Baudrillard 2006) Jean Baudrillard talks of how nowadays products force their rhythm upon people instead of people determining their rhythm by themselves. This surely applies to many products. For example, there are automatic error corrections in computer interfaces, ergonomic regulations in furniture, assisting “wizards” in cars, etc. that are all supposed to simplify things by spoon-feeding the user. It is all about the apparent optimization of use. Yet, in the actual use, these optimizations are often perceived as restrictions and thus are consciously or unconsciously ignored. Even if, as a designer, one detects something about the true, complex desires of users, there still is the client with her wishes and her cost-benefit calculations, which hinder the development of better products. This inevitably results in even more so-called “Conservative Products” (Auger 2005), which go by the dominantly established understanding of supposed optimal user satisfaction, and thereby jam developments in new directions. Design that orientates itself to existing markets and its products without analyzing them cannot bring any change. Dunne & Raby describe this uncritically confirming design as “Affirmative Design” (Dunne, Raby 2001).

4.2 Wondering Products

What could be the counter balance to these conservative products, which exclusively affirm the status quo and which embody the normative or official standpoint?

“Beneath the glossy surface of official design lurks a dark and strange world driven by real human needs. A place where electronic objects co-star in a noir thriller, working with likeminded individuals to escape normalism and ensure that even a totally manufactured environment has room for danger, adventure and transgression. We don’t think that design can ever fully anticipate the richness of this unofficial world and neither should it. But it can draw inspiration from it and develop new design approaches so that our new environment evolves; there is still scope for rich and complex human pleasure.” (Dunne, Raby 2001)

In accordance to Dunne and Raby, we argue that the counterparts to conservative products are artifacts that raise questions. It has to be products that are subject to uncertainty, which suggest open ways of use, and which question existing use patterns. On the one hand, this is a reaction to the lessons learned from the NID concept, on the other we are supporting the required reorientation towards more qualitative aspects of design research that adapt to the users’ improvised behaviors.

In their free play with things, users steadily test the boundaries of new values and norms creating unforeseen situations. This uncertainty must be turned into strength. Anthony Dunne claims, designers cannot expect to be able to dictate users’ behavior with absolute rules and fixed structures anymore.

“All he or she can offer are the contents of his or her own head, where internal imagination meets the external world of reality. Design is used as a strategy for linking these two worlds. Its outcome consists of conceptual design proposals offering a critique of the present through the material embodiment of functions derived from alternative value systems” (Dunne, Raby 2001)

Those conceptual design proposals stand between the imaginary and reality. They relate to Values and behavioral patterns, which are hypothetical or just made up, resulting in so-called “Value Fictions” (Dunne, Raby 2001) that are the basis of further designs. As we are moving around in this fictional world, we as designer are able to act like authors of stories. Fictions allow us to imagine any kind of condition, to ask questions, and to turn possibilities into subjects of discussion. Treated as actual possibilities, those fictions serve to make concepts and imaginations subjectively graspable for the reflection of our individual narrative. Hypothetical objects and products therefore contain some poetic aspects that allow us to experience imagined concepts closer to reality.

At this point, provocations and irritating objects are able to be reappropriated to enable new experiences far beyond usability. The Experiences are all about situations that evoke reactions. Furthermore, stimulating products are intended to play a crucial part in the analysis of those reactions. This kind of design facilitates to create wondering products, objects that ask questions, which can be used to address, illuminate, and even produce research-topics.

This kind of design is what Anthony Dunne calls “Critical Design” (Dunne 2006) as opposed to the earlier mentioned affirmative design. It offers the design-inherent qualities of mediating and illustrating complex problems and gives the user deeper insights to implications of current societal and technological developments. In this sense, “Critical Design” fulfills the educational responsibility to inform people, to communicate contemporary issues, and to offer the designer an opportunity to dive into the research field during the early stage of the design phase. The user’s reception therefore becomes a productive part of the design process.

"Critical Design needn't be judgmental of any particular technology, it simply asks for a more complete debate on how it is applied, who is applying it and how we could be affected by its mediation of our lives. Successful "Critical Design" comes about from good balance and application of three things:

1. *The application and usage of technology should be relatively feasible, i.e. the concept cannot easily be dismissed as science fiction.*
2. *The design concept, product or service needs to be desirable in both form and function.*
3. *Communication is of fundamental importance. This is why the written word usually reaches such a limited audience; a page of complex text does not encourage the average person to read on. A sophisticated "Critical Design" proposal can utilize props, newspaper articles and other means to entice and coax the audience into the discussion." (Auger 2005)*

"Critical Design" demands for dispute, enlightens researches, mediates and communicates through design.

Table 2 "Critical Design's" impact in project-works

MODE OF ACTION	PROJECT EXAMPLES
Stimulation (of the research field)	Stimulating: "Iso Phone" (James Auger), "Social Mobile" (Crispin Jones)
Simulation (of discussions)	Discussing: [all "Critical Design" projects raise discussions]
Measurement (for analysis)	Observing: "Placebo" (Dunne & Raby)
Comment (as a statement)	Commenting: "Huggable Mushroom" (Dunne & Raby)
Mediation (of complex topics)	Mediating: "Bio Jewelry" (Tobie Kerridge)

4.3 "Critical Design" as a research probe

Is "Critical Design" suited as a means of research? The table describing "Critical Design's" impact in project-works shows four modes of action that illustrate its versatility as a research tool. The first two are "stimulation" and "measurement". The metaphor of probe is an interesting approach to describe how "Critical Design" accomplishes these two modes. In its original meaning, a probe stimulates and at the same time senses. Both procedures of stimulation and measuring influence and change the study-objects simultaneously. The Heisenberg Uncertainty Principle already described this phenomenon that it is impossible to observe without changing the observed. This universal rule leads to the notion that fuzziness or blur are inseparable parts of nature that have to be accepted and dealt with. By including the aspect of uncertainty, the focus shifts on qualitative aspects of research that incorporate the idea of instability. Action Research and Grounded Theory, the two established methods of qualitative research discussed earlier, strongly relate to this principle of observing in the field and stimulating through interventions. "Critical Design" thus shows a natural affinity to those qualitative research methods.

The remaining two modes, "comment" and "mediation", emerge from Dunne & Raby's original concept. They stand for the development and use of design objects to raise discussions about societal and technological issues. Objects of "Critical Design" challenge the user by provoking or irritating them. The resulting reactions provide valuable insights for the product development that, for instance, could be revealing implications of new technologies. Projects like Dunne & Raby's Huggable Mushroom or Auger and Loizeau's IsoPhone exemplify how objects turn into critical comments on technology and mediate the issue in ways of embodying the statement, so that it can be discussed. They try to test the psychosocial limits of the user by questioning usages of technology.

Hence, "Critical Design" proves to have high potential to pick up debates on relevant issues in order to test them for further research and to inform early design processes. It is a useful research tool for the designer, which lets people substantially benefit from it: The mediation of technology and the probing of unprecedented possibilities in everyday life give people a useful tool that empowers them to self-engage with previously unnoticed issues and shape a personal attitude towards the same.

About the work of Dunne & Raby, who have pioneered this design approach, there is one crucial thing that is still missing in their practice. They only conduct a limited empirical analysis of people's reactions. Like the aforementioned probe, which provides observation data as well as stimulates the study object, "Critical Design" could sense and assess the importance, acceptance and integration of technology in everyday life.

4.4 The detachment from technology

The areas that Auger and Dunne mainly focus on are discussions about the implications of new technologies and their influence on everyday life. People as anti heroes of the quotidian life are confronted with invisible technologies such as electromagnetic radiation, radio waves, or other forms of data transmission. Many disclosed aspects, which design can make accessible for experience and vision are found in these topics, so that thinking about these technologies can be designed more effectively.

At first, the important aspect is to make the ability for critique possible, by avoiding any readymade opinions or fixed statements, and permitting future technologies to enter the personal sphere as a possible part of one's everyday life. The mediations of invisible or fluid technologies through physical interfaces is especially important to those people who are not so familiar with newer technologies, since they do not belong to the young, technology oriented, early adopters who have the money to buy e.g. the latest gadgets. In contrast to those, older and poorer people need a different access to technology. Thus, objects conceived as an interface to technology are the medium with which the particular and the society are able to recognize and identify themselves. In other words, in the industrial society there is a gap between the ability to use technology and the ability to integrate that technology personally and socially so that it becomes meaningful and individually relevant.

What do we get as we define these two positions as extremes? In the first case of early adopters, there is an uncritical and barely reflected relationship to technology, while in the second case of the elderly or the poor there are fears of contact and lack of understanding. For the first group the affirmative design develops gadgets with increasingly more functions and steadily growing usability as sign of a rising optimization. The affirmative design however does not develop those gadgets in the light of a meaningful integration to our everyday lives, but rather to bring them closer to or even into our human bodies. For the second group existing products are generally simplified to keep the people away from the real potential of the technology. In conclusion, technology is either invading and conquering or isolating and discriminating us through affirmative design. It is to question whether this quantitative outlook on the future relationship between humans and technology that is caused by affirmative design a desirable one.

A qualitative access to technologies must produce a necessary distance to them, so that other opportunities get visible, and that the optimization of objects does not simply happen based on a pure interface improvement between man and machine. Interface theorists like Donald A. Norman may have pioneered concepts of user-centered designs, yet those may fail to provide deeper values to people, as they do not pick up the social integration, meaning, and the development of new use-possibilities for products as the central theme.

4.5 A new prospect: Heterotopia

Utopia is always about escape and dream, as mystical scenarios filter the present real-world. Yet, how can we achieve that the desire for improvement in the world will not be exhausted in naive wishing? Design's credibility as a research discipline has always suffered from being too illusory. Consequently, the time for Utopia and utopian designs has to be over, since today's challenges do not demand for unreal and readymade visions that are inaccessibly rooted in the ideal world. However, what are other options to Utopia? Within the limitations of this paper, the authors introduce a fundamental notion to a methodology based on "Critical Design" that sits between science and art and that replaces utopian designs.

Such a design methodology would have to clarify aspects of its mode of engagement to avoid two common pitfalls. These are first, how far design manages to aestheticize without getting egocentric and unratable so that it would become Art, and second, how design activities gain accountability without losing their inspirational autonomy so that it would become Science. Since we are talking about design, one too obvious mode of engagement would be that of spreading utopian fragments through tangible objects and enactable scenarios in order to refresh our perception of the presence, to confuse the people and to provoke their reflection. This is partially happing already, however with little impact. Another more subtle mode would be the formation of a sense for possibility, which pushes aside pointless dreaming by promoting debates about the possible and the desirable and introducing a complementary model called "Heterotopia". It stands for actual 'places' integrated in the real society, in which autonomous rules of their own are valid, but also in which the social values of the real world are mirrored. Michel Foucault says:

"There are also, probably in every culture, in every civilization, real places - places that do exist and that are formed in the very founding of society - which are something like counter-sites, a kind of effectively enacted utopia in which the real sites, all the other real sites that can be found within the culture, are simultaneously represented, contested, and inverted. Places of this kind are outside of all places, even though it may be possible to indicate their location in reality." (Foucault 1967)

Foucault exemplifies such places as hospitals, prisons, elderly homes, cemeteries, or even travel journeys. Despite their reality, these places offer a large projection surface, which design can use. The garden, the theatre or the ship as metaphors provide us a "reservoir of imagination". We can utilize this "reservoir" with heterotopian products inspired by a "Critical Design" approach.

The concept of Heterotopia, which Anthony Dunne also describes in his book "Hertzian Tales", might become clearer through the help of a medical definition. Medically speaking, Heterotopia stands for a shift of healthy body tissue to an unusual or wrong place, where it causes vivacious activation. In accordance, a heterotopian concept of design could be understood as design being within society to which it brings constructive unrest, whereas the conventional utopian concept of design would locate it outside society, where it rather has a mesmerizing and even narcotic effect. Unlike science or the arts, which stand outside society to merely comment on it, industrial design has always been deeply rooted within popular culture and the everyday life and has always been commented on. This position of design bears great potential for a design research that emancipates itself from the shortcomings of overly rigid scientific approaches as well as from unaccountable artistic outbreaks. Design having an intrinsic heterotopian potential can inspire researchers across the disciplines for more ‘designerly ways’ in research. Would the true question even be whether science and art are not becoming design in the moment in which they leave their utopian position?

5. Future work

“Design is not engaging with the social, cultural and ethical implications of the technologies it makes so sexy and consumable.” (Dunne, Raby 2001)

Besides a first impression of the opportunities and potentials of “Critical Design” as a research tool, questions have primarily resulted from this study. There is a necessity to investigate following questions in further researches:

- *Which roots and parallels are there in art history and other past practices?*
- *To which areas can “Critical Design“ approaches be applied?*
- *In which context (research facilities, teaching, product development etc.) can “Critical Design” be established as a method?*
- *Is the arising discussion that is activated by “Critical Design” measurable through empirical studies?*
- *Are there alternative concepts for the technological economic understanding of efficiency and rationality?*

6. Conclusions

The world today is incredibly complex and our social relations, human desires, personal fantasies, hopes and fears are very different from the beginning of the 20th century, when design began to emerge as a disciplined activity. Since then the general image of humans has matured, becoming richer, messier, and increasingly down-to-earth. Most areas of culture have accepted that humans are complex, contradictory, even neurotic, yet design has not. Still, abstruse or complex emotions are mostly ignored in mainstream design. Instead, many designers keep considering people as predominantly obedient, predictable, and rational users/consumers, while neglecting those “complicated pleasures” that arise from the darker, puzzling side of human nature. In this world of increasing complexity, Anthony Dunne and Fiona Raby explain that the focus in design shifts to products, which pander to the side of people that is complicated, irrational, and contradictory. For that purpose, they introduced the concept of “Critical Design”, which so far can be described as the development and use of design objects for the discussion about social and technological problem areas. “Critical Design” provokes or confuses the user to elicit thoughts and attitudes that are subconsciously hidden or held back within the people’s mind. Instead of offering people merely optimized and therefore constraint action patterns, open situations and questions are created. The arising reactions provide valuable insights for product development and especially for design research. “Critical Design” emphasizes questions to complex pleasures and existential design. Therefore, this study has assessed the potential of “Critical Design” to be utilized as a novel research tool by utilizing conceptual products as a "medium that fuses complex narratives with everyday life" (Dunne, Raby 2001).

“Critical Design” illustrates the need for design researcher to deal with complexity encountered in the general dynamic of actors and in people's critical thinking. As Elizabeth Sanders and Pieter Stappers noted that, „What is being designed will change. Larger views across space and time will be needed. New tools and methods for design research will be needed to address increasing scope, scale and complexity.“ (Sanders, Stappers 2008), it is becoming apparent that sticking only to its existing knowledge, design might not tackle future challenges. On this Background, the goal of this paper is to explore novel and suitable approaches to deal with and conceptualize the complexity that is involved in the interplay of design and people.

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An Investigation into Features of Design Thinking in Fast Moving Consumer Goods Brand Development: Integration and Collaboration

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Abstract

Most companies and researchers have no doubt now that design envisages a way toward future products, services, and systems. Recently, however researchers have started to highlight ‘design thinking’ to ensure that design becomes the next competitive advantage in companies. They acknowledge that design thinking enables companies to develop differentiated products, services and systems which consumers and users need. However, there is little research which reports how design thinking can be embedded and fostered in different business contexts, especially in FMCG (Fast Moving Consumer Goods) brand development. This paper investigates what features of design thinking are employed in FMCG brand development via stakeholder interviews in three domains: agencies, companies, and retailers. This paper concludes with suggestions of how design thinking can be embraced in FMCG brand development.

Keywords

Design thinking; brand development; Fast Moving Consumer Goods; design integration, and collaboration

Branding is a key strategic asset for organisations in an increasingly competitive retail environment (Lincoln & Thomassen, 2007; Thomassen, Lincoln & Aconis, 2006; LePla & Parker, 2002; Southgate, 1994). Brand development is a complicated process in which stakeholders have different needs and expectations of the development process. Hence, to ensure that brands can be both competitive and sustainable, an understanding of integration and collaboration between different disciplines is of prime importance to the various stakeholders involved (Olins, 2007; Mozota, 2003). Literature suggests that design can assist in the development of competitive advantage in an integrated and collaborative way and support effective brand development (Brown, 2009, 2008; Mozota, 2003, 2002; Vazquez & Bruce, 2002). The manner in which this could be achieved has not yet been described within the literature. There is less research discourse detailing the interaction of design within brand development. This in part can be attributed to current working practices in organisations and associated resistance to change as well as the lack of awareness of the potential added value design can bring to this development process.

Many researchers affirm that design envisages a way toward future products, services, and systems (Berger, 2010; Martin 2009; Brown, 2009, 2008; Neumeier 2009; Mozota, 2003, 2002). Recently, ‘design thinking’ has received attention claiming that design can help companies to create competitive advantage such that they can develop differentiated products, services and systems which consumers need and desire. However, research has yet to focus upon how design thinking can be embedded and be fostered in different business contexts. Many researchers (Kimbell, 2009; Fraser 2006) also claims that design thinking research in design disciplines needs to consider approaches employed in design practice in more detail.

While FMCG brand companies compete in fast changing markets, they also call for new approaches to communicate with consumers and to develop brands effectively. In these contexts such challenges faced are not easily described, and this is not discussed in a meaningful way. Such problems currently faced by these companies are ‘wicked problems’, where neither the problem nor the solution is known (Buchanan, 1992). Recent discourse has likened wicked problems to design problems (Berger, 2010; Martin, 2009; Brown, 2008, 2009; Neumeier, 2009). Neumeier (2009) claims that the central problem of brand building is getting a complex organization to execute a bold idea so that design thinking helps organizations to appreciate fast changing markets and to find opportunities or solve undefined problems. Design and designers are well placed to tackle wicked problems that companies face and design thinking gears up for what FMCG brand development needs. Martin (2009) illustrates how P&G could avoid downturn in activities by adopting design as a core driver for a company. As organisations involved in the FMCG sector experience a competitive and fast changing market, it is imperative to employ design thinking in order to explore new brand ideas. This investigation aims to address the above needs for new approaches to both branding and design thinking research.

There has been limited research which outlines design thinking in FMCG brand development. This paper aims to investigate the role and features of design thinking in FMCG brand development and compare these identified features to more broadly defined concepts of design thinking.

The central research questions are:

1) What is the role of design thinking in FMCG brand development?

2) What features of design thinking can be identified in FMCG brand development?

1.0 Research Design

To provide a brand effectively to a market, brand development has to embrace diverse stakeholders from different disciplines supporting appropriate and effective communication. Companies who traditionally develop and produce FMCG brands (known as national brands) now face competition not only from other companies but also from retailers' own brands. In some instances, retailers' own brands are even taking over national brands (Lincoln & Thomassen, 2007; Thomassen, Lincoln et al, 2006). Since the growth of own brands, companies not only employ design thinking internally but also collaborate with external specialists to keep bringing new thinking into the development process (Martin 2009). Many companies, besides retailer, tend to collaborate with external agencies. It is more efficient to work with them in terms of time, money and creative efficiency (Berger, 2010).

As has been illustrated, it is crucial to study design thinking of three dominant stakeholders, who play a critical role within FMCG brand development: companies; retailers; and agencies. This research framework investigates the three stakeholders in Korea and in the UK in order to generate general features of design thinking in FMCG brand development.

2.0 Research Methodology

A qualitative research methodology was employed to explore the main research questions and included a series of semi-structured interviews with a range of stakeholders within FMCG brand development within companies, retailers, and agencies. The research aims to understand various perspectives upon FMCG brand development. These interviews informed a series of case studies that explored FMCG brand development processes and the role of design and design thinking within this context.

Communicating design thinking terms with interviewees is difficult because design thinking is not defined yet as a broadly understood concept. Due to the lack of awareness and the variety of interpretations of design thinking, interview questions explored terms associated with design thinking (design, design approaches, and creative design) rather than design thinking as a term itself. Therefore, interview questions are development to investigate design integration and collaboration through their project processes and their value to design.

Researchers (Berger, 2010; Brown, 2009; Neumeier, 2009) recognize that collaboration with external specialists is a way to foster design thinking. Design integration and collaboration are also important to embed design thinking into projects both internally and externally to an organization. Interviews investigated how agencies and their clients (companies and retailers) conceive and foster design thinking depending on perspectives of agencies, companies and retailers.

2.1 Rationale for interviewee selection

Interviewees of a company and a retailer in Korea were selected based on ‘Best Brand Award’ and ‘Brand of the Year’ by Korea Advertising Society. Participants were selected based on ‘design of year’ from ‘Design’ magazine, which specializes in brand and packaging design or have an independent team of packaging in the agencies. Packaging design is substantial aspect of FMCG brand development in contrast other brand development such as cars, electronic products, luxury products and so forth. Agencies that undertake packaging design were considered important to the study due to the relationship of packaging design to FMCG brand development. In the same way as in Korea, agencies and company in the UK were selected from the DBA’s (Design Business Association) ‘Design Effectiveness Award’.

3.0 Design Thinking

Before presenting the analysis of the interviews, it is necessary to discuss the term ‘design thinking’ to convey an understanding of its features and characteristics. Even though researchers have studied concept of design thinking from 60s, the term design thinking is ambiguous and confusing when used in design (Simon 1996). Definitions refer to the way in which designers think as part of the creative process (Brown 2009, 2008; Lawson 2006; Cross 2006; Rowe 1987); and a design attitude (most current researchers work in this area). In contrast to earlier design thinking research which studied that design thinking was analytical thinking or inductive thinking (Rowe, 1987), recent research argues that design thinking is synthetic and abductive thinking aligning with ways of approaching wicked problems as applying design thinking to whole organizations (Martin 2009, Brown 2009). Currently, Brown’s (2009, 2008) claim that the concept of design thinking is thinking like designers is accepted and broadly applied to other disciplines.

Successful cases employing design thinking can be found in pioneer design driven companies from design-related companies like Herman Miller and Steelcase to technology- related companies like Philips and Apple. Previous companies embrace design thinking to solve ill-determinate problems and to find a way toward undefined goals (Brown 2009, 2008; Martin 2009; Neumeier 2009). Research has started to investigate what these successes are derived from and design thinking becomes highlighted in other disciplines: business, organizational studies, and non-profit organizations. Researchers (Berger, 2010; Martin 2009; Brown 2009, 2008; Kimbell 2009; Neumeier 2009) start to delineate ways of applying design thinking at general strategic level. Even though, their concepts of design thinking are slightly different, most researchers claim a balance of thinking: integrated thinking; systematic thinking; balance between analytical thinking and intuitive thinking or abductive thinking, balance between divergent thinking and convergent thinking so that currently design thinking can be adopted to other disciplines beyond design practice. There is also the prime claim among researchers that design thinking helps organizations transform to implement innovation.

Research has sought to clarify characteristics of design thinking to help people to embed it into their organizations and develop competitive and efficient products, services and systems. Early research which investigated design, delineated some design methods and designers’ techniques like visualization, sketching, drawing, and so forth as attributes of design thinking (Rowe 1987; Cross 2006). On the other hand, recent research seeks to characterize design thinking as design attitude (Berger, 2010; Brown 2009, 2008; Martin 2009; Owen 2007; Lawson 2006; Dunne and Martin 2006). These attitudes can be interpreted as features of design thinking. Research identifies how design thinking is employed, and thus embeds design thinking beyond traditional design contexts and establish pervasive design thinking culture, incorporating this into business strategy (Porcini 2009) or non-profit organizations’ goals.

Research has emphasized different features and methods for design thinking. For examples, Brown (2008, 2009) makes emphasis on prototyping and user-centred approach in *industrial design*. On the other hand, Neumeier (2009) highlights agility, collaboration, and approaches to wicked problems and so comes closer to *branding*. So, there can be different acknowledgements of what stakeholders conceive for design thinking methods in FMCG brand development.

4.0 Interview Analysis

Interview data was been clustered in three groups: 1) agencies, 2) companies and 3) retailers (Table.1). The research data was analysed by thematic analysis utilising theoretical codes to link together the features that arise from the interview data and the concepts from literature. Thematic analysis is appropriate to provide a potentially rich and detailed account of data across theoretical and epistemological approach (Braun and Clarke 2006). Flexibility in thematic analysis bestows no limit so that a researcher can find essential and flexible themes from complex data without bias. Through reviewing data, latent codes arise and this provides the following themes.

Through using thematic analysis without any bias to data collection, three themes are distilled from agencies interviews: 1) features of impacting design integration and collaboration in FMCG brand development, 2) features of impacting FMCG brand development, 3) features of impacting own brand development. Two themes are in companies and retailer: 1) features of impacting design integration and collaboration in organizations, 2) features of impacting brand development or own brand development.

	In Korea		**In UK**	
Agency	Agency K1	CEO Specializing in FMCG brand development and packaging design development.	Agency UK1 Agency UK2 Agency UK3 Agency UK4.1 Agency UK4.2	CEO Co-founder and creative director Senior client team manager Director of brand valuation Creative director of FMCG Specializing in brand development and packaging design development. Whereas agency UK 3 and 4 are global agencies, agency UK 1 and 2 are based in the UK and work cross the countries. And comparing initial ones, companies are small.
Company	Company K1	Manager for design planning and packaging design A Korea leading FMCG company. Company K1 has a lot of brands in different businesses.	Company UK 1	Head of creative Starting from a SME company and now a leading company in category section
Retailer	Retailer K1	Brand manager for furniture and storages Being established as joint venture.	None	

Table1. Summary of respondents' organisations and roles [K=Korean; Agency K1=1st interviewee of Korean agency; UK=United Kingdom; Agency UK1=1st interviewee of United Kingdom agency]

4.1 Agency

Design thinking in agencies can be found in both internal projects and external collaboration. However, their role in FMCG brand development is limited and performs generally in identity development. Through their workflow and cases, features were extracted and analyzed. Approaches of agencies to FMCG brand developments are different depending on client processes, timing of agencies' engagement, types of brand development, their budget and so forth. Because as previously noted, problems which clients face are undefined or wicked problems, so if they have proprietary processes, agencies tend to tailor their process. If there is no proprietary process, the reason is that they build up an appropriate process and adapt it toward each different task. Especially in agencies UK 4 interview one respondent stated that projects and associated processes are "depending on clients" and emphasized flexible approaches.

	Features of impacting design integration and collaboration in FMCG brand development	
	+Encouragement	-Barriers
Agency K1	**+Clients' understanding of design** **+Consensus of what agencies and clients are doing** **+Early engagement** **+Long term relationship** **+Communication**	**-Clients' understanding of design** -Lack of money -Lack of time

Agency UK1	**+Consensus of what agencies and clients are doing** **+Communication** **+Working together as one team with clients** **+Early engagement** **+Building relationship**: long term relationship, strategic partnership **+Integrated work processes** **+Understanding consumers** +Challenge mindset: challenge +Proprietary processes +Key decision maker involvement +Combination strategy and execution +Clients attitude working with agencies +Articulated design brief +Keep providing good works +Who handle projects	**-Poor clients' understanding of design** **-Client mindset: cautious** -Clients attitude work with agencies -Lack of money -Who handle projects -Poor design brief -Consumer's reaction -Focused group
Agency UK2	**+Consensus of what agencies are doing and how ideas work** **+Communication:** Working at the same places for communication **+Early engagement:** early involvement on product development **+Integrated work processes** **+Building relationship**: providing good experience with clients **+Understanding consumers** **+Client mindset**: Brave, design leadership **+Working together internally** +Cover whole spectrum of brand development including campaign +Challenge to change the way of perception +Working with right people +Develop new research methods for consumer research +Changing clients recruiting systems +Consistent creative ideas	**-Poor clients' understanding of design** **-Client mindset:** anxious -Client internal politics -Wrong ways of consumer research -Recruiting systems
Agency UK3	**+Consensus of what agencies and clients are doing** **+Understanding consumers**: observing consumers and their lives +**Building relationship**: trust, long term relationship, partnership and credibility **+Early engagement** **+Agency's attitude: passionate, confident, and strong rational argument** **+Working together as one team** **+Integrated thinking and process** **+Clients mindset**: respect an agency, Clients' value design and design thinking **+Key decision maker involvement** +Cover whole spectrum of brand development +Proprietary process +Structure and processes of clients' companies +Providing what clients want +Collaborative work processes +Collaborative strategic design +Tailoring agencies' processes +Part of Global company +Rigor for creativity +Fusing client's confidences	**-Poor clients' understanding of design** **-Client mindset:** nervous -Structure and processes of clients' companies -A lot of clients' background work and agencies late involvement
Agency UK4.1 and 4.2	**+Agency's attitude: passionate** **+Consensus of what agencies and clients are doing** **+Communication:** informing clients **+Integrated approach and processes** **+Clients' understanding of design** **+Understanding consumers** +Flexibility +Interaction with clients +Designers' intuition +Diagnose situations +Inspiration: by environments, materials and so forth	**-Clients' understanding of design** -Rigid structure and processes -Insufficient knowledge -Wrong information that clients have -Time consuming convincing stages

Table 2. Summary of agencies' Interview: features impacting integration and collaboration in FMCG brand development (items mentioned more than three times from different interviewees are in bold)

The goal of FMCG brand development in agencies is to find opportunities, to find the optimum arena for the focus of their activities, and to change consumers and clients perceptions. When agencies and clients seek to find a way to achieve goals, they need a consensus about (re)defining problems and establishing frameworks to solve them. In agency interview UK 3 the respondent stated that “using design and design thinking helps actually to find out what‘s the optimum arena for brand and to load this presences”. This evidence suggests that agencies seek to achieve these strategic goals by employing and adopting design and design thinking.

As demonstrated in Table 2, there are nine common features to be found about encouraging design integration and collaboration: 1) clients understanding of design, 2) consensus, 3) early engagement, 4) building relationship 5) communication internally and externally, 6) working together internally and externally, 7) integrated approach and process, 8) understating consumers, 9) clients and agencies’ mindset. Each common feature has different details depending on interviewees. In contrast to the above common features, there are opposite opinions about some features. Whereas, Agencies UK 2 and 4 point out proprietary processes for encouraging features, Agencies UK 1 and 4 mention that these processes sometimes are avoided due to lack of flexibility. They account for developing flexible proprietary methods and then depending on projects, they prefer adopting appropriate methods in response to the specific requirements of each project. This difference is influenced by the nature of each organization, such as vision, size, structure and so forth. Above all, it depends what they value in brand development. The latter two agencies tend to value intuition, creativity, and disruptive thinking.

Features of encouraging design integration and collaboration in each group are interlinked and dependent each other. For example, building relationship between clients and agencies determines design integration and collaboration to cultivate effective design thinking. Communication between clients and agencies is necessary to build strong relationship and consensus of overall aims. Conversely, better relationships determines that agencies and clients communicate with each other well and that agencies can have more engagement with clients at a strategic level. This leads clients and agencies to have strategic partnership with trust and credibility. Through working with agencies interplay and integration issues enables design thinking to embed clients businesses and have more chance to identify consumers’ need and desire. It can be concluded that communication is a key factor in fostering design thinking within FMCG brand development

As demonstrated above, whether they are common or not, a variety of factors influence both national and own brand development. In their experiences, most interviewees noted that there are different design integration and collaboration approaches because the goal of brand development, and associated organizational structures, are different. Whereas national brand development is a matter of independent brand and is normally handled by a design manger, designer, or marketer, own brand development is a matter of developing brand architecture of category and is carried on by a marketer. Features of own brand development overlap with features of national brand development but there are also differences. Therefore, features seen in FMCG brand development in table 3 can be considered as developing own brand.

	Features of considering in FMCG brand development	**Features of considering own brand development**
Agency K1	• Emotional approach rather than marketing approach • Time consuming marketing research	• Communicating value rather than price
Agency UK1	• Providing new opportunities • Combination strategy and execution • Developing independent brand • Defining what brand stands for • Design development for building brand equity • Client’s project design brief • Consumer reactions • Changing consumers’ perceptions • Macro and micro consumer researches • Projects handled by a design manager, a designer or a marketer in client side	• Understanding brand differently • Developing architecture of categories rather than each independent brand • Different structure from national brand companies • Valuing product (category) not brand • Mostly In-house design team involvement • Projects handled by a marketer

Agency UK2	• Providing new opportunities • Wit and humor • Higher risk in national brand development • Contribution by design • Developing brand itself • Role of packaging in FMCG brand: the voice of brand, entertaining consumers to engage them, differentiation from competitors	• Low risk in own brand development • Developing own brand with corporate statements • Tactical advantage • Challenge with innovation
Agency UK3	• Providing new opportunities • Holistic approach • Creative ideas or disruptive thinking to change design • Brand engagement • Emotional residences • Decision's effect sales • Different approaches depending project types: new brand development and existing brand development • Role of packaging: embodying brand essence through packaging, differentiation of brand, communication of brand, change consumers' perception and lives	• Different creative approach but similar brand development process • Brand architecture process: communicating hierarchy of architecture on packaging • Navigating consumer to find own brand products: providing category cues • Changing consumer's perceptions: letting consumers feel pride to buy good quality
Agency UK4	• Holistic approach • Broad consumer target • Getting maintenance on shelves • Providing new opportunities	• Approach localizations: understanding what local consumers want

Table 3. Summary of agencies' Interview: features of considering in FMCG brand development and own brand development

4.2 Company

As previously mentioned in agency analysis, how companies value design determines design integration and collaboration between companies and agencies in order to develop a competitive and sustainable brand. Company K1 has many brands in different businesses and all design activity relating to their brands is carried out in-house a design centre in the company. However, the role of design centre seems to be limited in companies' strategy such that design thinking is not pervasive to other departments. Above all this company is a big organization and to achieve time and financial efficiencies, every stage is executed through computer-systematized processes. There seems to be a lack of communication to share ideas and opinions. In contrast, company UK 1 has two category lines but it is to be a leading company. The organisation has a flat managerial structure so its culture is appropriate to share ideas about problems. In addition, the mindset of company UK 1 stimulates challenge new opportunities rather than cautious attitude that company K1 has. The reason that this company can achieve leading position in around a decade is communication for sharing problems and finding a way together.

	Features of impacting design integration and collaboration in organizations	**Features of impacting brand development**
Company K1	+Updating new knowledge for design and design management +Sending designer to other countries to research their design and learn how other companies manage design +Design team supported by CEO in organizational hierarchy +Confidence of design +Developing design tool kit or library +Developing process for design -Strong sales team power -Reward for big profit -Stage gate process between teams -Brand mangers and category mangers handle design projects -Complicated process system -Every stages counted by money	+Design center for whole design spectrum +Planning tool -Sales person attitude: cautious for changing design to lose brand loyalty

Company UK1	+Entrepreneurship: entrepreneurship in design +Open space and mixed placement +Space (office place) itself: creative space for employees +Horizontal hierarchy +Whole employees engagement to solve problems +Whole employees involvement in generating ideas +Get problems and ideas from consumers +Commercially intelligent +Finding right external agencies: agencies' understanding problems +Taking about ideas freely +Simple decision process +Keeping finding great people +Keep learning -Wrong definition for problems	+Keep consistence of what brand stands for +Keep nature of brand +Great products +Brand engagement with consumers +Find what consumers want and then engaging them

Table 4. Summary of Companies' Interview: features impacting design in organizations and features impacting brand development

As can be seen in table 4, ways of finding and sharing problems in organizations affect approach to projects. Therefore, companies seek to find a way, which stakeholders can be engaged in order to find opportunities to meet consumers' unmet needs.

4.3 Retailer

Through this study, it is clear that retailers have started to value design to enable the development competitive advantages. They develop new ways to bring design in their organizations and own brand development such as collaboration with star designers and developing premium brands. However, they confront barriers, for example, complicated decision system and insufficient resources such as budget and people. The retailer seeks to adapt design for competing with competitors. The retailer employs design to develop differentiated own brand from other retailers and take a leading position in a market.

	Features of impacting design in organizations	Features of impacting own brand development
Retailer K1	+Collaboration with a star designer +Value design for competitive advantage to shift to premium line +Starting to hire designers in each different category line +Own brand test room -Structure complication -Complicated decision stages	+Brand development guideline +Packaging guideline +Using consumer panel and data +Benchmarking +Specific step guideline for developing own brand -Guideline and policy without considering capacity

Table 5. Summary of Retailer's Interview: features of impacting design in organizations and features impacting own brand development

5.0 Findings

Firstly, perspectives of design thinking from companies and retailers can be found in their interviews and agencies interviews. The role of design in FMCG companies is not to act as a catalyst and facilitator for design thinking, but to supporting other departments and to add aesthetical touches. Specially, the role of an agency is limited in developing brand identity. Thus, collaboration and integration between companies and agencies tend to take place at the latter stages of brand development. However, there are some approaches in companies and retailers to adopt design thinking consciously and unconsciously.

In Company UK 1 interview, they do not explicitly set out to employ design thinking but the organizational culture already has important features of design thinking. Employees from different departments share problem-solving approaches and collectively find ways to define problems in consultation with consumers. The space of the company is open and designed to communicate conveniently. In contrast to this, Company K1 has a different organizational culture in relation to design thinking, having rigid processes and roles within each department. This represents a barrier to effective communication and prevents integration of processes across departments.

Secondly, features extracted from three groups of interviewees are integrated and interlink with each other. Thus, it is necessary to conceive these features integrally. As can be seen in agencies' interviews, most interviewees argue that clients' understanding and valuing design has an impact on collaboration and integrated design process between companies and agencies. Most features, which are described in table 2, are determined by agencies' clients (companies and retailers), hence agencies need to build good working relationships for design thinking to pervade projects. In FMCG brand development, unlike in industrial design, evidence suggests that agencies do not foster design thinking within client projects and more broadly their strategic planning processes. It can be claimed that agencies are preoccupied with pleasing clients rather than engendering creativity and questioning the status quo. However, there is another stream of design agency. Agency UK 2 was the smallest within this study nevertheless they ranked in the top 5 agencies in UK (as published in Design Week, 2008). They are broadening their business activities from packaging design to brand campaigns. The respondent claimed that their agency needs to dominate projects rather than pleasing clients, and their intention is to strongly promote design thinking. In conclusion, it is crucial that agencies seek to find ways to collaborate and integrate with clients without losing their creative abilities.

Thirdly, retailers have potential to create a new way to develop own brands. Retail K1 collaborates 'star designers' to reinforce their brand and infuse creativity into their brands. Interviews with agencies demonstrated that retailers have a lot of potential to develop own brands in an innovative way. There is opportunity to implement design thinking and develop own brands with lower risks than national brand companies. There are some barriers to this, namely a lack of understanding of the value of design, rigid hierarchies, and focus on sales profit for example.

Data analysis (Figure 1) illustrates the features of design thinking for FMCG brand development between clients and agencies. This is divided into two groups: i) agencies, and ii) companies and retailers. Features identified in bold have a substantial impact. In first column, organizational culture has to be fortified as a foundation stone, and features in the second column need to be cultivated for design thinking to penetrate into projects. The third column provides further details. The features in the third column do not take place in a linear manner and these are iterative and integral in processes and further more organizations.

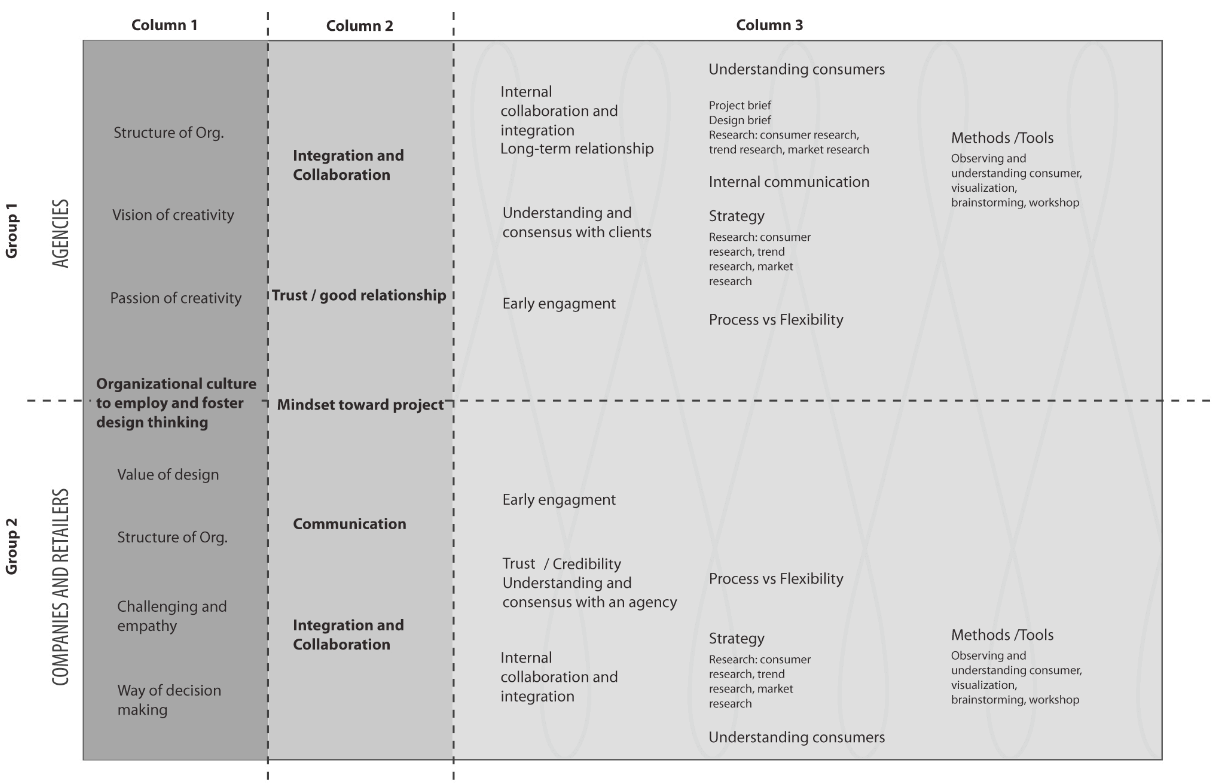

Figure 1. Design thinking features map in FMCG brand development

The empirical data collection via the research interviews has identified features of the role of design thinking in FMCG brand development that has not previously been identified in research literature. These features include lack of money to devote to a project, lack of time to undertake design thinking related activities, and the need to please clients. There is a clear implication of resource availability and the ability for organizations to undertake design thinking-led FMCG brand development. Many features identified within the interview analysis correlate with published literature upon design thinking. However, features such as prototyping and user-centered approaches (Brown 2009, 2008) which are noted in design thinking in industrial engineering design, is less pronounced in FMCG brand development.

Most companies and agencies still maintain traditional management styles and while FMCG industry operates in fast changing markets, associated strategies are not long-term. Agencies are often engaged in the latter stages of the brand development operating under compressed and unrealistic timescales. Therefore, agencies build long-term relationships with clients to engage with early stage of brand development, however the nature of these relationships results in agencies seeking to please rather than question clients. For this reason, disruptive ideas may not make it into presentations agencies make to clients.

In summary, the following are three important reasons for differences between design thinking in the literature and design thinking in FMCG brand development practice:

- FMCG industry context: fast changing market, a short-term brand strategy, value of sales, different stakeholders' involvement;
- Conventional relationship between agencies and clients (companies and retailers): the role of agencies is conceived as carrying the last stages of development of the aesthetical part of brand;
- Conventional approaches for developing FMCG brands: late design engagement, conventional consumer research methods, rigid roles of individual departments.

6.0 Conclusions and Further Work

It can be concluded from the interviews that design thinking is not yet a core aspect of FMCG brand development, but there are instances where its value is recognized and its use is increasing. Respondents identified the role of design thinking in the FMCG brand development process, where design is already valued and recognized a core activity. Where literature provides evidence of the value of design thinking across the functions of an organization, there was little empirical evidence of its adoption in organizations involved in FMCG brand development. Thus research undertaken within this study suggests that design thinking has not yet been adopted into broad processes of FMCG brand development organizations. Although literature claims that to develop competitive and sustainable brands it is imperative that features of design thinking are employed and fostered, there is a requirement to communicate this in an effective and concise manner to FMCG brand development organizations. The ongoing debate regarding design thinking – its meaning, value, and role in both design process and more broadly in business contexts – contributes to this communication challenge. There is a need for stakeholders involved in the use of design thinking (in its various guises) to provide concrete examples to stakeholders in the FMCG brand development process.

This research provides evidence that it is necessary to frame the role of design thinking in FMCG brand development while recognising the fast changing market context and the complexity of stakeholder accountability. Further work is planned that seeks to develop the initial work in this study by engaging with a much larger audience of stakeholders in FMCG brand development.

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Resonance rather than Solo: Shaping a Regional Image with Soundscape

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Abstract

As times change, industrialization and urbanization transform the structure of traditional rural society and result in imbalanced development between urban and rural areas. Then, as a result of population outflow and change in industries, rural distinctiveness gradually disappeared. Given that visual text was normally used to shape a regional image, this study further added audio text to enrich rural expression and also adopted the soundscape concept proposed by Murray Schafer (1973). Other than artificial sounds and natural sounds, soundscape also covers memory sounds, image sounds, cultural sounds and social sounds. The study incorporated the ecological triangle developed by Tilly (1974) – humans, space and activities, to analyze the urban and rural social structures; as well as the soundscape triangle developed by Schafer (1978) – soundmark, signal, keynote, to analyze the sounds in the environment.

This study utilized environmental marketing to transform sounds that are regarded as noises from negative exchange phenomenon to positive exchange of environmental resources. By using in-depth interviews, the study filtered out the scenic spots of Tongshiao Town, Miaoli County featuring mountainous or oceanic uniqueness and conducted a field survey to collect visual and audio text data. The text analysis method was used to analyze the data contents and meanings, and explored the derived interactive relation between humanistic emotions and the rural image. The study designed a soundscape shaping region prototype- Sonic Vison, which blended visual and audio test data into audio-visual interactive creation, in an attempt to help the study subject better promote the region's tourism industry and reinforce marketing applications. The results can also be used as a reference for future research on shaping a regional image in other rural regions.

Keywords

Soundscape; ecological triangle; Soundscape triangle; regional image

Introduction

Following its economic growth, Taiwan is now experiencing an imbalanced development between urban and rural areas. The lack of job opportunities in rural areas, the replacement of labor force by agricultural machines, and the shortage of social resources, have caused the widening gap between urban and rural areas, the outflow of rural population, and the gradual disappearance of rural features (Ding, 1999). Besides, many rural towns, which used to maintain traditional agricultural life due to restrictions of landform, location and transportation, have shifted the developmental focus to the tourism by means of the rich resources well-preserved because of difficult exploitation in the past, as the social structure changes in the rising tourist tide and now are gradually forming into famous tourism towns (Chen, 2000). It is necessary for these towns to build new images to attract tourists. Chiang (2001) pointed out that the "Image of the City" refers to the "memory" and "meaning" resulted from the "knowledge" of these urban and rural areas. Given that visual text was normally used to shape a regional image, this study further added audio text with local distinctiveness so that the image could be perceived and remembered both visually and aurally and then be transformed into special regional memory. The early industries were predominated by agricultural society and handcraft industries such as straw mat weaving and wood carving once thrived in the 1930s, which, however, declined soon due to the changing time and population outflow, and the characteristics of rural towns gradually disappeared. The high audience rating of the Taiwanese idol drama, Lavender, broadcasted in 2001, successfully marketed the Flying Crow Ranch in Tongshiao, which caused a whirlwind at that time and indirectly made the Flying Cow Ranch popular overnight and gradually promoted the development of scenic spots in the vicinity of Tongshiao Town, and the unexploited natural landscape of Tongshiao Town was developed into agricultural recreation areas in recent years. The town has shifted its developmental focus to tourism industry, which further attracts artists who brought to the town an artistic and cultural atmosphere. The disintegration of traditional social and urban structures causes the confusion of the image of the city, and since people gradually lose their "memory" and "emotion" about the urban environment, it is actually an important step to value and rebuild the image of the city (Chiang, 2001).

Wang (2001) views the city as an organism and studies the city expression with five-sense association method: soundscape, tastescape, smellscape, touchscape and mindscape. The research on soundscape, a concept proposed by Murray Schafer in 1973, launched a series of world soundscape projects, which paid special attention to the auditory feeling under the contemporary visual current. The soundscape of a city is an important environmental reference of quality of life in the urban setting (Pereira, 2003). Since each region owns special soundscapes of its own, this paper selected a rural region, whose tourism industry just getting started with its tourism resource of mountains and sea, as the study subject, and shaped the regional image by means of the soundscape triangle proposed by Schafe (1978), and the ecological triangle proposed by Tilly (1974). Then via the sounds and images created by the local landscape, this study aims to discover local characteristics from the perspective of environmental marketing and shapes a local image. In addition to establishing self-awareness and a sense of identity among locals, this study can also be served as a reference for future researches, and thereby successfully markets Tongshiao Town.

Literature review

The soundscape is any acoustic field of study. We may speak of a musical composition as a soundscape, or a radio program as a soundscape or an acoustic environment as a soundscape. We can isolate an acoustic environment as a field of study the characteristics of a given landscape (Schafer, 1994). The concept of soundscape was originally developed by Murray Schafer, a Canadian composer, in early 1970s, who launched a series of survey researches with the "World Soundscape Project" as the core. The idea of soundscape is "to employ the natural sound, the urban rhythm, the memory of artificial sound, and the sound within impression on this planet to take the image of landscape while catching its sound". This can be viewed as a special emphasis on auditory feeling in the contemporary visual current. Each region owns its special soundscape and since the sight and sound coexist with each other, and the missing of either will render the environment unnatural, the visual representation shall not be the only one employed to shape the regional image. Schafer (1977) proposed that other than artificial sounds and natural sounds, soundscape also covers memory sounds, image sounds, cultural sounds and social sounds, and since environmental sounds influence the locals imperceptibly, the analysis of environmental sounds can be applied to discover those of positive values, which can even serve as regional marketing strategy. Besides the sound as physical phenomenon, soundscape also covers the environmental space that transmits sound and the feelings of recipients; that is, soundscape is a method and an idea to study the interrelation among sound, environment and human and therefore, the harmony among those three is absolutely necessary for good soundscape (Shi, 2004). Among human, sound and environment, they supplement and complement the others and it is human that feels, thinks and remembers the sound and environment and then feeds back to the sound and environment. In other words, sound and environment transmit feelings to human, who will unconsciously returns sound and create environment of the same quality. (as shown in Fig. 1)

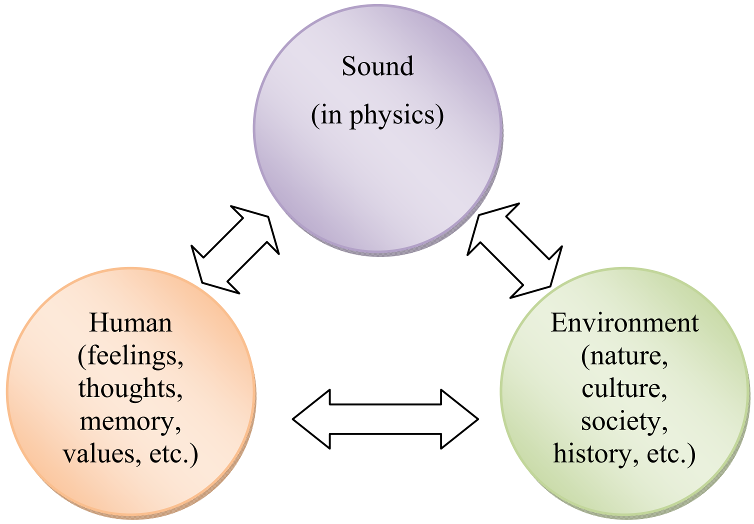


Figure 1 Relationship between sound, human and environment (Data Source: Shi, 2004)

The majority of soundscape studies in recent years focus on environmental noise, human perception about environmental sound and sound management. In such studies, noises are typically described by a quantitative metric such as sound pressure level and people's responses to noises are represented by a single evaluation of annoyance (Kawai, 2004). The point is to master its physical characteristics and analyze via the quantitative methods such as the measurement or calculation of decibel value, sound frequency characteristic and reverberation time, rather than its social, historic, environmental characteristics (Shi, 2004). The study on sound from the perspective of soundscape shall conduct comprehensive consideration about the multiple characteristics of sound and attach different values and cultural contents based on individual differences. Therefore, soudnscape is not only a pure physical concept resulted from acoustic measurement and spectral decomposition, but also a social and cultural existence attached with distinct personal emotions.

The image of a city is based on its residents' memory and meanings resulted from long-term observation, use and knowing about certain region in the surrounding environment (Chiang, 2001). The urban and rural citizens develop not only memories but also emotions about the place, and only the combination of urban appearance and personal and communal ideologies will form the image of the city. In the city, different groups develop different images based on their own social lives, and thus it is a must to master the nature of social experiences in order to know the structure of mutual urban and rural images. Kevin Lynch has published a classic work concerning the image of the city, The Image of the City, which simplifies the urban imagination into the physical form of the city, focuses on the readable spatial factors (such as paths, nodes and edges), proposes meanings of obtaining the urban experiences with mental map and represents the main tool for contemporary studies on urban connotations (Hsia, 1989). Since social practice plays a more important role than perception in form does, it is improper to apply the perception method to study the image of the city due to its incapability for symbol analysis of the image, and this study, besides using the perception method to discover images, applies soundscape triangle and ecological triangle in an attempt to find the environmental sound with local characteristics, and views soundscape as a non-physical exchange object for the urban environmental marketing according to the concept of soundscape proposed by Wang (2001) in the hope of transforming sound into positive exchange phenomenon of "environmental resources", rather than negative exchange phenomenon of noise, and applying the concept of soundscape as a special product for urban and rural marketing.

Method

Subject

This paper selected a rural region, Tongshiao Town, as the study subject, whose tourism industry is just getting started. This region is rich in tourist resources of mountains and sea. Taiwan lies on the right side of mainland China and on the left below Japan(as shown in Fig. 2); and Tongshiao Town lies in the northwest of Taiwan (as shown in Fig. 3) predominated by hills descending from the southeast to the northwest, which forms a gentle slope to the coastal line so that it is characteristic of mountains and sea. The unexploited natural landscape of Tongshiao Town was developed into agricultural recreation areas in recent years, and the town has shifted its developmental focus to tourism industry, which further attracts artists, who come and bring the town with artistic and cultural atmosphere.

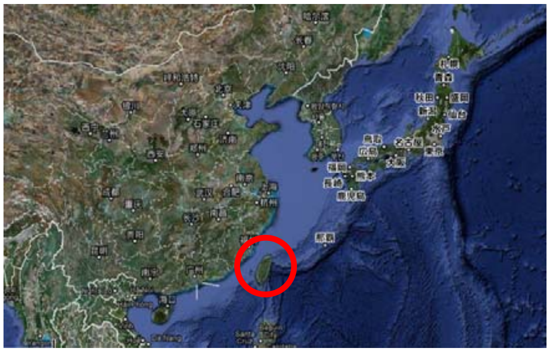


Figure 2 Location of Taiwan

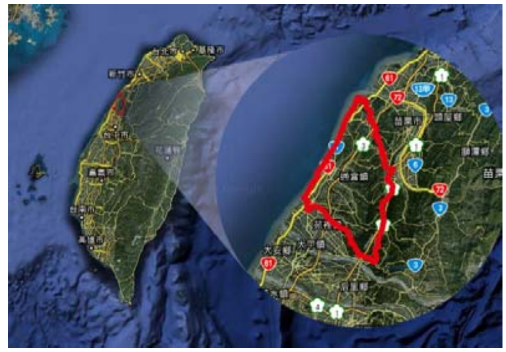


Figure 3 Location of Tongshiao Town

The scenic spots of Tongshiao Town were decided through two means: questionnaire and online statistics. The semi-open questionnaires were given to local seniors in order to find out the scenic spots of local characteristics, and meanwhile the scenic spots survey is also conducted on hot tourism websites; and the most representative scenic spot is concluded from the statistics of those two means, and then the collection of sound and image started officially. The questionnaires were distributed to 30 local residents and seniors who have lived there for more than 20 years and the distribution of questionnaire was conducted on the street in a convenient sampling manner. Three representative tourism websites were alos selected as the hot websites for survey (Taiwan Travel Information Net, Miaoli County Travel Information Net and Miaoli Travel Net). According to the result, the representative scenic spots are Flying Cow Ranch, Tongshiao Beach Resort, Mt, Hutou, Qiumao Garden, Salt Path, Tongshiao Shrine, Gongtian Temple, Taiwan Salt Factory, Tongshiao Thermal Power Plant, Flower Filed, and Coastal Windmills. Because of limits to environmental sound recording, only 8 of them obtained complete audio recording: A. Flying Cow Ranch, B. Tongshiao Beach Resort, C. Flower Field, D. Coastal Windmills, E. Tongshiao Salt Factory, F. Mt. Hutou, G. Qiumao Garden, H. Gongtian Temple. (Fig.4)

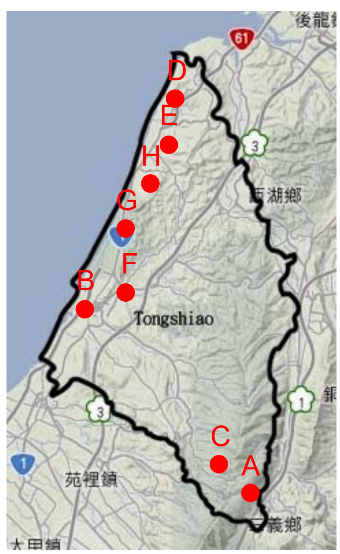


Figure 4 Location of Field Survey

Process

This study, mainly through means of literature analysis and interview, filtered the scenic spots of Tongshiao Town, Miaoli County and conducted field survey to collect visual and audio data in order to explore the interrelation between derivative human emotions and images of urban and rural areas, and proposed tourism promotions and marketing applications about the study subject's area employing characteristic text to create soundscape prototype, which can serve as a reference for future research on shaping the image of other urban and rural areas. The study's process is as follows:

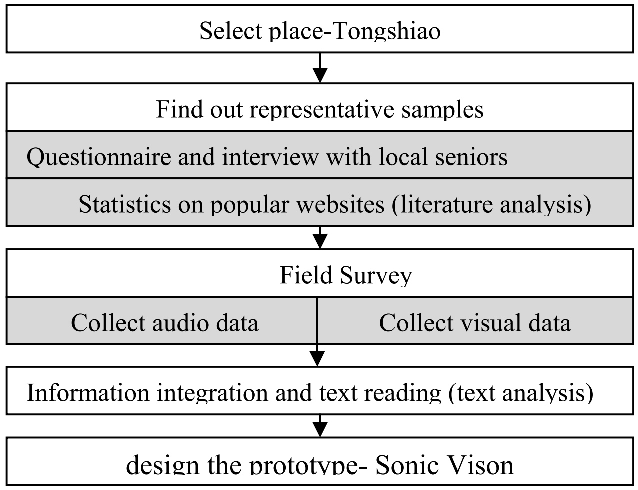


Figure 5 Structure of the study process

Analysis structure

As to the collection of sound and image, this paper directly observed and recorded in a manner of live field survey, where recording pens and digital cameras served as the collection means for this study to conduct collections of audio and visual data.

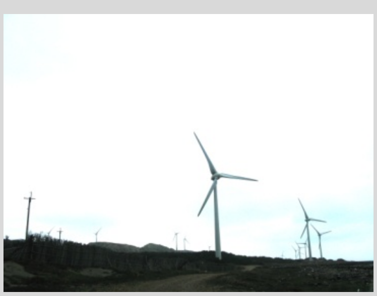
The study structure of soundscape proposed by Wang (2001) served as the analysis structure for data analysis. The ecological triangle of environmental ecology of Tilly (1974): human, space and activities, is employed to analyze social sound structure. Human serves as social actor, space serves as social container, and activities serve as social output. Since it is too narrow for human to serve as social actor of environmental sound, the data analysis structure of this study transformed the naming of human into social actor. Space stands for environmental sound in nature. Sound resulted form activities does not come from itself, a media is necessary for producing sound. This study employed social actor, space and activities as the horizontal axis for data analysis. The soundscape triangle developed by Schafer (1978) served as the vertical concept: soundmark, signal and keynote. The soundmark is a derivative word of landmark, which refers to the sound resource, and signal refers to the message transmitted by sound, and keynote refers to the representative sound or keynote sound in the environment. This is shown in the following table.

Visual Image	Ecological Triangle / Soundscape Triangle	Social Actor	Space	Activities
Fig.	Soundmark			
	Signal			
	Keynote			

Table 1 Soundscape study structure

Data Analysis

This study employed social actor, space and activities as the horizontal axis for data analysis. The soundscape triangle developed by Schafer (1978) served as the vertical concept: soundmark, signal and keynote. The soundmark is a derivative word of landmark, which refers to the sound resource, and signal refers to the message transmitted by sound, and keynote refers to the representative sound or keynote sound in the environment. This is shown in the following table.

Ecological Triangle Visual Image	Soundscape Triangle	Social Actor	Space	Activities
 A. Flying Cow Ranch	Soundmark	tourists, children, ducks, insects and birds	stream and forest	mowing, moving car, human activities and goat activities
	Signal	sightseeing area, recreation area and rural area	open, rivers and leisure	liveliness, human stream
	Keynote	tourists' voices, sound of playing children, duck quacking, insects chirping and birds singing	wind, stream murmuring and tree leaves rustling	sound of car, sound from mobile loudspeakers, sound of walking on the cobbled road and jingling of goat bells
 B. Tongshiao Beach Resort	Soundmark	tourists	rivers and sea	tide splashing
	Signal	sightseeing area	leisure, open, peaceful and comfortable	*
	Keynote	tourists' voices	wind, sound of sea, and river murmuring	tide splashing
 C. Flower Field	Soundmark	tourists, children, birds and dogs	wind	old motorcycle, moving car, mobile loudspeaker
	Signal	sightseeing area, recreation area and rural area	open	rural area, high mobility, liveliness and human stream
	Keynote	tourists' voices and birds sound	wind	old motorcycle sound, sound of car stream and mobile music
 D. coastal windmill	Soundmark	tourists, children, peddlers, insects and birds	Sound of wind and sea	spinning windmills, motors of peddlers, tourists walking, car moving, locomotive and camera
	Signal	sightseeing area, recreation area and rural area	open, broad, peaceful and comfortable	liveliness and beautiful scenic spots

	Keynote	tourists' voices, sound of playing children, of cries of peddlers, sound of insects, and birds singing	sound and wind and sea	windmills spinning, mechanic sound of windmills, sound of peddlers' motors, tourists walking, sound of cars and chugging-by locomotives
	Soundmark	tourists and children	thermal spring	*
	Signal	recreation area	leisure	*
E.Taiwan Salt Factory	Keynote	tourists' voices and the sound of playing children	murmuring of thermal spring	*
	Soundmark	tourists and insects	Wind	*
	Signal	sightseeing area, recreation area and rural area	open and mountains	*
F. Mt. Hutou	Keynote	tourists' voices and sound of insects	sound of wind	*
	Soundmark	tourists, children and peddlers	sea and wind	swing
	Signal	sightseeing area, recreation area and rural area	open, broad, peaceful and comfortable	happy tourists
G. Qiumao Garden	Keynote	tourists' voices, children's voices and peddlers' cries	sound of sea and wind	Swinging swing
	Soundmark	tourists, disciples and residents	*	people waking, sound of moving car, cup-dropping and paper-money burning
H. Gongtian Temple in	Signal	pious pilgrimage	*	sacrificing ceremony

Baishatun	Keynote	tourists' voices, disciples' praying and residents' talking	*	people waking, sound of moving car, cup-dropping and paper-money burning

Table 2 Study analysis of soundscape

In the table above, some blanks marked with * represent the state of silence rather than being drowned out by other louder sounds, which may render human unaware of its existence. In the following, the rural village soundscape of Tongshiao Town is summarized with characteristic illustrations of social actor, space and activities.

Soundscape of social actor

The social actor may cover orientations of ethnic group, class, sex and organization (Wang, 2001) including residents, tourists and the sound of animals. According to the background mentioned afore, since the population of Tongshiao Town outflows severely, only business talk is available in the scenic spot where collection is conducted, for example, the cry of peddlers. The tourist group is predominated by small families and lovers, and happy tone and sound of children's playing stand for the signal of sightseeing, which brings vitality and liveliness into the town. The sounds of insects and birds are the keynotes of the mountain area of Tongshiao Town, and as Tsai (2002) has proposed that people has a preference for sounds in the nature such as that of birds, cicadas, frogs, winds, stream, springs and stirring trees. Just as the relationship among sound, human and environment proposed by Shi (2004), Tongshiao Town possesses rich natural soundscapes, which will directly bring comforts to the locals and tourists, and then people will also feed back their happy feelings to the environment.

Soundscape of space

Space, as social container, covers natural or artificial structures, and the main study object is the soundmark of this place, which includes the sounds of sea, wind and stirring trees. The sound of water and sea is one of those important elements of soundscape in Tongshiao Town, and the connection with water is of quite an importance because that Tongshiao Town leans against the mountain and faces the sea with Taiwan being surrounded by sea, for example, there are murmuring streams in the mountain area, and the sound of sea and splashing tides in the coastal area. In the recent years, the beautiful coastal line has attracted many tourists and businessmen, which also invigorates the coastal line. In Tongshiao Town, the keynote of wind sound is loud and clear and the open rural area, comparatively low constructions and broad rural landscape together make it as reference note. And this broadness brings people with feelings of peace, leisure and comfort, and these special soundscapes of space have become unique to Tongshiao Town.

Soundscape of activities

Activities, as social output, cover various high-divided social interactions. The keynote of soundscape of activity in Tongshiao Town is the sound of human activities, such as traffic soundscape, tourists' walking, mobile loudspeakers, broadcast and so on. This activity soundscape refers to those continuously changing sounds in the environment, which bring the environment with different sound features. Besides, there are still other special sounds in the soundscape of activity such as sounds of spinning windmills and wind and sounds of cup-dropping of praying in the temple and paper-money burning. The windmill belongs to the wind power system established in recent years in a response to environmental protection, and there are about tens of windmills built off the shore of Tongshiao Town making special marine sight-construction. The cup-dropping sound and paper-money-burning sound transmit the local culture and belief and a grand sacrificing ceremony will be held annually in Gongtian Temple in Baishatun, in which the soundscape is much more multiple and abundant such as the firecracker sound and drumbeats. The traffic soundscape and the mechanic sound of motors are always classified as noise in the urban soundscape, however, the sound of car stream of traffic soundscape reflects the existence of mobility and vitality in urban and rural areas transmitting the signal of "sightseeing", and from the perspective of environmental marketing, the soundscape, a non-physical exchange object, will transform the sound deemed noises from negative exchange phenomenon to positive exchange phenomenon of environmental resources so that the environmental noise will be of a positive image. The continuously changing sounds in rural activities beautify the countryside just like the cosmetics do.

Prototype design of soundscape for shaping regional image

This study designed the prototype with an attempt of shaping regional images with soundscape concept surpassing previous regional image shapings, which only employed vision-oriented products, and soundscape researches, which only employed auditory perception. The making of this prototype combined senses of sight and hearing so that the regional image shaping products can make the browsers experience personally, provide the region of study object with sightseeing promotion and marketing application and serve as reference for future researches on shaping the image of urban and rural areas.

The elements for making this prototype are divided into two groups. One is audio elements and the other is visual elements, which are kept as original as possible. The audio elements come from the live recording of field survey, and although the field recording of one scenic spot is conducted in several places, the representative sounds of each scenic spot mentioned afore are mixed into one sound track during the making of prototype sound, which will become the representative soundscape of that scenic spot. The visual elements are constituted of pictures of field photographing without many special effects added or other treatments and they are shown through revolving playing.

The form of presentation of prototype design employed the website as the platform in order to attract more browsers through its convenience and interaction. The map of Tongshiao Town is used as the background of the page with specific scenic spots scattered in different areas and there are guide buttons on scenic spots for the browsers to click upon and on clicking, the sound of the scenic spot is played first and then the revolving play of visual pictures followed. The creation of prototype is dedicated to timeliness and spatiality and the browser can not see the regional image immediately as the webpage opens so that with the timely combination of hearing and sight on clicking, the total impression during that time can become the image of that area. It is difficult for people to experience personally because of the usual depth of field of flat vision; however, with the key characteristic of spatiality, the sense of space is created by sight and sounds.

webpage	Webpage design	Comments
logo		Logo Sonic Vison

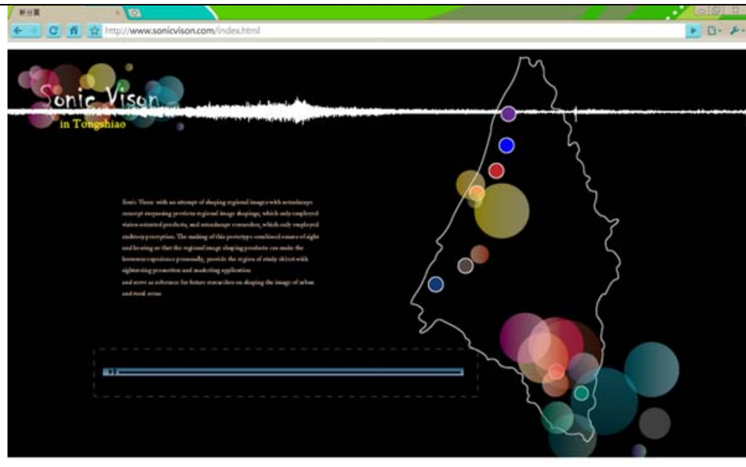
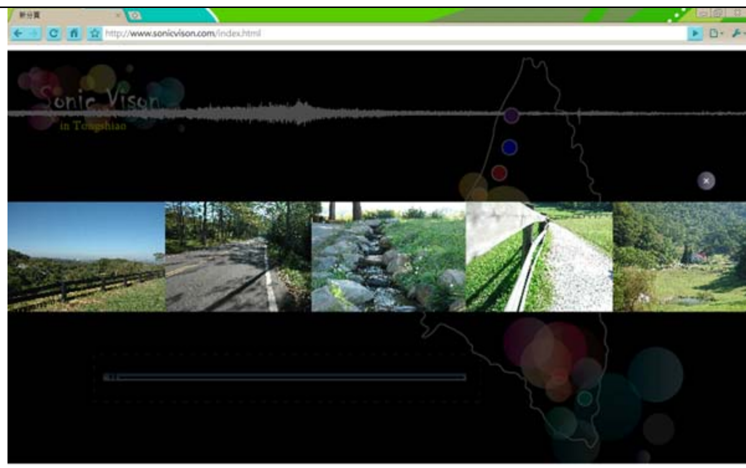
homepage		Index Sonic Vison
homepage guide		There is spot can guide user to chick.
revolving play of visual images		The sound of the scenic spot is played first and then the revolving play of visual pictures followed.

Table 3 Design of image commentary

Conclusion

Because of the preference for visual culture, more attention shall be paid to auditory feelings, and the missing of either will render the environment unnatural and audio orientation and visual orientation shall coexist with each other in the study of urban and rural soundscape. In the city, different groups develop different images based on their own social lives and it is a must to master the nature of social experiences in order to know the structure of mutual urban and rural image and the urban and rural citizens develop not only memories but also emotions about the place and only the combination of urban appearance and personal and communal ideologies can make the urban and rural image. It may require three important variables to explain the difference in environmental perception: social group values, life-style and culture, therefore, the discovery of urban and rural images must start from the viewpoint of human and then study the reflection of values of local groups and humanity history on the perception and image of the environment. As the study developed, it found out that the study subject, Tongshiao Town of Miaoli County, although being a town “leaning against the mountain and facing the sea”, does not view this characteristic as a focus of marketing in the urban promotion and this paper has revealed the characteristics of mountains and sea in order to make marketing effects.

Since the image and characteristics of one region shall be jointly shaped by the locals and external tourists, it is suggested in this paper that in the future, the opinions of the locals and tourists be considered, and to discover the urban and rural image through the integrated analysis of residents and tourists. To sum up, the future executive direction of this study will be: to verify and modify this prototype with depth interviews with the residents in the hope that the soundscape shaping, through the effort of this study, the plan of local governments and cooperation of associations in place, will actively conduct the marketing and promotion in a direction suitable to the town itself and show a better urban and rural environment after follow-up implementations and this paper can also serve as the reference for future researches on shaping of other urban and rural images.

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Consultancy designer involvement in new product development in mature product categories:

Who leads, the designer or the marketer?

Abstract

This research sets out to uncover how design is contributing more intensively to new product development. More precisely, it aims to understand the growing involvement of designers, and in particular consultancy designers, in NPD in mature product categories. The study seeks to build on recent evidence of design taking a greater leadership and strategic role in new product development, particularly in embracing the theory and praxis of the discipline of marketing.

The research methodology involved a quasi-ethnographic case study within a medium-size, internationally focused design consultancy undergoing significant transition. Three key areas/themes mediating designer involvement in new product development emerged in the findings: (1) a broadened designer remit, (2) the importance of consultancy-client relationships, and (3) a performance-design tension. If design consultancies take greater leadership in NPD, new marketing-related competencies will have to be adopted by designers, designers will have to be more sensitised and knowledgeable about the types and intensities of consultancy-client relationships, and designers and managers will have to actively manage the sometimes contradictory tensions between design integrity and commercial hard sell.

Keywords

New product development; design strategy; design process; consultancy design

Product design has its roots in industry (e.g. Heskett, 2001; Sparke, 1983), yet the role of design and designers in new product development (NPD) has always been problematic and complex in its approach, and in the extent of its involvement (Jevnaker, 1998; Leenders et al., 2007; Murray and O'Driscoll, 1996; Veryzer and Borja de Mozota, 2005). Recent evidence from the literature suggests that the role of designers in NPD is becoming more strategic and that design is taking a leadership role (Perks et al., 2005). That reorientation is the focus of attention of this article.

Design involvement in NPD

The integration of industrial design in business practice has been empirically examined extensively, especially over the last decade, in a range of domains: for example, (1) its impact on company performance (e.g. Gemser and Leenders, 2001; Hertenstein et al., 2001, 2005; Olson et al., 1998), (2) international performance (e.g. Ughanwa and Baker, 1989; Walsh et al., 1992), (3) management of (e.g. Borja de Mozota, 2003; Cooper et al., 2003; Leenders et al., 2007), (4) as strategy (Liedtka, 2000), and (5) its link to other functions (e.g. Bruce and Daly, 2007; Jevnaker, 2005; Martin, 2007). Of particular note is Jevnaker's (2005) study of 'outlying' design-business relationships in innovative companies whose success is concluded to owe much to their championing of design. These studies drive to understand the contribution of design to business: all point towards design as a 'strategic tool' (Kotler and Rath, 1984) of increasing value.

Despite these credentials, the disconnect between the design and business pairing runs deep (Martin, 2009), partly down to design's interest in the future and the unknown, versus the preference for predictability and logic in the commercial context. However, it has been suggested that the couple are more convergent than divergent (Borja de Mozota, 1998) – both are concerned by people, and must creatively solve 'wicked' problems (Rittle and Webber, 1973). Their methodological approaches, however, are fundamentally different. Designers generally work intuitively, while managers seek systematic logic and minimisation of costly NPD risk. A recent trend has championed the harnessing of design skills ('design thinking') for business (Boland and Collopy, 2004; Brown, 2008; Martin, 2009).

While the product development and design management literature remain divided between 'systematic' and 'intuitive' approaches to design, neither the systematic nor intuitive paradigms alone are responsive to the requirements of designer and manager alike. Martin (2007; 2009) suggests the optimum solution is a 50/50 balance between managerial 'reliability' (consistent, replicable outcomes founded on methodological rigour with the goal of risk minimisation), and designer 'validity' (meeting the objectives of the future, using judgment and bias in order to produce relevant products).

As design becomes more prevalent, organisations are increasingly turning to it to add value to the basic product offering. It is not novel that design can add value at levels greater than solely product aesthetics (Cooper and Press, 1995; Murray and O'Driscoll, 1996), yet few organisations are adopting a product strategy which integrates design from the outset of NPD.

Since paths of NPD are underpinned by firm focus and strategy, this focus determines who has the definitive input in NPD: the designer or the marketer. In 'evolutionary' firms (Borja de Mozota, 1998) a traditional genre of business leaders are dominant, and consider design an 'add-on' to existing practices, even despite the modes of integrative NPD fashionable during the 1990s (e.g. Hart and Baker, 1994). In the quest for reliability, design expenditure must be justified to eliminate risk. In contrast, in 'revolutionary' firms, design is wholly recognised and integrated. Design processes are less quantifiably rigorous, and more dependent on designer intuition. A review of the literature suggests two polar modes of NPD: marketing/business-led NPD, and design-led NPD (Table 1). This classification develops Borja de Mozota's (1998) distinction between the evolutionary and the revolutionary organisation.

Table 1: Polarity in NPD

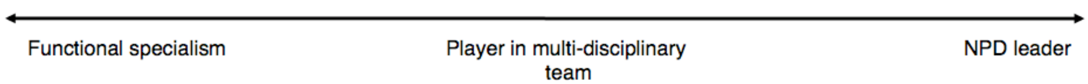
Marketing led / business led NPD	Design led NPD
Systematic approach	Intuitive approach
Design as a functional specialism	Design in leadership role
Designer is a 'small' player in a multidisciplinary team	Designer has pre-eminent role in a multi-disciplinary team
Idea sourced from consideration of business issue/emergent technology on behalf of trained designers	Idea generated from unknown depths of designer mind
Combined effort of team of specialists in a range of fields	Design has final say
Product functionality is key	Functionality and aesthetics balanced
Planned structured process	Intuitive, serendipitous discovery path
Solution emerges from problem definition	Co-evolution of problem and solution
Detailed market research	Serendipitous, experiential research
Later designer engagement to solve pre-determined problem	Early design engagement
Limited designer involvement	High designer involvement

Source: Developed by the authors from relevant literature

Both NPD and modern day industrial design are extremely complex and multifaceted, involving increasingly large numbers of stakeholders. While a recent study describes a move from marketing led to design led NPD (Perks et al., 2005), there is shortcoming as to design's role in the NPD and design management literature. Jevnaker's (2005) research laid the foundations of comprehending how designers work for manufacturing firms and identified relational and activity-based capabilities embedded in the firm side. However, empirical data on how design plays a role in NPD remains limited (Kim and Kang, 2008).

Perks et al. (2005) suggest that industrial design is gravitating to the role of NPD leader. Whilst traditionally design is a final, surface-deep NPD add-on, since the 1990s design has transitioned to player in a multidisciplinary NPD process. Moreover, a handful of companies, the authors suggest, are becoming led by design from the outset of NPD. This can be mapped on a continuum (Figure 1). This research, therefore, seeks to better contextualise the developing right side of the continuum. To understand the nature and level of changing design and designer involvement in NPD, the research focuses on the design side involvement.

Figure 1: Design involvement continuum



Source: adapted from Perks et al. (2005)

NPD in mature product categories

Processes of NPD differ depending on the type of product category being created (Trott, 2001; Veryzer, 2005). Classifications of product categories have been offered by, for example, Ansoff, 1965; Booz et al., 1982; Hart and Baker, 1999; Johne, 1995; and Trott, 2005. The Booz, Allen and Hamilton (1982) classification proposing six grades of product development is widely accepted in the NPD literature: just one of the six categories – new to the world products – involves radical innovation. Trott (2001) identifies 'discontinuous' (high-tech, innovative and radical products) and 'continuous' (additions and repositioning of mature products), and notes that only ten percent of all products can be considered discontinuous and technologically innovative. Hence, the majority of product development that takes place is not 'new', but falls into continuous, mature classifications.

The development of continuous products requires the revision of existing products, or replication of an existing technology (Veryzer 1998). Unlike high levels of risk in discontinuous NPD, due to sudden leaps of intelligence (Kim and Mauborgne, 2005) and the collaboration of a range of disciplines (Veryzer and Borja de Mozota, 2005), continuous NPD is the result of incremental progression, and gradual accrual of market research and intelligence. Development of these products is less reliant on frame-breaking technological innovation and scientific know-how, and more so on marketing and design, and the interactions between these disciplines. Thus, this research focuses on the role of design and designers' involvement in NPD in mature, continuous product categories, rather than in discontinuous ones.

Consultancy design and NPD

In-house versus outsourced

When it comes to the role of design in NPD, such design activity can be carried out in-house, or it can be outsourced, or a combination of both (Bruce and Morris, 1995). The choice of approach has been suggested to affect courses of NPD and product success. Outsourced design, external to the firm, is the most common approach (Press and Cooper, 2003), and can occur where a lack of resources or belief prevents investment in design (Walsh et al., 1992). However, the outsourced approach is generally considered to be more dynamic: consultants external to the firm have the ability to continually input fresh ideas (Bruce and Morris, 1998a; Lorenz, 1990; Walsh et al., 1992).

In contrast, although in-house design connotes top management support, buy-in and design recognition, specialised design teams can be weak, bureaucratic, and suffer from stagnation (Bruce and Morris, 1998a). Internal design usually exists attached to R&D and engineering teams: where many disciplines have input, NPD can be complex and problematic (Veryzer and Borja de Mozota, 2005). However, analysis of external consultancy design offers the potential to isolate the richness of interplay between the design and marketing functions. This isolation of the design-marketing interface makes for a more interesting dynamic which is rapidly evolving since consultancy designers must pitch for new work.

Types of exchange

Evidence from the literature suggests a spectrum of types of consultancy-client exchanges. For example, the relationship between client and consultancy can be enduring and close (a ‘family’ approach), more distant (‘arms-length’) or one-off (Bruce and Docherty, 1993). Bruce and Morris (1998) distinguish types of client-designer relationships based on duration and proximity variables. Since proliferation of many small, specialised design consultancies (Press and Cooper, 2003) has extended the reach of design expertise, firm focus can determine the use of one-off exchanges with a range of suppliers, or the construction of a more enduring partnership with one consultancy. Issues of trust affect the client-designer relationship: the withholding of sensitive information on the part of the client affects the course of NPD (Bruce and Morris, 1998b). However, where partnerships and trust build over several projects, research suggests that switching costs can become high. That long-term relationships evolve on a ‘learning by doing’ basis (Jevnaker, 1998) means that long-lived exchanges can become a competitive advantage (Bruce and Morris, 1998a).

This research, in focusing on consultancy designer involvement in NPD, gives the potential to look at a range of design situations, and design-client interactions, and renders it a rich and valid context in which to explore the role of design and designers in NPD. Jevnaker’s (2005) influential research, cited earlier, of the design-business relationship, studied companies using consultancy design. This research therefore focuses on the involvement of consultancy designers in NPD in mature product categories.

Methodology

That empirical evidence on this phenomenon is limited has implications for the research methodology. Since extant research is thin, an interpretivist, discovery-driven approach was necessary (Brannick and Roche, 1997) to be able to address the research issue (Easterby-Smith et al., 2002). The interpretivist paradigm, it is suggested, is more applicable to the discovery-driven research aims of the study in hand: its focus lies in being to understand what is happening in a given context (Carson et al., 2001). As such, a case study, with its naturalistic setting, quasi-ethnographic stance, and ability to offer contextual richness (Yin, 2003), was considered the best methodological approach for this exploratory research: the case approach enables an evolutionary development over time (Carson et al., 2001). It also holds the capacity to build theory (Eisenhardt, 1989), and therefore to enhance research contribution. The collection of context-rich, empirical evidence can assist in improving design practice (Tzortzopoulos et al., 2006).

An industrial design consultancy, Design Partners, was selected as the central research site. The consultancy was known to be in an interesting time of transition as it sought to reorient itself in the challenging economic climate of the post-Celtic Tiger. Established over 25 years, and employing 30 design professionals, the consultancy is the largest of its type in Ireland. It has prototyping and workshop facilities on-site, as well as office and meeting space. The consultancy works with a range of well-known international clients in consumer products, including Palm, Terraillon and Logitech. Designers often travel internationally to meet with clients, prospective and existing, as well as to suppliers and manufacturing facilities.

The lead researcher spent six weeks embedded in the firm in summer 2009, carrying out quasi-ethnographic observation and semi-structured interviews with designers and management. A rich qualitative dataset was collected from the case notes and diary kept by the researcher. It is based on quasi-ethnographic observation, informal conversations, and attendance at company and client meetings. Eleven interviews with staff were recorded and transcribed. Interview topics were accounts of participation in recently completed projects, liaison with clients and colleagues, and changes in job description. The firm was found to be in an interesting period of transition, between marketing led and design led. A studio in this position has yet to be empirically examined in the literature.

Findings

The consultancy was found to be in a period of significant flux, moving from a situation where the client ‘called the shots’, often based on uni-dimensional market research, towards one where the design studio sought to win greater involvement in NPD. Reorientation from a passive, and often late, role in NPD towards one of fuller leadership and greater input is a central feature of this research, and marks the shift from ‘evolutionary’ to ‘revolutionary’ (Borja de Mozota, 1998), and from marketing led NPD to design led NPD.

The findings corroborate Perks et al.'s (2005) proposition of the increasingly influential role of design in NPD. In charting the shift from designers as followers to designers as leaders, three major themes emerged steering the transition: (1), the broadened remit of designers, (2) the impact of client-consultant relationships, and (3) the design-performance tension. The effects of each of these are described.

Broadened designer remit

A significant amount of conventional design work was gravitating towards business analysis and marketing conceptualisation. To that end, the consultancy team, previously comprising only design and administrative staff, was tentatively recruiting marketing and business development personnel. The company's new mantra was to "manifest our clients' brand through great product design", signifying an underlying business-driven purpose.

This shift in direction marks the movement from the designer's role as a mere service provider to one of design authority. As such, the remit of the designer was broadening to encompass a complex cross-fertilisation of the activities of design and marketing.

The designer-marketer

Designers were *au fait* with the language and craft of business, and in particular marketing. In a number of ways, the designers used this accruing expertise to strategically take a greater degree of responsibility for the development process. This meant that design roles were greater than just the functional and the aesthetic: designers also imbued commercial and strategic value in concepts and products.

The reorientation towards strategic, conceptual, analytical work was evident in many ways. Designers commonly dissociated their work from simply product form, adamant that their task was more than just having ideas; or as one junior designer put it: "our job isn't just to draw pretty pictures" (D2:7). Rather, all design concepts were accompanied by 'stories'. Stories were the marketing propositions around which the design became valid in its commercial context. A senior designer described his job as being to create a tangible marketing vision:

> we're being asked for the emotion and the spirit and the big story, and the strategy to link much more with marketing so that the vision that marketing have for a product, that doesn't exist yet, is embodied when the designer starts to make the product tangible (D6:11)

In conceiving a story, designers engaged in a high level of analysis on product, user and brand, and in doing so, again exhibited the skills and tasks normally adopted by the marketer. Moreover, that the designers themselves undertook research enabled further immersion in the project. Presentations showed that brainstorming normally yielded around four keywords which designers used to encapsulate the ‘spirit’ of the project. This meant that all concepts followed a specified set of values, and this was important for designers.

Identification of customer segments and their needs was another area for which designers took responsibility in concept development. These studies were so in-depth that clients listened as designers explained their propositions. Target user groups and their motivations to purchase were dissected, accompanied secondarily by design ideas and sketches. In this approach, the designer’s natural instinct to create directly according to user needs is enhanced by an entrepreneurial approach to product development. In the quest for relevant product design, the designer’s attention to market segmentation extends the traditional scope of design training.

Designers manoeuvred strategically to guide clients. At concept selection, guidance was offered by tactical selection and ordering of the presented ideas. For example, ‘sacrificial concepts’ were included to emphasise relevance and features in other ideas. By having identified and created a vision for the product, concepts were so honed that rarely were more than six presented. Noticeable also was the reliance upon verbal communications in ‘selling’ the vision encapsulated in each concept – models and sketches were only an aid in convincing the client.

However, that strategic manoeuvring was required at all was down to the design-marketing disconnect. Designers usually possessed intimate knowledge of the client brand, having participated in its creation. However, where advice based on sound judgement was rejected, designers were left frustrated. In some cases, client preference for hard data, choice, and extra research resulted in reluctance to buy-in to ‘spin’. Tensions arose when the designer felt he/she was merely fulfilling a service providing role, rather than being considered an authority on design, design process and brand.

By embracing, and adopting the culture, language and activities of marketing, the designer attempted to foresee and combat this disconnect. For instance, that no sketches were produced without having a marketing story was intended to assert, and make palatable for the client, the product’s market relevance. Designers still found hardship in justifying gut-instinct, and this was often frustrating.

However, the strategic, tactical and analytical aspects to the role, described here, show that designers are assuming extra responsibility in product development, and are fulfilling part of the traditional role of marketing. Ironically, the consultancy’s embracing of the culture of business was enabling the clients’ NPD processes to become more ‘design-led’. By default, designers have an enlarged sphere of influence, and move roles from service provider to design authority.

Consultant-client relationships

The consultancy has two significant, global clients with whom the relationship had begun in the 1980s, along with a number of smaller, newer international and local clients. The extent to which extra responsibility, leadership, could be successfully assumed depended, in a large part, on the relationship between designer and client. These relationships were tailor-made, and determined the extent and timing of involvement of designers in NPD. Different types and intensities of relationships were observed.

Importance of ‘chemistry’

That a firm is only as strong as its people is a philosophy resonant at the consultancy. Great caution was exercised to ensure that the ‘right’ designers were assigned to the ‘right’ projects. Personalities and chemistry clearly influenced the course of product development, corroborating the research by Bruce and Morris (1998a). Designers were all client facing, even those most junior members of staff.

The consultancy’s approach to business was transparent and honest, built on warm personal relations – a ‘family’ approach (Bruce and Docherty, 1993). The consultancy ‘courted’ its clients by, for example, organising extended business trips for bonding. This fostered repeat business, and positive recommendations, and had allowed the business to grow. Relationships were ‘marriages’, one manager pointing out that the clients ‘love’ the consultancy for its approach: for the client, a smooth, efficient development process is as memorable as a successful product outcome. The designers’ quest for ‘great’ product design ultimately underpinned their goals for relationship formation. For them, relationship quality was linked to the product outcome. The closer the ties, the easier the process of communications, the better the product outcome.

Relationship asymmetry

Relationships were of paramount importance due to the typical closeness of collaboration. However, relationship intensity had the capacity to blur the boundaries between design teams and client teams, and the parties became interdependent. This had repercussions for the nature of the collaboration: in some ways, designers were more liberated to take control of the design process. For example, where relationships were intense, warm and enduring, designers understood the client brand so intimately that it was not uncommon that briefs were written by the consultancy to be vetted by the client.

However, the symbiosis was, on occasion, asymmetric: the consultancy was treated as an in house resource by significant clients, and in this instance, was taken for granted. For instance, the consultancy regularly undertook extra work for the same fee, agreed to unfeasible deadlines, and designers were always available by telephone or IM (instant message) contact.

Naturally, the development process was affected by these relationships - some designers considered that these blurred boundaries produced the best design results. However this considerate, honourable and respectful approach exposed a sense of ambiguity within the consultancy. That design was ‘selling’ was regularly reinforced by management at company meetings, yet relationship asymmetry prevented greater self-assertion on the part of the consultancy design team. This was often a source of internal tension.

The design-performance tension

The extension and increasing complexity in the role of the designer is accompanied by a set of designer and consultancy tensions. Designers acknowledged and actively embraced their adoption of the role of marketing. However, the consultancy’s state of ambiguity – service provider versus design authority – caused tension.

Designers were meticulous, almost to the point of being pedantic, about the miniscule detail of their designs. One senior designer confided that his colleagues “really care about what they’re doing, and they love what they’re doing” (D4:12-13). Designers managed their own time and budgets and were therefore responsible that projects came in on time and on budget, and this work-integrity meant that working hours regularly stretched beyond 6pm, sometimes into the night. Compromise of design ideals therefore becomes a dimension of the job.

Necessity of compromise meant that the ingrained passion and quest for ‘great’ design appeared to only to last so long. For some, often more senior, designers, there was little attachment to the hundreds of designs churned out. One senior admitted to not owning anything he had designed. In contrast, for those more junior, projects and completed products were compared to offspring.

Designer salesman

As previously noted, designers sought to convince clients of concept validity, and models and sketches were only one tool in achieving this objective. More and more, the idea of the sales aspect of design was becoming of paramount importance. The ‘sales pitch’ was a performance, crystallised during client contact. One junior designer described his job as equivalent to sales:

> basically what we do every day is sell our insights, sell our thoughts, our designs our sketches, our renderings and our skills (D2:14)

To that end, designers were savvy about the world of business. Many spoke in the language of the marketer, and demonstrated an acute understanding of the hierarchies and political processes common in large corporations. Yet the job was regularly compared to artistic performance - musical, sporting and theatrical. The nature of the design performance is troubled in its paradoxical quest to marry, by process, a fusion of the irrational aesthetic and functional, with the rational business objectives.

Tension and disillusion

Recognition of the client quest for increased revenue from design resulted in an uneasy tension between the business of design, and the creative, liberal, right-brain attitude of designers passionate about the work that they do. A senior designer was disillusioned about the notion of being 'design-led':

> Sit in on client meetings and you'll see interaction of how things become design-led…but it's actually money led (case diary, 9/4)

Frustration regarding compromise and short client reins resulted in jadedness and intense disappointment, not in their current positions, but in the nature of the profession as a whole. It manifested in the realisation that clients recruit them not for the sake of 'great' design, but for the purpose of revenue and increased profit margins. The bottom line was that design is business.

That the individual is responsible and personally attached to the work is a characteristic of the service provider. However, the firm sought to meld, depending on client, both service providing activities and exercise authority as a consultancy, which brought a lack of clarity in internal and external perceptions. In some ways, designers were essentially service providers, and engaged in an elaborate performance, orchestrated to convince the client of validity of propositions. However, in other regards, the designer was a consultant, and acted with authority, guiding the client based on respected expertise.

Conclusions

This research seeks to examine the growing involvement of consultancy designers in NPD in mature product categories. The paper's subtitle asks who leads this new development process – designer or marketer. In an era when design, its uses, its tools and its organisation are taking on an increasing complexity, there is emerging evidence of design embracing a greater leadership role in new product development. Three important areas mediating designer involvement emerged in this study.

First, across the NPD process, designers regularly undertook tasks beyond the traditional realm of design, in line with the conclusions of Perks et al. (2005). More and more, however, they encroached upon the role of the marketer. By adopting these tasks, designers assumed a crucial role in NPD, and extended their responsibility: designers guided clients, and this meant increased control of NPD. Such was the scope of change in the remit of the job, designer competencies had to evolve in line. Fluency in communication and management skills were becoming a necessary complement to traditional design training.

Second, the constellation of the consultant-client relationship emerged as a significant factor mediating designer involvement in product development, developing research by Bruce and Docherty (1993). This chemistry also had the scope to influence quality of the design outcome. Relationships of varying closeness and intensity were observed, and in some cases, an asymmetry – where the relationship became overbearing and ambiguous – left the consultancy in a weakened position.

Third, the reorientation often left designers frustrated, even disillusioned, as they struggled to come to terms with their new role. Designers were required to at once provide a service, and exercise design authority. As they sought to pander to the client's business sense, the personal goal for 'great' design was compromised. This brought tension, especially for those more experienced, in the new direction of the profession.

The seemingly contradictory opposites in the designer's remit – design versus marketing; synthesis versus analysis; doing versus thinking; leading versus following – indicated the challenges to the discipline in its state of flux. While paradox is often interpreted as imposing a simple 'either-or' choice between polar opposites, a more inclusive notion posits that, in a 'both-and' approach, we can acknowledge and better cope with the ambiguous, complex and diverse nature of business and organisations (O'Driscoll, 2008). For design, with its multitude of facets and new challenges, this is a valuable proposition. The early embracing of the language and craft of marketing has enabled designers to reorient themselves into a more powerful and increasingly knowledgeable position, and in doing so, they have assumed a degree of ownership and responsibility outside of the traditional sphere of influence.

However, to fully utilise the potential of this transition, to assume greater credibility and recognition in business and NPD – for example, design representation at board level – these tensions need to be fully addressed, managed, and resolved. Where relationships are crucial, where designers are marketers, the researchers suggest an urgent and widespread need for designer (re)training to be able cope with new and increased demands. As the design-thinking literature suggests, the discipline has a widespread applicability, and potential (Borja de Mozota, 1998; Martin, 2009), and the task now is to educate and enhance its reach. Further research – charting greater designerly contribution to NPD, comprehending how designers may have a more holistic impact upon both product strategy and product function, and exploring how design activity may be more usefully integrated into organisations – is required.

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When artists and designers inspire collective intelligence practices: Two case studies of collaboration, interdisciplinarity, and innovation projects

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Abstract

Current mainstream collaborative processes and practices are not always fit to deal with the complexity of our society and the problems it generates. The lack of complexity-based practices for empowering collective intelligence conditions makes it difficult to address and solve intertwined multi stakeholders situations. As a disciplinary attitude can rarely succeed to solve complex and wicked problems, there is relevance and a need to question today's mainstream approaches to collaboration and innovation. We explore this issue by asking how design can be of help to lead this reflection and to translate collaboration into pragmatic activities. We propose that by focusing on a constructivist paradigm and an interdisciplinary approach, collective intelligence can be constructed. It will then generate new ways to address complex situations.

To support this, we draw from two interdisciplinary projects done in two organizations where collaborative design has translated into various social practices. In one case the creative process involves artists and managers, in the other, collaborative reflective practice within an HCI project brings stakeholders to focus on a human-centered approach to design and sustainability. We examine how design has in each case been of help, and finally, we conclude by presenting pragmatic ideas easily translatable into guidelines for fostering collective intelligence.

Keywords

Collaboration; Interdisciplinary; Complexity; User-centered approach; Project-grounded approach; Collective intelligence; Innovation.

The issues the world has had to face in the last decade have become increasingly complex, global, and interdependent. When social, political, economical, or organizational problems prove to be intertwined, the communities at stake still largely address these issues with abilities based on XXst century disciplinary methods and tools.

In such a context, counting only on disciplinary problem-solving approaches is thus inadequate to address the complexity of the global and emerging issues in a long term, responsible, and sustainable perspective.

This decade has also seen an increase in social movements claiming for recognition, expecting to take part in the reflection, and in the design of solutions as recognized stakeholders. Groups have become active, exercising ownership and willing to commit. This call for participation from various lobbies and communities has become vocal, putting pressure not only on governance but also on methods and tools to negotiate participation and problem solving. Thus collaboration has now become mandatory and unavoidable. Consequently, the abilities required to engage in this perspective of collective intelligence are becoming central to foster innovative solutions for complex problems.

While short-term, narrow sighted solutions are still often privileged over long-term commitments, the complexity and pervasiveness of today's issues call for questioning XXst century methods, as well as their underlying epistemology, which have shown their limitations.

Encompassing collaboration, shared goals, and processes, the concept of collective intelligence is a helpful paramount construct, useful to translate what we pose as being a desired outcome and a nurturing context to address complex and wicked problems from an interdisciplinary perspective. This being posed, what are the core practices that can be associated with it? What are the conditions that support the emergence of collective intelligence and, more specifically, how is collaboration embodied? While technology, organizational and interpersonal communication, creativity and facilitation skills come to mind as some key dimensions to consider, for the purpose of this paper, we limit the scope of the exploration to the contribution of design. The central question of this paper then becomes **how design can be of help to lead this reflection and to translate collaboration into pragmatic activities**. To answer this question we will explain how we relate 'collective intelligence' to 'design' and 'innovation', considering collaboration as the key process leading to the construction of collective intelligence, in an innovation context. We will illustrate this by drawing from two interdisciplinary projects done in two organizations where collaborative design has translated into various social practices. Before providing answers to the research question, we will examine how design has in each case been of help, and finally, we will conclude by presenting some pragmatic ideas easy to translate into guidelines to foster collective intelligence.

Is collective intelligence something to design?

For Morin and LeMoigne (1999), complex thinking is essentially dealing with uncertainty by providing clarity to the strategies human beings put forward to address today's world. Complex thinking is able to *design* complex social, human and technical systems like organizations. Complexity is also the ability to bind, bridge, and connect, to put in context, to globalize while recognizing singularity, uniqueness and the concrete aspects of a phenomenon. Based on this definition, design can naturally be considered a relevant approach to address the collective phenomenon of collaborating. With the development of information technology, an interest in the active user and in activity theory also grew. The designers of human computer interfaces (HCI) found themselves confronted with new demands of users, which were created by the evolution in Information Technology (IT), and by the lack of performance of the classic engineering-type interfaces (Linard, 1998; Norman, 1988; Winograd & Flores, 1986).

While multidisciplinarity addresses the study of a same disciplinary object by different disciplines or domains, interdiciplinarity aims at transferring methods from one domain to another. Nicolescu (2002) shows how interdisciplinarity triggers innovation inside and across domains by making possible new applications, epistemological reflections, and even the emergence of new domains. By considering design as the method shared between domains we are able to see how collaborative practices are enacted in different domains, as the two cases presented hereafter will illustrate.

For the purpose of this paper, innovation is seen as the key motivation and context, and we refer to Lawson (1984) who compared students from architecture (design discipline) and science (non-design discipline) and concluded that designers are 'solution-focused' whereas scientists are 'problem-focused'. In other words, innovation is seen as new and creative solutions found by design teams when attempting to solve complex problems.

Practice-based knowledge differs largely from academic theory-based knowledge in its production process. Where academic knowledge is mainly mono disciplinary, practice-based knowledge is multi and inter disciplinary, and co-created by the communities to whom it is relevant. Focused on finding complex solutions for complex problems, practice-based knowledge assumes a close collaboration between all actors. Many (Carroll 2000, Löwgren & Stolterman 2004, Findeli 2008) suggest that design focused on human beings could constitute an ideal collaborative research mode to create innovative systems.

Considering complexity, humanism, and action based learning as the grounding epistemology for the research presented here, the concept of design translates itself into methodology, problematic, products, and impact (LeMoigne, 1994; Findeli, 2001, 2008). Accordingly, collaboration embodied as practices -which are enacted through an inner posture, attitude, and processes- is the conjunction and meshwork of talents from different fields and disciplines. These practices are anchored in an asserted humanistic perspective, valuing collective and personal responsibility and ecosystemic sustainability. Thus, collaboration is a process where individuals and groups engage in collective thinking and action for the common good.

In a variety of fields, such as building design, human computer interface, artistic-creative processes, it is recognized that to solve complex problems an efficient form of collaboration among all actors involved is needed; the knowledge for problem solving lies in the interaction between actors rather than in a collection of many individual expertise. Thus, collaboration depends largely on social skills, the ability and the will to share knowledge, leadership skills, and the aptness to act collectively in an intelligent manner, as birds in a flock do, in synergy, contributing to the knowledge flow. This flow (Csikszentmihalyi, 1996) is neither planned nor conducted, it emerges from a collective body sensing situations and reacting to them organically. This collective learning process depends on the perceptual acuteness possessed by each member of the flock, its ability to feel, anticipate, and adjust. Encompassing all the skills and abilities described here, the concept of collective intelligence provides a useful understanding of the phenomenon of purposeful collective interaction. We will refer to this as “*the capacity of human communities to evolve towards higher order complexity and harmony, through such innovation mechanisms as differentiation and integration, competition and collaboration”* (Por, 2008).

Considering human collective intelligence, in the area of HCI for example, interfaces are traditionally designed through a technology centered approach using problem solving methods (Carroll 2000, Dourish 2004). But for almost a decade now, user centered approaches have been thoroughly researched (Dourish 2004, Löwgren & Stolterman 2004) and it is accepted that to develop HCI, collaboration within a multidisciplinary team is crucial. However, in practice, we continue to recognize that HCI specialists, mostly computer scientists and designers, have a different understanding about users’ interests and needs. So design practitioners encounter conflicting situations, meaning, it is difficult for team members to create a shared understanding about the needs and motivations of the end-user.

Needless to say these situations are complex ones. Current mainstream collaborative processes and practices are not always fit to deal with the complexity of our society and the problems it generates because the solutions invoked to solve such problems have themselves been designed *within and from* a much simpler and more controlling view of the world, as Boulding’s nine levels of complexity model suggests (Pondy & Mitroff, 1979)[1]. This absence of complexity-based practice as mainstream collective intelligence empowering conditions draws our attention to the need for change.

Alone, today’s practices, fruit of a modernistic Cartesian reading of reality, are no longer relevant to address the difficult task of finding solutions to problems that no one discipline or expertise can understand on its own (Senge, 1991). Thus, there is a discrepancy between the situations we are facing, and the tools we use to address them. In other words, we can act collectively but it is difficult to be effectively intelligent together.

There is also a discrepancy between the ways actors see the situations: designers deal with 'wicked' problems and ‘messy, problematic situations’. This is as noted by Rittel and Webber (1973), for whom design and planning problems were characterized as wicked problems, contrarily to techniques of science and engineering, which dealt with ‘tame'' problems. Alexander, Simon, and other thinkers also pointed out the distinction between design methodology and science as we can see in the following quotes. Alexander (1964) explained that ”*Scientists try to identify the components of existing structures, designers try to shape the components of new structures*.” Later Simon (1969) described: ”*The natural sciences are concerned with how things are… design on the other hand is concerned with how things ought to be*.” The discrepancy in understanding situations as designers versus other disciplines is highlighted by the concept of the ‘designerly’ way of thinking and communicating, which differs from scientific ways of thinking and communicating (Archer 1979).

Collaborating in complex situations to solve problems in an innovative way often assumes that all the information required for understanding the problems is available and understandable. Schön (1983) challenges this positivist idea which assumes that problems are well-formed and thus possible to solve. He brought about the idea that design has to deal with ‘messy, problematic situations’ and offered a constructivist paradigm instead. He proposed the concept of ‘reflective practice’ which is to search for “*an epistemology of practice implicit in the artistic, intuitive*

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1 Boulding proposed to read complexity as a 9 levels hierarchy where « all human organizations are level 8 phenomena, but our conceptual models of them (with minor exceptions) are fixated at level 4, and our formal models and data collection efforts are rooted at level 1 and 2 ». (Pondy and Mitroff, 1979, p.7)

processes which some practitioners do bring to situations of uncertainty, instability, uniqueness, and value conflict."

To address the central question of this paper, we therefore propose that by focusing on a constructivist paradigm and interdisciplinary approach, collective intelligence can be generated and complex situations can be addressed. According to Morin (1994), the interdisciplinary approach supports a dialogue and exchange of knowledge, analysis, and methods between two or more disciplines. It also implies interaction and a mutual enrichment between specialists.

Situated in this constructivist paradigm, the task for the research is then to find embodied practices that are collective and lead to intelligence; they should be collaborative, complex, and interdisciplinary. They must also nurture innovation and be innovative in their being, or, that is to say, in the way the process is sketched out in the making and how it unfolds throughout the project. Considering this, there is a need to find inspiration from design approaches focused on contexts rather than steps and procedures.

From design to collaborative design

We have defined several concepts that all contribute to creating collective intelligence situations, where wicked problems are discussed and solved by people from different disciplines who act-learn-innovate together in a creative dynamic. This collaborative design is defined by Kleinsmann et al. (2008) as "the process in which actors from different disciplines share their knowledge about both the design process and the design content. Doing that, they will create a shared understanding of both aspects." This shared understanding leads to collective intelligence, which is needed for dealing with complex situations.

Methodology

To explore the various collaborative design practices with the cases, we will refer to artistic creative processes involving artists and managers as inspiration for developing practices useful for facilitating organizational innovation in the context of sustainable development and corporate social responsibility. We present two parallel cases, the first on organizational innovation with the example of a Cirque du Soleil architectural project held in 2001-2002 (Mahy, 2008), and the second, on collaborative reflective practice within HCI projects (Zahedi et al., 2008) held in 2005-2006 at Princeton University. Two realities of collaboration will be presented: collaboration in a project where the priority was given to innovation and artistic aspects, (Mahy, 2008) and collaboration in a website design project where human-centeredness and development of the project in a timely manner were particularly critical. A comparison between the two projects follows the presentation of their respective practices focused on how collaboration emerges through design.

The Cirque du Soleil Case

The organization and project studied

At the crossroads of arts and management, this Cirque du Soleil architectural project was studied through ethnography (Mahy, 2005, 2008). A group of 25 persons, both artists and managers, worked together for more than a year to design the architecture of a cultural centre, called the 'Complexe Cirque', in Montreal. At the time of the study, while pursuing its principal activity of creating circus shows, the company was seeking to develop new products and services to respond to pressing demands from clients. From these expectations sprang the idea of a laboratory that would serve to imagine and test concepts of a new lifestyle in a place set up in Montreal before being launched elsewhere. The spirit animating the Montreal project was one of an 'innovation lab', where an exploratory prototype of a 'creative life' targeting the creative class would be created.

Any player in the creative industry faces the challenge to innovate in each project, as creativity is the DNA that flows through all business initiatives. Any creative breakthrough will eventually translate into greater business capabilities to fuel future projects, while repeating oneself means diminished power of attraction. How does an organization such as this one deal with the complex task of innovating the outcomes – shows, music, films, television series, private VIP parties or large architectural projects to host theatres, lounges, bars, etc. – as well its work processes – artistic creative content design, business planning, reporting, etc.? What inter-group practices are enacted to foster innovation between artists and managers? The study (Mahy, 2008) revealed that both groups had their own specific creative and managerial practices while some were shared between the two groups.

More specifically, the study led to understanding how the Cirque culture permeated the creative and management practices of two teams working together, the artists and managers. The practices showed how both teams interacted, and what tools they created in order to deal with their innovative challenge by way of collaboration, in an artistic and business environment where both needed to find common ground. Collaboration emerged through the different practices presented below. For the purpose of this paper, following a short overview of the spectrum of practices, one specific practice is underlined: the storytelling process the artists used as a language to sketch out, test, update and communicate their vision. This ongoing prototyping of discourse on -and about- the project acted as a catalyst of their goal and, as such, became a design tool.

The practices

Shedding light on all the practices the artists and the managers adopted, the metaphor of the tribe acts as an anchor point and it reveals fundamental qualities of the culture. For the artists, their team is their family, with all its potential dysfunctions. Falsely egalitarian, this emotional community is propelled by trust and tragedy. Co-optation is the rule and the privileges are numerous. For managers, the tribe translates a peculiar community – they deal with artists in a world where the organization's primary leader is an artist himself. Thus, the artists' culture, rituals, and rules eventually permeate through to the managers, who leverage it and give it the strategic or operational spin they believe it requires to achieve their business goals.

While interdisciplinarity is a shared practice, artists and managers organize their respective work differently. The jam session analogy, with frequent cacophonic sounds, illustrates well the organic organization of artists, while the mountain expedition and a roped party give a good idea of the relatively hierarchic organization of managers.

The rapport between actors reveals itself through an ongoing dynamic, crossbred between the two cultural groups. It translates into openness, as well as silos. Biculturalism becomes an advantage when seeking to cross barriers between groups.

While the tribe of artists and managers try to establish dialogue between the two teams to communicate about their respective work, the artists use storytelling to talk about their goal and the vision they created to convey it. Dialogue about the expectations, requirements and management of the project is made up of encounters and misunderstandings. Through formal and informal meetings artists and managers share their views and misunderstandings are common. Neither do the teams share the same mental models, nor do they speak the same language but artists design their vision by creating evocative narratives. They speak about their creation through storytelling made up of imaginary narratives that give life to various dimensions of their vision. Then, in their work, managers use the artists' stories to sell the vision, along with their economic rationale made of facts and figures. By doing so, they add to the narratives and create their own. A polyphony of stories soon springs out of these ongoing conversations and become available to the different participants to speak about the project.

Storytelling and Narratives

Among the practices presented above, the practice of storytelling and the different narratives are central to illustrating collaboration, interdisciplinarity, and innovation. They act as strong communication tools, vehicles of expression, mobilization, and desire, used by the organizational members in their work for the purpose of creating necessary and affective binds that underlie learning, buy-in, and commitment. Flowing into or disappearing from the organizational collective memory (Halbwachs, 1951), narratives offer concurrent perspectives on the project by tapping into distinct facts, perceptions, and aesthetics, all depending on the storyteller's profile.

As presented above, the study revealed two types of narratives which acted as useful catalysts. The first type was created and used by the artists in the process of organizing the project to give the managers and external partners 'a feeling' of what was being designed by the artists. In this case, stories were told about the architectural project, the Complexe Cirque, which was about to be built. Characters, events, origins, culture, everything was imagined and dramatized to offer an aesthetic, artful, and meaningful story. For their part, once convinced by the artists' narratives, the managers would develop the business side of the same story in order to support it with the rationale of a business plan focused on return on investment, pride of being part of such an innovative, prestigious, and audacious project, etc.

Such an inter-group communication strategy assumes that both understand the others' language and intent. The study showed each group had difficulty thinking outside of their own 'disciplinary' culture, and that they might have experienced more fluid interactions if they had relied more on members who were 'bi-cultural', with interdisciplinary competences, and who were at ease within both cultures. Had there been a reflection on how to improve on these communication flaws corresponding to a collaborative approach to design, the project organization could have helped participants integrate those who were fluent in business, arts culture, and process.

Unable to understand and support each others narratives, members of both groups had to spend time trying to 'translate' the other group's narrative into their own rationality. To do so, both groups held regular meetings and long summits during which they would present to each other the artistic and the business version. The summits would last 1 to 3 days and the executive management team along with the company's founding-president would attend and intervene. The president ultimately refocused, adjusted, commanded, or dismissed ideas and people. This external regulation helped in decision making, but it also ignited rivalries and confrontation. This disconnect between the two rationalities made the project difficult to present to external partners when trying to convince them that it was a coherent, robust, and attractive initiative, both aesthetically and business wise.

The harmonic polyphony of narratives often became a cacophony for many participants in the project and it did create some dissonance among the tribe. Resulting from an artistic creative process, the stories created by the artists carried a dream. The managers ones conveyed the economical interest of becoming a partner. Between the two, stories on how to translate the dream into concrete were missing and the reflexive knowledge on the process did not lead to concluding that another type of narrative was missing and greatly needed. A story on how to work together between the two teams would have helped but it was not observed or heard of in the study.

Nevertheless, a collective narrative evoking the vision was created and had a positive reception. While it was appealing to all participants and partners, the political and economical context of the time played against the project and it was finally stopped before the building phase.

The case of HCI design

The early stages of the design process of a website was studied in order to understand what really happens during collaboration within the assigned team. Project-grounded research (Findeli 2004, 2008) was privileged for this study. This approach allows the designer-researcher to conciliate theory and practice (Findeli 2008, Jonas, 2007). In other words, conducting research and constructing knowledge become part of the design project.

The project was about the redesign of a complex website for Princeton University. The existing website was designed a short time before this intervention, however it had technical flaws which seemed to be the single reason for the client's request to redesign. A careful analysis of the website made it clear that it was designed following the administrative structure of the institution and very elaborated visual elements were used to make the website attractive to users. Although most content was valid for reuse, the site had several shortcomings from a user point of view, including deficiencies for those who had to feed the site and keep it updated. These people were office staff members who had the responsibility of updating the site daily. They were also in direct contact with users of the site and received regular feedback. A functional site was urgently needed to serve both groups but very limited time was available for redesign and development of the website. However, the time constraint in this case was of help; the client accepted to make everyone involved in the project available for the redesign and the development of the site. The availability of these people for a set period of time was the needed condition for applying a new design model, one geared to translate disciplinary collaboration into new knowledge construction, useful for the purpose of the project.

This professional design project became our field of study. Through this research and project, we aimed to find out what conditions were needed for a variety of experts to think outside of their disciplinary boundaries, to enrich the collective knowledge regarding the end-users of the project. The idea was that the enriched knowledge would contribute to a more successful design, and to the development of the project in a timely and more economically efficient manner.

Collaboration within an environment of reflective practice

We introduced a new design model for this project (Zahedi et al., 2008). The model is based on 'interdisciplinary attitude' and 'joint reflective practice'. Its purpose is to facilitate collaboration and knowledge sharing among team members of a complex project, early in the design process, while positioning the user at the centre. The model, 'environment for reflective collaboration', allows for the construction of collective knowledge, which can be achieved by collaborative learning opportunities that combine theoretical and practical aspects.

The concept of interdisciplinary attitude means shared commitment, acceptance of approaches from other disciplines, and looking at the problem from various perspectives (Boyarski, 1998). It allows openness to other perspectives and a willingness to share information. This is to say, the interdisciplinary attitude is the mind-set that encourages an informal teaching and learning dynamic. With shared information in the context of the project, all team members understand divers perspectives and see the relevance of diverging viewpoints. Schön (1983) emphasizes on "complexity, uncertainty, instability, uniqueness, and the value conflicts" of situations of professional practice and explains that these situations are not problems to be solved. They are problematic situations to be understood. Through 'joint reflective practice', we bring together diverse knowledge and skills, allowing the team to notice interconnected problems, construct new knowledge, and to formulate the situation differently. As reflective practice is associated with learning from experience, it allows the team to change its perspective, gain new knowledge, and challenge the concepts and theories by which they make sense of knowledge. By joint reflective practice the team can bridge different understandings and produce new knowledge to deal with uncertainty.

The model is composed of three elements: an intensive workshop to encourage both the interdisciplinary attitude and the joint reflective practice; tools to support knowledge sharing and team performance; and design as a method to facilitate collaboration and understanding between people. The workshop, the tools, and the designer in the role of facilitator, are strongly related. By applying the model, the multidisciplinary team works closely together, focused on user needs and motivations in order to redefine the objectives, the priorities, and the information architecture. Reaching consensus on these factors, coupled with the knowledge produced, was essential for specifying the parameters of the project and realizing it efficiently within our time constraint.

The team was composed of 11 persons, including office staff members, web programmers, content experts, higher management, and a designer. Although, in most activities the workshop functioned with 6 or 7 team members. Based on the previous analysis of the project, its estimated complexity, and the knowledge about the team, the workshop was planned for 6 days. We designed a set of activities to support the workshop and planned to facilitate its progress. Visual representations of design and development process were shared with the team. Also the team developed a web-based system for gathering information about the project which could be accessed when needed. As the main goal of the intensive design workshop was to redefine the information architecture of the site with a user-centered approach, it was clear that a common understanding of users' interests and needs was essential. The team participated in a set of activities such as creating persona and use scenarios. Their discussions and exchange of knowledge contributed to redefining the objectives and priorities of the site, the methods to achieve them, and to retaining a constant focus on the users.

It was clear that we were dealing with a 'messy' situation. In HCI, these situations are complex: they are unique in their context; there is a continuous change of users' needs; development of information technology is fast; and there is a necessity to work within a multidisciplinary team. In working with multidisciplinary teams we had already noticed that team members were mainly concerned with their own expertise, making it very difficult to consider the end-user, and that they had different understandings of users' interests and needs. Being engaged in the activities of the workshop modified the focus and understanding of team members.

The activities of the workshop led to the exchange of knowledge and new ideas. By using the project-grounded research approach, the theory was situated in the project and its implication on practice was directly observable for us, but also for other team members. During the workshop activities, as the team become more familiar with the user-centered approach to design, new questions emerged and modified the viewpoints of all contributors. Their interest in theory and its implications in practice grew. Discussions regarding the concerns of each discipline helped the team to share information and develop a common understanding; it also helped them to realize the complexity of the project. Their attitude toward collaboration and exchange of knowledge was modified. Design as a method for understanding people and knowledge sharing contributed to increased innovative solutions for the project.

Discussion and conclusion

The cases presented here aim to answer the 'how' question introduced at the beginning of this paper: how can design be of help to lead the reflection on collective intelligence and to translate collaboration into pragmatic activities? The two cases showed how complexity and interdisciplinaity are connected. It also showed that design can be used as a means to encourage and motivate construction of new knowledge at a personal and collective level. In both cases, collaborative design brought the team together for social practices. The outcome was that design was very useful as an overall framework for guiding practice. The following is what we have learned.

Design the conditions for meaningful conversations

We saw different social practices and creative ones, both based on one shared assumption: that there is a need to nurture meaningful conversations among the groups and teams who work together on challenging projects. When design helps to bring collective intelligence to a team, it acts as a method to encompass complexity.

A planned-change approach, made of steps and procedures, can be useful in complicated situations where the problems are well defined, not 'wicked', where all the information is available, and when the future can be anticipated. But when a situation is complex, events and situations that could not be anticipated do happen. This characteristic of emergence intrinsic to the concept of complexity (Morin and LeMoigne, 1999) contribute to inviting new approaches, those that do not focus on control but on nurturing and sustaining the process in the making. Consequently, the shared assumption for both cases is the fact that conditions for nurturing meaningful conversations becomes mandatory.

Design attractors to foster culture

Design was also put to work in situations where keeping memory appeared to help projects. In one case, an aesthetic and memory dynamic process was created in order to nurture the creative activities of Cirque du Soleil artists. It was done by offering them a mirror to their work, an alternative perspective on their culture from which they could learn and draw ideas. In the second case, a web-based system was created around which team members could gather and contribute to sharing ideas, understanding, and meaning. This fostering tool nurtured the project culture and its evolution.

Design shared stories

Characters, personas, and scenarios were created in both cases as pieces of a grand narrative about each project. The use of images, metaphors, and stories is a powerful and artistic creative technique able to reach out and touch human senses while acting as an emotional lever. This approach added a rich texture of humanity to daily work and helped team members feel they are part of an inspiring initiative. By contrast, we have seen that the interweaving of different stories can also be delicate when interdisciplinarity is not present. It is a intangible process that implies competencies, and reflexivity from all team members.

Design collaboration

Collaboration is a complex phenomenon, one which fluctuates when context changes and pressures from project environments increase. Because relying only on planning, procedures, and control is irrelevant in a complex situation, collaboration gains from being supported to emerge and maintain itself, thus considering design as a framework for sustaining collaboration is a useful perspective.

Design collective intelligence

As we have seen, different practices in an interdisciplinary setting contribute to leveraging collaboration in innovative projects. Because it is fully social, shared knowledge and the collective learning process reside largely between the team members (Hutchins, 1995), and is enacted through all communication, in all activities. Acting as a favorable condition for collaboration, in an intelligent and positive way, reflexivity presents itself to be a keystone of collective intelligence. The idea of fostering -holding the space for[2] the project to bloom, or in other words, for good ideas to emerge, is a key aspect of this collective intelligence.

Design bridged the gaps

We benefit from the research approaches in design, which helps the team to connect with the complexity of the situation, and integrate the theory and practice within the project. Design, as a vehicle for changing the way team members interact, makes integration of all viewpoints possible.

Conclusion

The previous considerations invite us to propose that collective intelligence is not the sum of all the discourses created in a project and that complex collaboration requires reflexive experience-based rules to shape action. It also implies interpersonal and collective trust, a will to explore, creativity and playfulness, as a recent study on collaborative challenges has shown[3]. In the two cases presented, we saw an ongoing design strategy of sketching out the project vision and its activities through discourse. The successes and flaws lead to proposing that strong reflexive and interpersonal skills are required for this nature of collaboration but because of the very nature of such projects, which implies complexity thus chaos, collaboration needs to be the centre of attention and to achieve this, it needs to be designed. This design does not aim at sketching out complex social interactions through planned procedures but to create the conditions, or in other words the context, for interactions to emerge and to be experienced as positive and nurturing. To support this humanistic view on design, Scharmer (2007) proposes that deep listening skills, reflexive skills, and more than a superficial openness to co-creation are mandatory to create such conditions. Scharmer suggests that these social design skills focusing on how to embody co-sensing, co-presencing and co-creating states of being could be of help to revisit the expected competencies needed to create collective intelligence.

To conclude, we have found that design actually acts as a catalyst when collaboration becomes mandatory for complex projects success. This finding opens further research questions on the appropriate guidelines we could provide project members to help them with organizing their initiatives. Anchored in a complexity paradigm, this question would lead to developing adaptable social change supporting tools and techniques.

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[2] As the concept of "Ba" or context, countainer or place, proposed by the japanese philosopher Kitaro Nishida. This concept was the leading idea of many innovation projects studied by Nonaka, Toyama and Scharmer though the lense of knowlegde management, in Nonaka I., R.Toyama, O. Scharmer. (2001). *Building Ba to Enhance Knowledge Creation and Innovation at Large Firms*, http://www.dialogonleadership.org/Nonaka_et_al.html

[3] This study based on an exercise called ‘the marshmallow challenge’, presented by Tom Wujec, reveals how team deal with collective abilities to collaborate http://www.marshmallowchallenge.com/Welcome.html

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Author Biography

Isabelle Mahy

Prior to becoming faculty in the department of social and public communication at the Université du Québec à montréal, Isabelle Mahy worked in various organizations for 25 years, in organizational design, collective learning, knowledge creation and sharing. Her research focuses on transformational change, collective intelligence, organizational communication, participatory action-research and art-based methods. In 2008, her book "*Les coulisses de l'innovation, création et gestion au Cirque du Soleil*" was published at les Presses de l'Université Laval.

Mithra Zahedi

Currently Mithra Zahedi is a visiting assistant professor at the School of Architecture & Design at the Lebanese American University. Prior to this she was a lecturer at the School of Industrial Design at the University of Montreal for eight years. Mithra holds a Masters of Science in Educational Technology, preceded by her study in Industrial design at La Cambre Brussels. Mithra worked as a design consultant for more than 15 years, focusing on human-centered product and communication systems in the IT industry and in educational institutions. In her current research her main interest is in team interaction and support for design activities in a multidisciplinary group. Mithra is currently a Ph.D. candidate.

Perspectives on critical design: a conversation with Ralph Ball and Maxine Naylor

Matthew Malpass, Nottingham Trent University, UK

Abstract

This paper features an edited conversation with designers Ralph Ball and Maxine Naylor. It explores their thinking in relation to critical design.

In the preface to *Form Follows Idea* (Ball & Naylor, 2005) Jeremy Myerson describes Ball and Naylor as being regarded among Britain's most thoughtful furniture designers.

In 1985 Ball formed a design partnership with Maxine Naylor a reputable experimental designer maker. Together they began to challenge the boarders between art, craft and design. They have exhibited work internationally and held teaching positions in colleges in the UK and USA. Over the course of a decade from 1985 Ball taught on Furniture, Jewellery and Industrial design at the Royal College of Art where Naylor taught on Furniture Design, directing the course between 1995 and 1998. Today Ralph Ball is Professor of Design at Central Saint Martins University of the Arts London and Maxine Naylor is Professor of Design and Director of the Design Research Institute University of Brighton.

Through practice and academic tenure they have developed a distinctive approach to practice based research and refined their critical perspectives. They describe themselves as critical designers and use design as a critical, visual discourse to communicate ideas about design culture and society today. Taking experimentation as a research method they subject their ideas to a critical process of refutation. They question the work through a scholarly approach that challenges protocols of design to enhance the design profession.

In this conversation the designer's concepts of 'open-process' and 'design poetics' are discussed. They describe their role acting as critics of design from within design practice. They outline their thoughts on the increasingly un-ideological culture of industrial design. They describe how through playful experiment they question the value of repetition in design and mass production of products. They do this by taking modernist axioms to extremes and 'embedding narrative' into objects as commentary on the state of contemporary design.

Supplementing the conversation the author offers his reflections. Primarily this exposes a form of critical design that differs significantly from popular and often technologically orientated notions of critical design.

Keywords

design practice; industrial design; reflective practices; rhetoric; poetics.

A growing number of designers employ Product Design as a medium for critique and speculation within disciplinary and societal frames. Although they are distinct from each other in their concerns and approaches, what these designers share is not simply a transgressive attitude but a critical perspective on design's self-understanding. Each challenges established discourse, institution or episteme and present alternative roles for design to those characterised by industry and driven by technological and financial concerns. They offer new interpretations of prescribed agendas legitimising and problematizing alternate forms of design work that extend product design's cultural agency.

These alternative approaches are understood under various terms, for example, Moline (2008) describes experimental design. Bruce and Stephanie Tharp (2008) describe discursive design outlining a design approach that leverages functionality to spark contemplation. In a discussion on the origins of critical design and its operation in Sweden Robach (2005) describes koncept design emphasising the link between critical design and conceptual art. More recently a discourse has emerged surrounding speculative design. (Kerridge, Loizeau, Caccavale, Auger, & Soares, 2008)

Arguably, speculative design has developed from of the popular understanding of Critical Design developed by Dunne (1998).

These practices are uniform in that they suggest a move away from commercial design towards a conceptual, discursive, inquisitive and often provocative role. Design as a critical language where the object and medium of design are used as a form of inquiry in societal, technological and disciplinary discourse.

To understand how product is used as a form of critical language in terms that do not exclusively rely on established discourse in other disciplines – for example in Art, Architecture or Sociology– we need to develop a disciplinary understanding of critical designs meaning, potential and explore its contribution to Product Design.

To establish this understanding we need to question in design terms: What are the examples of practice – the designs? In what contexts do these designs operate? By what methods and tactics do they operate? What is the focus of critique or the subject of investigation through design? In addition to analysing individual projects and practitioners we need to consider them in the context of the whole that they form. We need to attend to the subtle differences in the approaches and explore the links between the individual modes of critical practice. Underpinning this we need to consider conditions in mainstream design that have led to the emergence of critical design practice.

In this paper the author begins to address these questions aiming to illustrate one approach to critical design through the perspectives of designers Ralph Ball and Maxine Naylor.

Method

This conversation is one in a series of interviews with critical designers that form part of a PhD project contextualising critical practice in Product Design. The function of the PhD is to analyse approaches in Product Design that have been described as critical in an attempt to conceptualise the field and thematically separate examples of practice (Malpass, 2009). Using literature and interview transcripts as a source of information the author has developed thematic categories through a process of dialogical reasoning and “constrained generalisation” (Butler, 2002). The author aims to structure the field of practice and illustrate through taxonomy: the function of critical design practice; the rationale for critical practice; the contexts where it operates; the projects; the designers; the methods by which it operates.

A hermeneutic is employed (Klein & Myers, 1999; Gadamer, 1998). A nessecery element to satisfy the hermenutic method is to engage with multiple partcipants to elicit multiple interpretations of the field. To staisfy this element interviews were arranged with expert designers. Through interview the ‘critical’ designers were encouraged to reflect on their experience and practice. A conversational approach to interviews is used. (Rubin & Rubin, 2004; Laverty, 2003)

A hermeneutic approach enables the participants to reflect on the meaning of their experiences. Gadamer understood hermeneutics as a process of co-creation between the researcher and participant in which the very production of meaning occurs through a circle of reflective interpretations. This approach supports a dialogue between the researcher and participant. The participant’s contributions are allowed to affect the co-construction of ideas. This principle calls on the researcher to acknowledge and reflect on the construction of the data derived from the interaction. The reflexive discussion supplementing in this paper contributes to this process.

The participants and context

Ball and Naylor are identified amongst a group of expert participants who through writing and practice present an alternative perspective in critical design discourse. Their practice differs from those in critical design that deal with scientific engagement or technological futures – “What if’s” (Dunne & Raby, 2009) or “Design Fictions” (Bleecker & Nova, 2009). Using an experimental approach they design and make furniture. Ball and Naylor’s approach forms part of an academic strategy that they describe as a practice led approach to research. Through object they offer commentary on the impact of design in society. To set the scene the interview was conducted at

Central St Martin's University of Arts London on an afternoon in August 2009 where Ball and Naylor were preparing work for their exhibition 'Chair Poetics: Envisioning Anonymity' part of the London design festival.

On: Critical design

Matthew Malpass: You describe your research activity as critical design practice. It might be good to have some definition of what critical design is. Is this something you can give?

Ralph Ball: I think the first thing it means is that the objects we produce are about making commentary or comment on design practice. That means the objects themselves don't necessarily need to be functional, practical objects but they need to refer to functional, practical objects or to the culture of design in order to make relevant comment. We use objects instead of using text. Those will be visual observations about particular issues associated with design. The issue might be to do with sustainability, excessive obsolescence, it might be to do with obsessive focus on a particular ideology and where that might lead. In some cases, we've explored the axioms associated with modernism and demonstrated how the axioms if taken to an extreme produce absurdities. The ideology finishes up being problematic. It's a way of exposing the fallacy of unreflective ideologies of any kind.

On: Open process

MM: You write about an 'open process' can you explain this?

Maxine Naylor: It's a way in which we work at the moment. We both trained as furniture designers. As a furniture designer you are often working on your own projects – certainly in your educational experience and often as a professional. In a more 'open process' what you're doing is you're working with other designers. It's a much more communal activity and it's where ideas are debated and discussed – they're moved through a conversation. In many ways critical design is a dialogue. It's a visual dialogue about our ideas concerning design thinking. The 'open process' is that process when you are having a discussion and debate while you are working. It's also substantially to do with the idea that you are not working for a client. You are working to a design agenda rather than a client or service agenda.

RB: If you are working as a professional you are invariably doing something relatively preconditioned whether it's a specific design brief or a particular set of required parameters to operate within. In an 'open process' those things are much less constrained and you can allow all sorts of other elements in. We talk about allowing accidents to happen, finding things by accident and the fact that when you are working with the juxtaposition of objects in space something might happen simply by the fact that two things come together. You can be aware of that and use it to lead off. In a conventional design brief you would often have to ignore that newly opened route.

When we talk about 'open process' it doesn't mean there aren't any rules. The rules are determined by the choice of the object or the choice of story that we're trying to tell. When we conceived the 'Archaeology of the Invisible' – the overarching project is called 'Sustaining Desire' – what was interesting is that we were working deliberately and specifically with objects that had already been designed and we were redesigning them.

What that strategy does is that it objectifies the process in a different way because you are starting with a given. For example, that is a generic stacking chair and asking the question, what are we going to do with that? We can both buy into that discussion objectively. It's not about whether I think that this proportion is better than that or I'd detail something in a different way to Maxine. It's about what makes sense in terms of telling the right story about this specific object. The objects impose certain kinds of rules because they are what they are.

Figure 1: Blackstack. Archaeology of the Invisible collection 2003-04

RB: A stacking chair is a stacking chair and not any other kind of chair. It has a certain set of rules about what it does and doesn't do and we have to honour those rules.

Maxine Naylor: There are particular parameters implied by the objects themselves. We try and define and operate with those principles. We almost agree a set of principles before we start working so that we know we can't do that but we can do this. The old design principle of creativity within specific constraints. By limiting the language we actually exploit it better. We get more out of it because we focus on the elements which are appropriate.

This type of designing is a much more open ended activity. When we started the first collection Archaeology of the Invisible it wasn't determined that there would be a collection of chairs. There was a discussion about chairs. The objects are a manifestation of the conversation we were having.

On: Design poetics

MM: You talk about 'design poetics' and the use of rhetoric in your approach. Can you describe the notion of 'design poetics'?

RB: 'Design poetics' is coined and used in the same way as literary poetics and poetry. Something doesn't have to make literal sense it has to make poetic sense. What does that mean? It means that in literary poetry you can put words together that wouldn't necessarily make figurative sense but elicit a different kind of meaning. For example, if I talk about someone having a loud voice that would be a normal literary statement but if I talk about a pale green voice or a dark blue voice that would be a more poetic description – one which engages the faculties of both imagination and interpretation. We can consider 'visual poetics' in the same way. We put together something which creates a contradiction, creates a paradox, or creates some form of visual resonance, which is different to conventional expectation but which throws light on the object that we are dealing with.

MN: Often the work is about engaging people in looking at objects afresh and it doesn't have to be serious and ponderous. It's actually often quite witty and amusing. One of the things we had happen quite a lot when we first showed *Archaeology of the Invisible* was people asked me if it was alright if they laughed at the pieces. I said yes, they're funny, they're funny aren't they? It's about people getting it rather like comedy. Being poetic about something allows people to look at things in a very different way.

MM: Is humour is an important element?

MN: Culturally it is and so it should be in our design work.

RB: Another point about the poetic aspect is that we are making objects that look both familiar and strange. In literature there is a recognisable relationship between ordinary prose and poetic language. Poetic language uses the same words as ordinary prose it just puts words in different orders. When we're working with chairs we're making objects that are familiar but we're remaking them to be simultaneously unfamiliar.

MN: We also look at features, characteristics and differences. Because we're both furniture designers we look at chairs very closely. Chairs have got real personalities and attributes. These characteristics are invisible to most people. By altering them they become generally more readable. We shift and emphasise. We make their personalities stronger and people see them more fundamentally.

Figure 2: Plastic Gold (anonymous and ubiquitous white plastic stacking garden chair) & 24 Star (generic office chair). Archaeology of the Invisible collection 2003-04

RB: The whole point about the *Archaeology of the Invisible* collection is that it's actually 'digging up' awareness, making visible that which, because of it being so common and so ubiquitous, is invisible, culturally buried. The value of stacking, or the economic or structural difference between one chair frame and another goes unappreciated.

MN: Whether an object is 'designed' or not designed, or if it is well conceived or not well conceived is often simply not considered at all.

On: Rhetoric and Embedded Visual Narrative

MM: Other critical designers talk of rhetorical use presenting work that alone you wouldn't have any idea what it is or is for. It needs an external narrative to establish context of use and with that persuasive narrative you can imagine using the design. Is that how you use rhetoric?

RB: No we don't use it like that. We are interested in what we call 'embedded visual narrative'. The idea is that we're trying to use a visual narrative. What we are looking for is to have the object speak for itself or declare its intentions directly. The story ideally is embedded in the object rather than existing as a separate narrative. You don't have to have a piece of text to go with it. That's the difference between what other critical designers may do and what we do. We intend that you are able to directly, visually read what the object is about.

MM: Critical design isn't functional in a traditional sense. Do you ever see this type of design practice feeding into a more traditional idea of the design process or is it something that should remain separate?

RB: I think it can occasionally become conventionally functional as an accidental by-product of the process. In the past some of the things we made prior to *Archaeology of the Invisible* which were developed within a critical or an ideological frame of reference and driven by that particular definition. But we were designing these objects within a product design ethos that meant that we were conceiving and detailing them as if they could be produced. That suggests that if, by accident, they happen to have a commercial viability then it's possible that they could easily migrate over the object boundary and become products. This happened with *Golden Delicious* and *One Day I'll Design the Perfect Paper Light Shade* (Fig 3). They became products but only because they're conceived using the language of industrial design – they therefore already have the latent possibility of being product design. They were originally conceived and presented as one off pieces but within industrial production ideology.

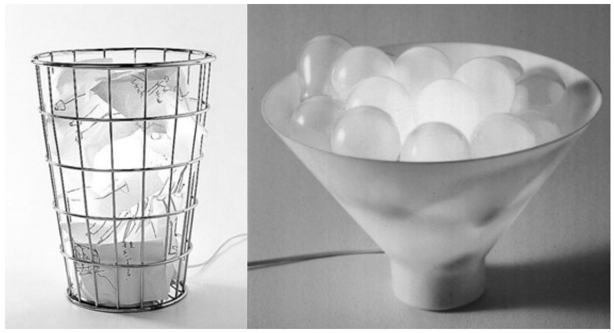

Figure 2: One day I'll design the perfect paper light shade 2000 & Golden delicious 1997-98 for Ligne Roset

MN: By nature because we're designers we try and rationalise as a designer would. We put things together in a rational way using the principles we've grown up with – economy of means and so on and we use materials effectively and appropriately. So in a sense that's what it's also about. It's expressing those traditions. They are now traditions of thinking about how things are manufactured. Even if it is something we've altered it's still reflected in the language of the piece and in the way it was manufactured.

MM: Can you tell me about anything that motivates your practice are there any notable influences, inspirations, education or any theoretical perspectives?

RB: One of the things that initially motivated me was a kind of frustration with what I would call an endless cycle of the same neo-modernist work. Also a frustration with the way that postmodernism and various forms of contemporary design simply seem to be fairly stylistic activities with very little intellectual content. Certainly postmodernism was used to attack modernism as being something, which has nowhere else to go and was caught in a stylistic cul-de-sac. Postmodernism as a replacement can be accused of equally facile activity and limited works. There are exceptions of course; there are exceptions in both camps to that limitation. So yes what we're interested in are the exceptions rather than the rules. In that category we would put people and influences like SITE, the architectural practice, Marcel Duchamp's Rue Larrey Door. There are certain types of objects and certain things that make sense to us in terms of what we are doing now that are historically part of that same lineage. I think initially it's to do with frustration with the design work that was and still is coming out and seems to be more and more of the same. I don't see any value in actually doing something, which is no better than something that Charles Eames did in 1950.

MN: The work extends in terms of education. In many ways the thinking came from – well certainly from me – a frustration with students being unable to look properly at objects. They don't look at things analytically or critically. People don't look at things more than superficially. Students particularly have to cultivate a sustained concentration and the project turned into one where actually I got my students to appreciate objects better. They looked at things for longer. They understood the implications of manufacturing an object. They started understanding that it was built, it was constructed and that many people worked on it. They gained a greater appreciation of artefacts, and this goes back to engaging the sustainable debate.

On: Mature typology

RB: There is another difference in how we work. Because we are furniture designers we are interested in what we call 'mature typologies', types of object which generally have an agreed consensus on basic form. I'm not particularly interested in electronic objects which don't seem to have reached any kind of formal maturity. The other definition we have therefore is that there are 'immature objects' and they haven't reached a final form because, for example with the telephone the function is to communicate with somebody over a distance. That form and method keeps changing doesn't it? With the chair the basic form was established thousands of years ago. We have many variations on the same fundamental form – something that holds your body at a certain height off the ground, to make it comfortable for your legs. With regard to talking to people over a distance that's changed from smoke signals to mobile phones and could continue to morph into something that's almost intangible.

MN: The thing about furniture is it's about ritual, it's about culture, and it's not just about comfort. The electronic world is driven by micro technology, which is fascinating but it's an expansive, shifting and a kind of amorphous entity that in a sense could be almost invisible. In contrast, furniture is always going to have a physical presence.

RB: That goes back to the 'embedded' narrative. We are working with recognisable archetypes. I think the problem with electronic products is that they are less recognisable. That is why some designs need an external narrative to explain what they are. You could have a cube or a minimal shape and you can say this is a something – a radio for example – you declare that's what it is.

MN: Driven by hidden electronics it could be anything. Is this cube a calculator or a smoke alarm?

RB: Then you have the idea of imagining using. As soon as I pick this up and put it to the side of my face it becomes a mobile phone. As soon as I pick this up and behave with it in a certain way it becomes the object associated with that particular behaviour. But it requires a 'theatre of use' to have that happen. With mature objects we already recognise them so therefore we've got a recognisable narrative to start from.

MM: I'd like to talk a little about framing your practice. What makes your objects design objects and not conceptual art?

MN: We have this debate quite a bit. Sometimes out of perverseness, sometimes we want to – if we're labelled as designers – say no we're artists and sometimes when I'm called an artist I say no I'm a designer. But actually in the end I don't know if it's an interesting debate in itself. As soon as you set yourself in that position people look at the work in a particular way. I know they need to set it in a particular context but my thinking is that they look at it how they want to look at it. If they want to see it as conceptual art fine, but if they want to see it as an interesting statement about design that's also fine. I would probably always say fundamentally I'm a designer because I like the problems that designers tackle. I think they have serious implications for the world. If you're going to get deeply philosophical I think designers have an ability to make a huge impact on our environment. Not just in terms of sustainability but to the quality of the environment. We suffer for a lack of quality and integrity and at the moment society still doesn't know what design is. They think it's a styling exercise, they think its packaging, they think its branding, but the core activity fundamentally is coming up with good products.

Figure 4: Chair Archive 2008. Indeterminate Cases exhibition. La Sala Vinçon Barcelona

RB: It follows from that. You might choose to use art as a strategic label because people sometimes take art more seriously intellectually. There is a perception, a position – when you locate something in a gallery it is looked at differently than if placed in a retail store. You can use this perception of the gallery context. It's strategic to use the idea that it is somehow art about design or better, art using design as a point of reference in order to make statements about design.

MN: I think your point earlier, which I would agree with, it's that we honour the process of designing. We don't mean to throw it out of the window and start from first principles. We have a good legacy to work with. What designers haven't done is move design on to where it needs to be. We've corrupted it by doing these copies of things. In general we have a very different idea of what design can be than many designers. I think it is a very, very significant profession that's been much abused and much misunderstood and actually what I find upsetting is I think many other professions understand what we're getting at more than the profession itself, what the value of it is.

MM: Other critical designers focus on issues that can be considered outside of the design discipline – what I describe as ‘With-out’ – using design to address societal and ethical concerns such as bio-ethics and scientific futures. Your work seems to subvert design challenging the discipline by offering critique of a design core – what I describe as ‘With-in’. Is this something you would agree with?

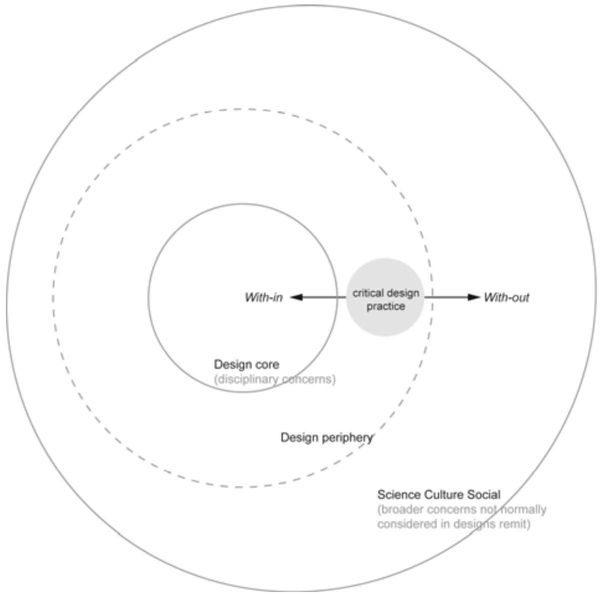

Figure 5: The focus of critique. Illustration used as a discussion prompt.

MN: It’s subversive in a sense of challenging current design thinking and practice, that is, much of design often defaulting to branding exercises. Yes our design actively opposes that. But not subversive fundamentally I believe design can be a powerful tool that doesn’t need to be completely dismantled; it just needs to be paired back to what it’s capable of doing.

RB: I would agree generally with that. However, additionally we are looking at sustainability, in a way I think is different to other people. Sustainability does belong to that larger territory. The umbrella title of the original project was called Sustaining Desire and the idea involved looking inwards to project outwards again to a larger social context. It’s basically proposes that we need to start valuing the good things that we already have rather than making more and more, throwing them away and making more and more again. So Sustaining Desire becomes: let’s focus on both the intellectual and the aesthetic marriage of things which are really good pieces of design. So we have to go inward i.e. to be introspective in terms of looking at what these objects really are and what they do by representing the forgotten and the familiar.

MN: But then also it’s interesting because it depends on the audience. I would say that our audience is primarily a design audience. I see other designers as my audience. I’m trying to inform and motivate that inner core to do something. Yes they are being asked to look outwards but what we are doing is trying to influence design education and in how we deal with, how we think about design as a profession. We’ve got very complacent.

RB: Well it’s not very ideological anymore is it? It’s very commercially orientated.

MN: It’s driven by very specific criteria that are very limited and ultimately terribly disappointing and design isn’t only about that.

RB: I think that’s strange and it’s perhaps why we keep getting attached to art.

MN: Through their work artists are allowed to comment and critique and we’re not. We’re told you’re not really a designer unless you’re providing a ‘service’. I am providing a service it’s just not got a client in a traditional sense. The client is the educational system, it’s design thinking.

Reflections

It is difficult to put in place the critical rhetoric it takes to visualise a need for a revision of the status quo through design. Ball and Naylor aim to do this by reflexively turning design method on design itself. They present a tension of structure and ornament, and point to the contradictions of functionalist design traditions, satirically exaggerating the effects of instrumental approaches to design and superficial replication.

Ball and Naylor describe their approach as research. If critical design is framed as research it must conform to some measure of rigor and validity. In their work Ball and Naylor present a method of visual citation referencing designers and modernist design ideology in the objects they design. In their tactics they draw on literary composition; mechanisms of juxtaposition and satire to create contradiction and visual resonance. They establish an analogous language to that of the written word using object as prose in their concept of 'design poetics' through which they offer both critique and affirmation of design methods.

They aim to challenge design thinking by reassessing contemporary practice and how designers read objects. Their critique is established by grounding critical design in established traditions episteme and discourse consistently referencing design principles; this in turn incites reflection on tradition. They are loyal to a core set of industrial design skills, proportion, production, manufacture, quality and function. These are subverted reinforcing the need for an attention to these principles.

Ball and Naylor recognise their audience as a design audience. Through their 'open process' they enter into a dialogue with the audience. The work is disseminated in the gallery context and through publication. They engage with how the object is shown and read in the gallery context exploiting any association with Art.

Design commentary informed by art sometimes treats design's preoccupations as over-determined and misguided. Ball and Naylor negotiate this suggesting that it doesn't matter if the object is read as Art or Design. Associations with Art and gallery dissemination facilitate the concept behind the object and the commentary through it. Objects of critical design are however, always the result of a design process conceived and developed in the ethos of Product Design.

This identifies a challenge and opportunity to a mainstream design community and raises the question: How do we develop critical practice without relying on discourse in other disciplines –for example Art – and the critical analysis applied in these disciplines and develop a lens with which to view and further understand objects of critical design in our own disciplinary terms?

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Design Research : Towards a History

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Abstract
Various starting points might be selected for the origin of design research but this paper will begin with the design methods movement in Great Britain. Two of the leading figures in the movement were Bruce Archer and John Chris Jones. The original conference on design methods was held in London in 1962 and Jones published the first edition of *Design Methods: Seeds of Human Futures* in 1970. Archer was involved with the establishment of the Industrial Design Research Unit at the RCA in the early 1960s and was also a founder of the Design Research Society in 1976. The DRS journal *Design Studies* was founded three years later. Design methods in the United States continued to develop through the Design methods Group at the University of California, Berkeley in the late 1960s. Horst Rittel was a central figure in this group. In 1968 Herbert Simon gave the Compton Lectures at the Massachussetts Institute of Technology. These were published shortly thereafter as *The Sciences of the Artificial*, which became a seminal book in the field of design research. Another group on design methods, which included Donald Schön, also developed at MIT. In the fall of 1982, the academic design journal *Design Issues: History, Theory, Criticism* was founded at the University of Illinois, Chicago and the first issue was published in 1984. Among its activities, the editors organized the first conference on doctoral education in design, which was held at Ohio State University in 1968. During the 1990s, the international network of societies and associations involved with design research expanded to include organizations in Europe, Latin America, and Asia. The Design Research Society organized a series of international research conference and an organization that includes a number of research societies in Asia and Europe was formed. While there is much activity today, there is still a problem in connecting the various discourse communities into a more coherent field of activity.

Keywords
design research, design studies, design history

Introduction
Design research is today an international enterprise. Various starting points might be selected to mark its origin but I will begin with the design methods movement in Great Britain, simply because one can identify a trajectory from there to where many researchers are today. However, the field of design research is much broader than most researchers recognize and it encompasses diverse actors, quite a few of whom have little or no knowledge of what others are doing. Actually, the field consists of multiple discourse communities or networks, each of which pursues its interests based on its own criteria for best practice and meaningful results. These communities have diverse aims and are of different types. For some, the research objective is to create new products. For others, it is to gain a deeper understanding of design as a cultural phenomenon. Thus, we need to recognize that the term *design research* has different meanings, depending on who is using it.

I don't want to give the impression, however, that discourse communities have little or no contact with each other. On the contrary, they frequently overlap and sometimes even merge. Researchers often belong to several communities and move back and forth between them. Journals, Internet sites, and conferences may originate within a particular community but often attract researchers from beyond the community's own ranks. In fact, it is through cross-pollination that a research field with multiple communities expands and produces results that transcend the more narrow interests of any given group.

Design methods in Britain

Two of the leading figures in the British design methods movement were Bruce Archer and John Chris Jones, both were engineers who became interested in design. They were among the organizers of the initial conference on design methods, which was held at the Imperial College in London in 1962. In 1970, Jones published the first edition of his seminal book *Design Methods: Seeds of Human Futures*, in which he introduced a number of methods that designers could use, mostly adapted from other fields. Two points about his choice of methods are salient. First, he wanted to enable designers to work at the higher levels of system and community design as well as at the level of products and components. And second, he intended to make the designer's methods transparent, changing the common belief that design arose from a black box of inspiration into an understanding that an articulated methodology could greatly assist the design process. Jones also plays a noteworthy role in the design methods movement for his rejection of it in 1977 when he declared that design methods had become too rigid (Bayazit, 2004). His defection was a major contributor to the demise of what Horst Rittel had earlier called "first generation design methods" (Bayazit, 2004, p. 21).

Bruce Archer was far more flexible than some of his colleagues in characterizing design as a practice that lay somewhere between science and art. In 1960 Tomás Maldonado invited him to join the faculty of the Hochschule für Gestaltung in Ulm, Germany, where he wanted Archer to mediate between several camps of faculty who had firmly set views about the nature of design. In 1962, Archer returned to England to head a research project at the Royal College of Art on the design of hospital equipment.

The establishment of the Industrial Design Research Unit at the RCA in the early 1960s with Archer as its head was a major step forward for design research. When the Design Research Unit became the Department of Design Research, it joined the school's other departments that trained graduate students. In a seminal article of 1981, published in the proceedings of the 1980 conference, *Design: Science: Method*, Archer provided an appendix with a long list of studies that had been carried out by students in the Department of Design Research (Archer, 1981). The range of studies was noteworthy for its emphasis on products for special users rather than on consumer goods as well as for the occasional attempts to deal with values, methodology and related issues. Most of the studies addressed the design of particular products – hospital equipment, products for physically disabled children, or police command and control consoles – but a few were more abstract such as the creation of mathematical modeling systems for use in design. A second appendix to Archer's article is also noteworthy because it lists the studies in related departments that focused on art and design history, design education, and graphic design (Archer, 1981). Though Archer did not go into detail about why he thought cultural studies were a valued component of design research, he nonetheless saw a relation between cultural research and design.

When the Design Research Society (DRS) was founded in 1976, with Archer as one of the original members, design methodology was a central concern as was the question of how to characterize design. Was it a science or something else that made use of scientific methods? What made design knowledge unique and different from other kinds of knowledge? Questions of what constituted design knowledge, how could design be characterized as a discipline, and what exactly were designerly ways of knowing persisted at DRS conferences and were continued in *Design Studies*, the DRS journal that was founded in 1979.

Design methods in the United States

Interest in design methods spread to the United States where a Design Methods Group was established at the University of California, Berkeley, in 1967. Shortly thereafter, the group began to publish the *DMG (Design Methods Group) Newsletter*, which provided news about research and new publications in planning, architecture, and industrial design (Bayazit, 2004). The leading figure in this group was Horst Rittel, a German, who had been at the Hochschule für Gestaltung, Ulm before he was recruited to teach in the College of Environmental Design at the University of California, Berkeley in 1963. Other active members of the Design Methods Group were two professors of architecture, Christopher Alexander and Henry Sanoff,
Alexander remained at Berkeley for the rest of his career but Sanoff had left Berkeley by 1968, the year he co-founded the Environmental Design Research Association, whose aim was to promote research on the relation of individuals to the environment.

Rittel rejected the early design methods as too rigid and simplistic. Instead, he argued that designers frequently dealt with “wicked problems” which he characterized as being “ill-formulated” and “ confusing” (Buchanan, 1992, p. 15). To replace the original methods, he proposed “second-generation design methods,” that would more effectively deal with complex situations (Bayazit, 2004). Alexander took a more extreme position. In 1971, he stated that rationality as the design methods theorists espoused it, “had become a toolkit of rigid methods that obliged designers and planners to act like machines...” (Mitchell, 1993, p. 51). Subsequently, he withdrew from the movement.

In 1968, Herbert Simon, who wrote his doctorate on organizational decision-making but later contributed to many fields including artificial intelligence, and computer-modeling, was invited to give the Karl Taylor Compton Lectures at the Massachusetts Institute of Technology (MIT). As his title, he chose *The Sciences of the Artificial* and the book that ensued, came to denote his broad interest in design and his belief, similar to that of early design methods theorists, that rational analysis was the best method for approaching design problems. Within today’s broad design research community, Simon is not well understood. He is mainly cited to justify the idea that design is not limited to a particular subject matter but can instead be broadly defined as a method of transforming existing situations into preferred ones (Simon, 1996). In fact, Simon, as a professor at Carnegie Mellon University, was involved in many areas of research that lie outside the boundaries of design as most researchers understand it.

In 1982, fourteen years after the Compton Lectures, a group of professors in the MIT School of Architecture and one from the School of Engineering founded the Design, Theory, and Methods Group. They included Louis Bucciarelli and Donald Schön, a philosopher who came to MIT in 1968 and became Ford Professor of Urban Studies and Education in 1972. The group also included Patrick Purcell, who had earlier collaborated with Bruce Archer at the RCA on a mathematical modeling system for design. Both Schön and Bucciarelli had an interest respectively in studying the working processes of architects (Schön) and engineers (Bucciarelli). In fact, Schön’s book *The Reflective Practitioner: How Professionals Think in Action*, published in 1983, became a foundational text for researchers who do phenomenological studies of how designers work.

Design Issues and the Ohio Conference

In the fall of 1982, the academic journal *Design Issues* was founded at the University of Illinois, Chicago and the first issue appeared in 1984. The five founders identified the themes of the journal as history, theory, and criticism, thus staking out a space in the field of design research that was not occupied by any other publication or discourse community at the time. The aim of the journal, as stated in the initial editorial was "to be provocative and raise controversial issues," rather than seek the foundations of a science or theory of design, The editors positioned *Design Issues* as "a journal of ideas that will embrace many forms from scholarship to polemics" (Margolin, 1984, p. 3). Their intent was to explore design as a broad part of culture rather than an enterprise with a particular theory or methodology. The journal's subject matter included both product design and graphic design and has continued to expand to cover new forms of practice such as interaction design and the design of aquariums and organizations. As the editorial policy evolved, the expression of pluralistic views became an explicit aim of *Design Issues*. The journal never sought to define itself as a scientific publication but rather its intent was to accommodate authors from numerous disciplines and practices.

Design education was always a welcome subject for *Design Issues* but the editors had never made a specific commitment to it as a special theme. In 1998, however, they organized a conference on doctoral education in design at Ohio State University. Participants came from almost twenty countries in North America, Europe, Latin America, the Middle East, and Asia. As Dennis Doordan noted in his introduction to the conference proceedings, "The Ohio Conference marked the end of an era of isolated efforts to provide doctoral level design education and the emergence of a vigorous international community of design educators" (Doordan, 1999, n.p.) Similar to the pluralistic editorial strategy of *Design Issues*, the combined papers did not represent a particular objective or point of view. Some reported on doctoral education in specific places; some discussed individual models or curricular content, and others tackled the difficult question of what constituted design knowledge. In his keynote address, Richard Buchanan, one of the *Design Issues* editors, noted that many design researchers were already pursuing multiple lines of investigation. "What is our task," he said, "is to understand the implications of such research, in its breadth, depth, and diversity, for shaping design as a legitimate field of inquiry" (Buchanan, 1999, p. 15). The implication of Buchanan's call was that no single definitional or methodological truth need be sought in design research but rather that useful knowledge would arise from an exposure to competing forms of inquiry and a consideration of their value for understanding and practicing design. Three subsequent conferences on doctoral education were held following the meeting in Ohio but after that discussions on the subject were absorbed into other events. One significant outcome of the conference was that two of the participants, David Durling and Keith Russell, founded the PhD-Design listserv, which has continued to function as a forum for discussion and debate on numerous topics.

Expanding the international network

Despite the burgeoning during the 1990s of societies and associations that addressed specific design activities such as interaction design, or software design, the Design Research Society maintained its identity as an organization whose membership embraced a broad range of interests. In 2002, the society organized *Common Ground*, a conference held near London that sought to involve researchers from some of the discourse communities that previously had little contact with each other. While it did not attract many representatives from the technically oriented design networks nor did many design historians participate, the conference nevertheless created a forum for a diverse group of researchers. The thematic inclusiveness of *Common Ground* became a new conference format for the Design Research Society, which followed it with three subsequent biennial conferences: *Future Ground* in Brisbane (2004), *Wonder Ground* in Lisbon (2006), and *Undisciplined!* in Sheffield (2008) and the format continues with the current conference.

Another group that began to organize research conferences with broad themes was the European Academy of Design, which was founded in 1994. Its stated aim was to promote research collaboration within Europe and to foster the publication and dissemination of design research. Since it's founding the Academy has hosted biennial conferences in different European locations and in 1997 it initiated its own publication, *The Design Journal*. More recent groups of European design researchers are Die Deutsche Gesellschaft für Designtheorie und -forschung (DGTF) (German Society for Design Theory and Research), which has organized five annual conferences since its founding in 2003, the Swiss Design Network, which held its first conference in 2004, and the Nordic Design Research Network, which mounted its own initial conference the following year.

In Brazil, researchers have organized eight biennial international conferences on design research and development in design. Brazilian researchers have been active for many years with special emphases on semiotics, ergonomics, eco-design, and design history. Several research journals are also published in Brazil: *Arcos*, initiated at the Escola Superior de Desenho Industrial (ESDI) as a printed journal but edited now in digital form, *Revista Estudos em Design,* published in Rio de Janeiro by the Associação de Ensino de Design do Brazil (Brazilian Design Education Association), and *Revista Design em Foco*, edited at the Universidade do Estado da Bahia.

In Asia, the first design research organization was the Japanese Society for the Science of Design, which was founded in 1954, followed in 1978 by the Korean Society of Design Science and some years after that by the Chinese Institute of Design. In 2005, these three societies, joined by the Design Research Society and The Design Society, an international group that originated in the Federal Republic of Germany, formed the International Association of Societies of Design Research, which thus far has held two conferences, the first at the National Yunlin University in Taiwan, the year the association was founded, and the second two years later at the Hong Kong Politechnic University. A third was held in October 2009 in Seoul, Korea.

This proliferation of design societies and conferences is markedly different from the aims that motivated the first design methods researchers. Design research, particularly as it is now ensconced within universities, has become an activity that is independent of any preordained purpose. This is valuable in the sense that the potential for a vibrant field exists but the danger lies in the possible absence of a clear sense of what such research is intended to accomplish. While there is no single goal for design researchers nor should there be, the aims of design research in the basic sense are to improve the quality of products and to reflect on the transformation of design practice while at the same time contributing to a greater understanding of design as a social phenomenon.

Conclusion

There is much that I have left out in this paper but to document the history of design research in a more complete way would require a book at least. Discourse communities related to artificial intelligence, design cognition, human/computer interaction, sustainable design, design for development and science, technology & society studies are active and regularly convene conferences and produce volumes of proceedings while research organizations such as Bell Labs, Xerox PARC, Microsoft, Google, and the AgeLab and Media Lab at MIT continue to transform technology into new products.

These new developments are evidence of how much design, design education, and design research have changed since the founding of the Japanese Society for the Science of Design in 1954 and the beginning of the design methods movement at the start of the 1960s. The rapid expansion of doctoral programs in design has created the need for a discourse community or communities that can publish and disseminate a growing volume of research. Thus far, some of this research has contributed to the development of new design practices such as interaction design, sustainable design, medical design, service design, organization design, universal design, and design for development. That is its positive side. It is also true that design research is not always directed towards shared questions or problems and consequently it attracts moderate interest and makes little or no impact on the field..

The problem with the disconnect between discourse communities is that much design that occurs today is highly technical and as it is configured into large systems it has a significant impact on our lives. We need more research to help us understand these systems. New connections need to be made between researchers who study design's meaning in the past, present, and potentially in the future and those who are doing the research that is generating new and unprecedented products.

Bruce Archer was prescient in recognizing the relation between two kinds of research, one directly related to making things and the other concerned with understanding not only things themselves but the milieu in which they are conceived, made, and used. The comprehensive taxonomy of design research that he outlined in his article "A View of the Nature of Design Research," in 1981 may not be the one we would adopt today but the sense of wholeness that it represented is something that we need to recapture. Archer was concerned with the practice (praxiology, modeling, technology, and metrics), understanding (history, taxonomy, axiology, philosophy, and epistemology), and teaching. We would do well to reclaim Archer's broad vision of design research and move it forward with contemporary methods, themes, and purposes.

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Representation-phobia and the complexity of embodied interaction

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Abstract

In current interaction design research there is a widespread belief that situated action and embodied interaction should replace mental representations in the theoretical account of human cognition. This exclusion of representation is however diagnosed as a sign of representation-phobia by Anderson (2003) who claims that it is misguided. This paper aims to show why and how it can be overcome. Initially, a literature review will show how representation-phobia manifests itself through two different versions in HCI research. On the basis of this I argue that representation-phobia leads to a theoretical dead end. Then, by drawing on semiotics and recent findings from cognitive research, I argue that we cannot understand the rich complexity of embodied interaction unless we furnish our thinking with a dynamic notion of representation.

Keywords: cognition, embodied interaction, representation, experiential knowledge, semiotics

In interaction design research, the two notions of “embodied interaction” and “situated action” are thought to be useful for understanding how to design interactive artifacts or environments that resonate with the rich complexity of our bodily and everyday interaction with the material world (Dourish, 2004; see e.g. Hornecker, 2005; Klemmer, Hartmann, & Takayama, 2006).

Despite their divergent foci of interests, proponents of embodied interaction and situated action generally share the view that cognition is not an internal affair in the head of the user, but something that is shaped and evolves through our actions as we react to real-time requirements from mundane settings. Further, in much recent work, the increased focus on action and bodily experience is coupled with skepticism towards the role of mental representations (Rowlands, 2009, p. 127). In fact, the adjectives “embodied” and “situated” are sometimes used as synonyms for the idea that cognition unfolds in a direct manner without the intervention of mental representations and that HCI would therefore be better off if is simply deleted the concept of representation from its terminological vocabulary. For this reason, embodied interaction and activity theorists often see their frameworks as being diametrically opposed to traditional HCI and classical cognitivism.

However, as Anderson has warned us, the just critique of traditional HCI’s notion of representation should not lead to a “representation-phobia” in interaction design research. Thus, according to Anderson, it is a mistake to exclude representations from frameworks of embodied interaction. What embodied interaction is essentially about is a re-thinking, rather than a rejection of representations (Hutchins, 2005; Rowlands, 2006, 2009; Sinha, 2005; Zlatev, 2005)

Interestingly, a similar warning is echoed in Suchman (2007) who is careful to underline, in the recently republished edition of *Plans and situated action*, that the supplanting of mental representations with action is a theoretical dead end. True, the nature and foundation of mental representations must be re-conceptualized, but embodied and situated cognition relies essentially on a subtle interweaving between action and mental representation.

The aim of this paper is above all to cure interaction design theory of its representation-phobia by showing that, contrary to what is being claimed, mental representations do in fact play a foundational role in user experience – even at the most basic levels of tangible and physical interaction. To set the scene, I begin with a literature review focusing on two different forms of representation-phobia and the common cause of their outbreak. First there is representation-phobia as it comes to the fore in ideas of embodied interaction claiming that our abstract reasoning and making sense of the world is primarily made up from meaning structures the nature of which is physical and spatial, not symbolic and representational. Second, there is representation-phobia as found in activity theory where it is reflected in the belief that mental representations are too static and inflexible for coping with the ever changing and ill-structured nature of everyday situations (for exceptions see Bærentsen & Trettvik, 2002).

Having identified the key characteristics of representation-phobia, I will draw on semiotics and findings from recent cognitive research in order to show why it must be abandoned. More specifically, I will argue that the discovery of canonical neurons show that representations are present at the most basic level of embodied interaction. This presupposes of course a well-defined notion of what a representation is. Therefore, I will provide such a notion together with a stratified model showing how low-level representations grow into more sophisticated symbolic forms. To improve the understandability of my argument, I will provide as many examples as possible throughout the paper.

1. Literature review: Representation-phobia in theories of embodied interaction and situated action

Since its early conception in the 1950s, research into the design of Human-Computer Interaction (HCI) has been a cross-disciplinary scientific enterprise encompassing computer science, cognitive psychology and Artificial Intelligence (AI). Out of this original core of HCI-disciplines various theories of the human mind and cognition have been developed over the years in order to understand how to design human-computer interaction in harmony with principles of human thinking and experience (see e.g. Carroll, 1987, 1991).

As is well known, theories of situated cognition and embodied interaction have been developed because of an increasing dissatisfaction with the once so dominant symbol system approach to cognition. According to this approach, which was originally founded by Newell and Simon (Newell, 1980; Newell & Simon, 1972) cognition basically consists in the algorithmic manipulation of symbol structures. Through the work of Newell and Simon's successors these symbol structures have become known in HCI literature as goal-oriented plans, scripts (1977) frames (1975) and mental models (Norman, 1988; Payne, 2003). Generally speaking, these concepts refer to the idea that we use stereotypical background knowledge as structures for comprehending events and objects reoccurring in everyday life. The basic assumption is that these knowledge representations are built in as part of a prior knowledge base in long-term memory, which we can recruit from for the purpose of planning and executing action relevant in a given situation. For instance, according to Schank & Abelson (1977) we presumably possess a RESTAURANT script representing background knowledge for a sequence of actions relevant to perform when visiting a such a place, namely entering >> get seated >> ordering >> eating >> paying >> exiting.

There are two main objections that have been raised against the notion of such inner symbols. First, it is claimed that symbolic knowledge representations are unable to account for how we handle problems and execute actions in everyday settings. Because representations, under the symbolic view, are algorithmic and presuppose pre-existing and static knowledge structures, while everyday situations, so the argument goes, are unbound and ill structured and therefore not compatible with this format (Winograd & Flores, 1986). Central for the consolidation of this objection was the work of Suchman (1987) who convincingly argued for the role played by the resources of the immediate situation in shaping human action. People are improvisatory and employ ad hoc rules for reasoning instead of abstract algorithmic rules for decision-making and inferences (Kaptelinin & Nardi, 2006, p. 16).

The second objection is that the symbol system approach completely ignores the role of the body for our understanding and making sense of the world. According to Newell and Simon inner symbols are “substrate neutral” in the sense that the nature of our bodies and perceptual apparatus is regarded as irrelevant for the constitution and structuring of their content. This is evidenced by a passage in *Human Problem Solving*, where Newell and Simon overly admit that they have omitted both low-level “sensory and motor skills, and many aspects of perception” from their study of symbols, because they do not consider these factors central for the constitution of symbolic activity (Newell & Simon, 1972, p. 8). However, as the proponents of the embodied mind paradigm have convincingly argued, we cannot understand human thinking and reasoning unless we take structures derived from our perceptual and bodily interaction with the physical world into account (Johnson, 1987; Lakoff, 1987; Lakoff & Johnson, 1999; Varela, Thompson, & Rosch, 1991).

Situated Action and Embodied Interaction are two conceptual frameworks that were introduced in HCI during the late 1980s and 1990s in order to compensate for the theoretical shortcomings of traditional HCI. While situated action is essentially about trying to understand how to design technological systems based on the principles of our online cognitive activity in the world (see e.g. Kaptelinin & Nardi, 2006; Nardi, 1996; Suchman, 1987; Wilson & Clark, 2005; Winograd & Flores, 1986), embodied interaction is a design theory focusing on how to design intuitive, tangible, graspable and direct physical interaction with technology (Dourish, 2004; Ehn & Linde, 2004; Hornecker, 2005; Hurtienne & Israel, 2007; Lund, 2003; Lund & Waterworth, 1998).

What these two approaches have in common, despite their many profound differences and divergent foci of interests, is a widespread distrust of the concept of internal symbols or any sign of mental knowledge representations. In fact, the adjectives of “situated” and “embodied” are often meant to put emphasis on the assumption that cognition unfolds in a *direct and distributed* manner and that human-computer interaction should therefore be conceived of as being non-symbolical.

For instance, AI-researcher and roboticist Rodney Brooks goes as far as to deny internal symbols any existence in his account of embodied cognition, and he claims that this insight is a prerequisite for building human-like intelligence successfully into robotic devices (Brooks, 1999).

In a similar vein, Tangible and Embodied Interaction is promoted as a subfield of interaction design that sees non-symbolic spatial and physical structures derived from sensori-motor experience as predetermining how people understand and make sense of the material world (Hurtienne & Israel, 2007). Under this view, Lund and Waterworth (1998), for instance, define embodied interaction as aiming towards building spatial structures into interfaces rather than seeking to communicate mental models (as suggested by Norman, 1988).

However, some proponents of embodied interaction are not convinced that ascribing primacy to spatial structures over symbolic representations is a tenable strategy. Dourish defines embodied interaction as a design research program that deals with the *relationship* between bodily and physical interaction on the one hand, and a symbolic realm on the other hand. Further, in his insightful field guide to Embodied Cognition (EC), Anderson (2003, p. 100) posits that:

> it is a vice too often indulged by scientists working in EC to make the absence of representations a touchstone of virtue in design, and to therefore suppose, just as do the creatures they devise in the lab, so too must humans display an intelligence without representation. Representation-phobia is a distracting and ultimately inessential rhetorical flourish plastered over a deep and powerful argument. For rather than targeting representation *per se*, the central argument of EC instead strikes at their nature and foundation.

Anderson argues convincingly that the conclusion to be arrived at is not that the symbolic representations of traditional HCI ought to be given up altogether, but rather that we must find ways to systematically relate the symbols and rules of abstract reasoning to the more evolutionary primitive mechanisms which control perception and action. If it can be shown that symbolic representations are at play in the cognitive processing involved in bodily and perceptual experience, then the representation-phobia of embodied interaction must be abandoned.

To expel representation-phobia from situated cognition requires a slightly different therapy. More specifically, it must be shown that representations play a genuine role in online cognitive activity and for the realization of actions. Interestingly, it is worth noticing that in the recently republished edition of *Plans and Situated Actions*, Suchman (2007) actually asserts that viewing her situated cognition framework as non-representational would be a gross misinterpretation of her original argument. In her book, she did not wish to deny the existence of plans conceived of as mentally projected representations of courses of future action. Rather, in 1987, when the book was originally published, Suchman wanted to point towards the critical and, at that time, largely overlooked role played by the immediate context as actions are realized, that is, how real-time requirements and unexpected changes in the context usually call for a continuous revision and modification of the mentally projected plans. Thus, Suchman sums up that her emphasize “is *both* on the utility of projecting future actions *and* the reliance of those projections on a further horizon of activity that they do not exhaustively specify” (Suchman, 2007, p. 19). And further on:

> My position then and now has been that plans are conceptual and rhetorical devices […] that are deeply consequential for the lived activities of those of us who organize our actions in their terms. Just how plans are consequential for the actions they project defined, at least potentially, a territory of mutual interest for the social and cognitive sciences. (Suchman, 2007, p. 20)

Try to compare Suchman’s theoretical afterthoughts with the following description taken from a special issue of the journal *Cognitive Science*, where Vera and Simon (1993, p. 10) defend the symbol system approach against the claim that it is incapable of relating inner symbols to actions in everyday settings:

> Symbol systems can be (and sometimes are) used to store in memory representations of external stimuli. They can manipulate these representations as one way of planning actions, and can then execute these actions to change the external situation. Of course, the internal representation of a real scene will be highly incomplete and may be inaccurate, with the result that the actions may or may not have their desired consequences.

Ignoring the fact that the term “system” would undoubtedly be foreign to Suchman’s vocabulary, we might say that for Suchman as well as for Vera and Simon, the projection of plans and the execution of actions constitute an open-ended feedback loop between a context, a conceptual system and a sensori-motor system. Hence, the situated action approach should not, as Suchman is careful to underline, be seen as antithetical to the symbolic approach. On the contrary, the two approaches would ideally be able to complement each other in productive ways.

Admittedly, as almost everybody else, Suchman has reservations concerning the narrow algorithmic definition of plans defended by Simon (Newell & Simon, 1972; Simon, 1969). But if the notions of plans and mental representation, as found in the symbolic approach, are broadened so as to include a more dynamic, flexible and situated understanding of the interplay between mental representations and real-time interaction, then a representational view of online cognition might even enrich the SA account of this interplay. This however would require a re-conceptualization of fundamental ideas and concepts belonging to the symbolic approach. The question is of course whether such a re-conceptualization exists? If it can be shown that it does, then the representation-phobia haunting much current work in situated action would seem unjustified.

2. Levels of mental representation

In this section I aim to show that mental representations permeate our perceptual and bodily interaction with physical objects. This presupposes of course that one has a more elaborate notion of what a representation is.

Taken in its most basic sense, a representation involves a sign that stands for something else in a real or imaginary world to the individual. Note that a representation thus consists of a relationship between three elements: world, sign and an agent. Smoke rising in the air stands for fire, but not in itself. It relies on the interpretive work of the perceiver. Just as traces in the forest standing for the feet of an animal or lines and figures on a picture plane standing for the naked body of the model.

Theories of representation in design research have often been criticized for naively believing that representations acquire their meaning from the things or events in reality that they refer to (cf. Krippendorff, 1992). But this criticism seems to have confused “reference” with “representation”. In semiotics, the term ‘reference’ is generally used to designate the relationship between a sign and its referent, while representation is seen as the activity of knowledge-making which the use of signs allows humans to carry out (Nöth, 2000, pp. 148-9). Representations are not mere copies or faded reflections of reality; they involve an active and deliberate use of signs motivated by the individual’s egocentric purposes and cognitive abilities. This is a key insight in the semiotics of Charles S. Peirce (Peirce, 1932). What makes Peirce’s semiotic project seem highly relevant even today is that he anticipates the idea in cognitive science that representation is the most central explanatory device for human cognition (Apel, 1981; Innis, 1994).

When applying the notion of representation to human cognition, we are postulating that mental states somehow act as representations. In cognitive science, it is common, as Cummins (1989) has shown, to distinguish between four different forms of mental representation. Mental representation may thus refer to (1) neuro-physiological states, (2) perceptual content, (3) mental concepts; and (4) more complex symbolic structures, which can take the form of mental models, frames or scripts.

The revolt against representations in embodied interaction hinges upon the idea that human thinking emerges primarily from sensori-motor interaction between an organism and its environment and that representation play no role at all at this level (Johnson & Lakoff, 2002, pp. 249-50). But what if neuro-physiological states in the sensori-motor brain actually show signs of representation themselves? Indeed, the recent discovery of canonical neurons asks us to consider this possibility.

2.1 Sensori-Motor Representations

Canonical neurons are neurons in the pre-motor area of the monkey brain (F5) that are activated when monkeys engage in action execution. In an experiment conducted by Murata et al. (1997), it was shown that canonical neurons that become activated when monkeys physically grasp an object also become active upon the mere observation of the object. Later studies have indicated that similar mechanisms exist in the human brain. This has been taken as evidence for the idea that canonical neurons are crucial for our ability to recognize object affordances: “when a three-dimensional object is seen, the F5 motor neurons for the actions it affords are activated“ (Sahin & Erdogan, 2009).

What is interesting about this study is that it points toward the centrality of representations in the sensori-motor system. If canonical neurons fire upon the mere sight of an object, then it means that, on a neuro-physiological level, they inform the organism about a possible future action that can be performed with this object. They do not refer to the object as such, but help to select one functional value of the object that might be relevant for the organism-environment interaction. In this sense, canonical neurons seem to be a good candidate for a neuro-physiological state that acts as a representation as shown in Fig. 1:

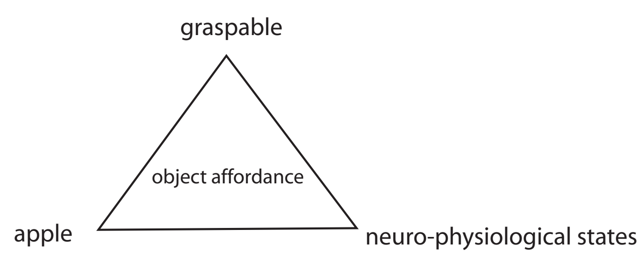

Fig. 1 The representational structure of object affordances

This is in line with Jeannerod (1994) who argues that these neurons are rough motor representations encoded into our semantic knowledge about the object. These motor representations contain initial plans for generating low-level kinesthetic operations presupposed by the execution of an action, for instance grasping, holding, throwing, and so forth. It is important to note that the motor neurons represent a *type* of action and not the bodily operations themselves. This means that if we see a red apple, we may recognize immediately – thanks to the neurons – that it is graspable. But these motor representations evoked from this perception say nothing about whether we should use our left or right hand for carrying out this action.

2.2. Affordances as representation

The discovery of canonical neurons seems to run counter against the concept of affordance, as it was originally introduced in Gibson’s ecological theory of perception

(Gibson, 1977). According to Gibson, affordances are possibilities for action that we simply pick up at a pre-reflective level of awareness. As such affordances are thought to be perceived directly without the interference of mental representations or higher-order cognitive operations of any kind. However, Rowlands (2006) has argued that we need to take a refreshing new look at this assumption, because it rests upon a too narrow view of the forms representations may take.

According to Rowlands, there are three kinds of actions that we need to be able to distinguish from each other: *actions, deeds and doings*. An action is inextricably bound up with our intentions such as our volitions, motives or belief-desire couplings. Deeds are defined as pre-intentional acts that depend on the online, feedback-modulated adjustments we perform during the course of interacting with the environment; and doings are sub-intentional acts that are not performed for any reason. Let me try to explain this in more detail.

Actions are performed for some reason in order to accomplish a goal or realize a state of affair that will satisfy our intentions. In philosophy, there is a strict concept of action that holds that the status and identity of an action can only be defined in terms of an antecedent intention (Rowlands, 2006, pp. 96-7). For instance, I may whistle a melody while, at the same time, tap my foot on the floor. Are there one or two actions involved here? According to the strict concept of action this can be determined by asking what intentional states I am the subject of. If I am the subject of a single intentional state then there is only one action. Thus, if my intention is to tap my foot while whistling (for instance as a way to keep the beat), then the corresponding action is one rather than two. If, on the other hand, I am trying to tap my foot and trying to whistle, which just happens to be synchronous, then according to this view I would be performing two actions instead of one (cf. Rowlands, 2006, p. 96).

By reaching out for a goal or state of affair in the near future an intention clearly bears the mark of a representation as it has traditionally been defined. More specifically, an intention can be seen as a plan that is projected imaginatively (however short-lived) and that contains motor representations for how this plan could be fulfilled .

It is important not to confuse these motor representations with the motor representations that have been discovered to be at work at the level of canonical neurons. Compared to intentional states, canonical neurons are intimately bound up with their connection to the physical environment and the perceptual acts we perform in order to cope with our surroundings. Their firing depends utterly on the directness and presence of objects and information available from the environment. Suppose my sister gets angry with me and wants to throw an object at me. She may quickly scan the room visually for objects with the functional value of being *throwable*. In this scanning process canonical neurons may fire upon the sight of an apple, a tennis ball, or a pencil, but not on her viewing the teak dining table in the corner or the car parked outside the window. This means that the canonical neurons are activated because of an action potential evoked from my sisters perceiving of the first three items. Since throwable is indicated from her perception of very different phenomena, it cannot be reduced to some physical properties. Rather it is dependent on the relationship between the surface of the object and the visuo-motor operations of the perceiver. In this sense throwable counts as an affordance. However, since throwable can also be applied to various different phenomena, it must have a certain type-like quality about it. Hence, it also qualifies as a representation.

According to Rowlands many of the acts we perform in order to exploit and manipulate object affordances are not anticipated by any intentional states in the strict sense. Suppose I have noticed the intention of my sister and I therefore start running to escape her attack. In a second or so, she must pick up a throwable object, before I run out of the door. She immediately grasps the pencil and throws it at me. Less than a second is not sufficient to form the intention of whether she should pick up the pencil by grapping it with her whole hand or if grasping it between her thumb and index finger gives a better hold. “In such situations we simply find ourselves acting” (Rowlands, 2006, p. 104). Since these acts cannot be determined with reference to an antecedent intentional state, they are not actions taken in the strict sense. Rather they are what Rowlands calls “deeds”. Deeds are pre-intentional, meaning that even though they are performed in order to fulfill a goal, they cannot be accounted for in terms of intentions. However, they are not reducible either to mere bodily movements, since we do perform them for a reason.

This is what distinguishes deeds from doings. Doings are sub-intentional acts we perform without any reason. If you start attending to your bodily limbs and organs you’ll notice that almost every part of you are in motion: your tongue, toes, eyes, and so forth. We simply cannot help performing these micro-sensational acts or doings to use the term suggested by Rowlands.

By using Rowlands’ three categories, it has been possible to differentiate between representations at the level of actions and representations at the level of deeds, that is the online feedback-modulated adjustments we perform in order to handle everyday situations. These representations are to a very large extent detected by canonical neurons in the flow of our interaction with the physical environment. However, while canonical neurons may inform us about the type-like actions potentials of visible objects – for instance that an apple is graspable – another question that seems relevant to ask is whether we also know from the canonical neurons that the apple is tasty and juicy inside? (cf. Eco, 2000) This seems highly unlikely. The background knowledge we use for inferring such gustative qualities from the apple depends rather on knowledge acquired through our previous experiences of objects of the same kind. If you have never eaten an apple before, you wouldn’t now what to expect. This implies that we draw on prototypical conceptual representations of objects stored in our memory in order to project plans for more complex embodied interactions with the objects at hand. These representations are involved in the forming of intentional states and in the next sections I will briefly account for these representations in terms of concepts, perceptual judgments and mental frames.

2.3 Mental Concepts

It is generally assumed in cognitive science that we use mental constructs of the kind that is usually referred to as ‘mental concepts’. Thus we have concepts for almost everything in this world: apples, stones, the sun, God, shopping malls, and so on. When we encounter things and events, we not only use mental concepts for determining the nature of objects. We also employ them for making what is known as *perceptual judgments and for performing more abstract forms of reasoning*. According to Eco (2000, p. 63) a perceptual judgment is a hypothetical inference based on object affordances and other perceptual inputs that we set up in working memory for purposes of local understanding. Some examples of perceptual judgments would be: “This X is an apple” or “Apples are juicy inside”. Or “This X in front of me is a stone”, “It is struck by sun light”, and “it is hot” . We may even construct more complex propositional representations out of these perceptual judgments, for instance, if we manage to reach the conclusion that “The sun heats the stone”. In this instance we subsume a particular relationship between two entities in the world under the general law of C*ause-Effect*.

Interestingly, Johnson (1987, pp. 37-40) has argued that such logical inference patterns like Cause-Effect, the Law of the Excluded Middle and the Law of

Transitivity, which we normally see as part of abstract symbolic reasoning, have their intuitive basis in our daily experiences with physical objects and orientation in space. The idea then is that symbolic reasoning is constrained and, to some extent, made up from structures derived from sensori-motor interaction between the organism and its environment (this idea is accurately captured in the so-called Spatialization of Form Hypothesis, see Lakoff 1987, p. 283). While Johnson who is an esteemed philosopher argues convincingly for this idea, the truth of his claims has in fact not only been anticipated, but also demonstrated by the experimental phenomenologist Albert Michotte. Through a series of empirical experiments Michotte found that our immediate sensory experience consists not only of objects or entities, but also their causal relations (see e.g. Michotte, 1963). For example, in one of his studies Michotte proved that the duration of contacts between two colliding objects is crucial for how we understand their causal relation. This study is nicely summarized by Heft (2003, p. 167):

> If an object "makes contact" with another, and then ceases moving just as the second object begins to move along the same prior trajectory, observers report that the first object "launched" the second. However, when the first object even after contact continues to move along the trajectory with the now-moving second object, observers report a pushing or a chasing ("entraining") rather than a launching effect.

Michotte's study shows that spatio-temporal relations among objects that we experience might lead to our perception of different types of causal effects. A result like this challenges the influencing assumption that was introduced by Hume, namely that entities in sensory experience are disjoint and that the order and lawfulness, they appear to have, are the result of reflective operations on the part of the subject that subsume sensory tokens under *a priori* logical principles of the intellect (an idea that reached its culmination in Kant's *Critique of Pure Reason*). What Michotte's experiments reveal is that some causal effects are not the result of reflective intellectual judgments, but of pre-reflective perceptual judgments.

However, in order to provide an adequate account of human cognition, we need to move beyond the level of perceptual judgment toward inferences and mental representations of an increasing complexity. There is clearly a difference between perceiving one ball as having a launching effect on a second ball and the causal relations that may be involved, for instance, in the planning of a trip to Montreal. Eco (2000) has suggested that we conceived of inferences as semiotic processes that work their way up from the level of sensory experience to higher-order mental representations as a kind of scaffolding process. Like a cognitive spiral where low-level meaning structures develop into ever more complex mental representations. For instance, according to this model object affordances are integrated as part of the perceptual image of 3-dimensional objects; this perceptual content can then integrated as part of perceptual judgments or be subsumed under mental concepts, when, for instance, we identify this X as a species belonging to this category. Further, mental concepts can be integrated as part of more advanced symbolic forms such as mental models, frames and scripts. If we take an apple as our example this scaffolding process can be diagramed as in Fig. 2:

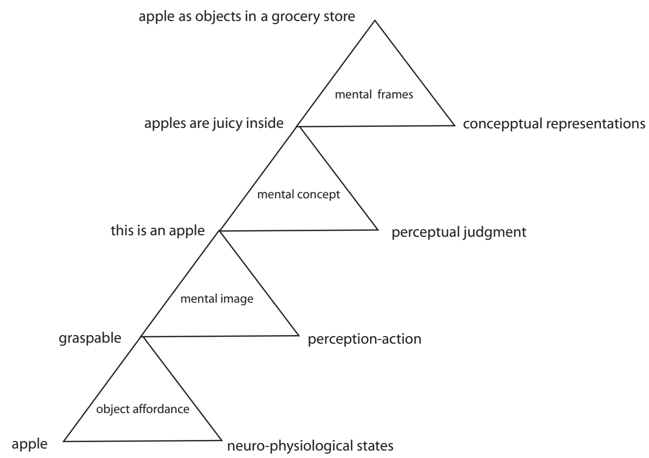

Fig. 2 Diagram of how higher-order cognition relates to the mechanism controlling perception and action.

The interconnected triangular structure of Fig. 2 illustrates how representations from low-level cognition grow into more complex knowledge representations. The next two sections will explain the nature of these representations.

2.4 Mental Frames

Apart from perceptual judgments, mental concepts are also important for building up even more complex networks of conceptual representations. Among such networks we find mental frames. Basically, a frame is conceived as referring to an organized system of concepts representing stereotypical background knowledge that people unconsciously draw upon when using language and thinking and acting in the world (Kövecses, 2006, p. 69). Consider Fillmore's (1982) so-called BUY frame (see Fig. 3). The idea is that we would not be able to understand the meaning of the verb "buy", unless we automatically activate a mental frame that allows us to make default assumptions about the situation that the verb can be used to describe. For example, "buy" presuppose a *buyer* owing an amount of *money*, a *seller* that offers some *goods* that the buyer wants to have, and so forth (cf. Ungerer & Schmid, 2006). Since the frame thus represents intentional roles they are important for forming goal-oriented plans.

Fig. 3 Fillmore's Buy Frame (adapted from Fillmore, 1977)

In Artificial Intelligence Minsky (1975) found the notion of frame valuable for explaining people's default knowledge about objects or events involved in routine tasks and reoccurring situations in work places. In cognitive psychology and cognitive linguistics it has also been shown that we use frames in our perception, planning and memory for events (Coulson, 2001; see also Barsalou, 1992). In so doing, we become able to create expectations and make predictions about the consequences of actions in a given context.

For example, I may have some friends coming over for dinner. To surprise them I want to make a juicy apple pie. But I realize that I don't have any apples at home, so I go to the grocery store to get some. To fulfil this intention I must draw upon a rich array of conceptual representations and knowledge structures. For instance, I need to be able to distinguish certain sort of apples from others, so that I'll get the right ones for my pie. At the point where I have to pay for the apples, it might be assumed that I draw unconsciously on a BUY frame in order act appropriately in this economic transaction. Obviously, the structure and content of such a frame will be sensitive to people's socio-cultural learning and background. For instance, in the Southern parts of Europe it is custom to bargain over the prize, while in the Scandinavian countries it is not. Hence, the precise nature of the BUY frame must be assumed to vary slightly from one cultural context to another.

However, while this is relatively uncontroversial, one of the main critiques of the notion of frames is that it is unable to account for how people manage to cope with changes in practices, unforeseen occurrences or novel situations that violate their expectations. Being products of long-term memory, frames offer pre-existing and default mental templates for thinking, not dynamic and flexible models adjustable to the immediate context as actions are realized. This is one of the central objections made by proponents of situated action and distributed cognition.

To many situated activity theorists, our everyday life seems most of all to resemble river rafting. In river rafting it is impossible for the canoeist to act according to abstract mental plans, because the violent stream, turbulence and protrusions, force him constantly to improvise and act according to *ad hoc* rules in order to control and keep the canoe in balance.

Everyday situations have their own turbulences and protrusions. Ethnographic field studies of people's shopping behaviour have been taken as evidence for this. When people are going to put the items they have bought into a shopping bag, there are typically a whole series of factors that might distract them from the purpose of their actions. Items come down the line in the shopping mall in a random order, so it is a challenge to us to decide what items should go in the bottom and which ones at the top. Then, while we are in the midst of packing our bag, our mobile phone may start ringing, or the cashier may interrupt the course of actions telling us that we haven't given him the exact amount of money. In such instances, it is unlikely that we rely on an abstract representation or algorithm in the head telling us what to do. Or put more accurately: perhaps there is such an algorithm but it is of no use, since unforeseen occurrences and events constantly force us to deviate from such idealized mental models. To explain how we nevertheless succeed most often in getting home without finding splashed eggs in our shopping bag, it has been suggested that we use the items themselves as external vehicles for informing us about weight and size and whether they should be placed in the bottom and at the top. By externalizing cognitive resources into the environment we are able to adjust to real-time requirements (see e.g. Hutchins, 1995; Kirsh, 1995).

However, even though I agree that such situations undoubted question the universal validity of abstract mental representations such as frames, they should not be taken as a model for all forms of cognition (Rowlands 2006). Just as well-structured intentional acts such as following a recipe or going to the grocery store should not be taken as a model either. Moreover, even stressful situations do not prove that the role traditionally assigned to representations can be completely taken over by actions without representations. Spontaneous acts and improvisation that we may perform during our shopping do not unfold beyond the representational. If so, they would be reducible to mere doings, bodily movements that are performed without any reason.

This is clearly not the case. We perform those acts spontaneously in order to accomplish goals or satisfy our will. Hence, they are deeds that – as we have seen – rely to a large extent on representations, however not of the kind that intentions are made up from. Deeds stand halfway between doings and actions. They involve our real-time coping with representations at the level of canonical neurons and direct perception.

3. Conclusion

To sum up, in this paper I have argued that representations permeate our entire existence from its most basic manifestation at a neuro-physiological level to conceptual representations in people's memory motivated by social-cultural learning and practices. We must of course recognize that representations come in various forms defined by increasing complexity (cf. Fig. 2).

If this idea is taken seriously, then we must reject the idea that the absence of representation should be made a touchstone of virtue in design. Many representation-phobic researchers either from the design or HCI community seem to believe that embodied interaction is a design strategy for working primarily with physical structures at the sensori-motor level. However, from a representational point of view, physical structures can only be properly understood if they are seen as one element in a triadic relationship between object, sign, and organism.

Taking my point of departure from Anderson (2003) and Suchman (2007) I initially claimed that the central argument of embodied cognition and situated action consists in a re-conceptualization rather than a rejection of representation. More specifically, this re-conceptualization relies on one being able systematically to relate the symbols and rules of abstract reasoning to more evolutionary primitive mechanisms, which control perception and action (Anderson, 2003). In order to carry out this task I first drew upon Rowlands' (2006) distinction between actions, deeds and doings, which allowed me to isolate representations at the level of intentions from representations at the level of our pre-intentional perceptual interaction with the physical world, that is deeds. The latter are adjustable to dynamic changes in the context. In this sense, it seems as if deeds could have the potential of bridging a situated action perspective with a representational perspective. This however needs to be studied more carefully in a future work.

Furthermore, I have attempted to show how the ability to infer generality in terms of laws and relations between objects in perception (such as Cause-Effect), which we normally associate with abstract reasoning, in fact emerge from primitive mechanisms in perception itself.

In order to provide the reader with a clearer view of the rich interplay that are at stake from neuro-physiological states to abstract thinking, I have laid out a diagram in Fig. 2. Much of what has been said about the upper levels in this diagram is standard knowledge in cognitive science. However, the idea of including these levels in the diagram is of course that embodied interaction encompasses the whole continuum of representations from canonical neurons to mental frames. It is this continuum that accounts for the full complexity of embodied interaction.

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Lighting Design: Non-visual impacts and its influence on employees' health and well-being

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Abstract

In the last ten years, findings in medical science reveal that light plays important roles in maintaining optimum regulation of biological rhythms and hormones on a daily basis. Despite the decades of research, it was only in 2002 that David Berson discovered the connection between light and a third type of photoreceptor in the retina and this was the missing link in the description of the mechanism of biological effects controlled by the light and dark cycle. This discovery revolutionized the research on the spectrum, the intensity, the duration and the type of light that affects biological responses. This work addresses this issue of non-visual impacts of human exposure to light, in an attempt to relate the quality of lighting design to health, comfort, and well-being of female retail store employees. The sample for the cross-sectional study was randomly established with 30 female volunteers in street retail stores (possibility of outside visual contact) and shopping mall retail stores (no outside visual contact). Assessment of lighting considered the occurrence of glare, color appearance of light, flexibility, and possibility of lighting control by employees. The tools to assess well-being and health were psychometric scales internationally validated by the psychiatric field to measure depression, anxiety, and stress symptoms. Assessment of sleep conditions and analysis of the activity/rest rhythm was carried by a wrist monitor with attached luximeter and the analysis of the body temperature rhythm was made by a temperature sensor, to which each participant was submitted for five consecutive days. The lighting pattern's influence on the circadian system was verified by measuring saliva melatonin and cortisol levels. The degree of satisfaction of employees and their preferences regarding work environment lighting were surveyed by applying questionnaires. Data were analyzed using Pearson correlations, ANOVA, and stepwise regression.

Keywords

lighting design; health; circadian rhythm; cortisol; melatonin; retail stores;

The role of design has become increasingly more complex in daily life, increasing the need for understanding users' desires, needs and priorities and the way they interact with new products and technologies, which include, among others, new lighting design technologies. Studies (Campbell et al., 2007; Margolin, 1997) have systematically pointed out the relevance of incorporating the information provided by the user into the design in order to develop innovative products, spaces and, especially, sales outlets. In the specific case of lighting in retail stores, the previous work by the author (Martau, 2009) shows that there is a significant conflict between a lighting design oriented to product sales and a design oriented to the health and well-being of store employees, which can influence their productivity. In view of these complex challenges, a user-based research approach is an alternative for qualifying answers provided by the design. The Human-Centered Design approach aims at the better understanding of human needs in order to monitor, assess and propose innovations in the field of design having social and financial viability in mind. Desmet and Hekkert (2007) describe the potential of this research approach which encompasses from behavior studies to the affective experience resulting from the interaction between humans and products to define design attributes and parameters (Wellings, Williams & Pitt, 2008). The study of the interaction process between user and retail store lighting system has this goal, since in placing human beings once again as the central object of lighting design new strategies need to be established so as not to fail to address the primary objective of a retail space, namely, advertising a product or brand while at the same time allowing users/workers to be in good health and well-being conditions.

Background

The architectural typology adopted in shopping mall buildings in Brazil and the type of service provided generate many environments without outside contact and work shifts that advance into the night, both potential factors for the alteration of biological rhythms. A major challenge in the past years in the illumination field has been to define how light affects health, not only in aspects related to vision, but also related to metabolic processes (studies of circadian rhythms and tumor development, for instance). A population of special interest for the study of the relationship between light and health conditions is that comprising shopping mall employees, who are subject to artificial lighting in environments without windows during the day and often work until late at night. These individuals seem to be potentially more susceptible to diseases related both to excess lighting and to insufficient lighting. Although literature presents several studies on offices (Galasiu & Veitch, 2006) there are very few works relating commercial space employees to lighting (Heschong Mahone Group, 2003), both in the area of architecture and marketing or behavior, in which only Bitner's work (1992) stands out for including the employee and not only the consumer. Consequently, many shopping mall buildings have uncomfortable conditions for occupants, who, out of necessity, end up adapting themselves to the environment (Martau e Duro, 2005; Martau, 2009).

The knowledge about the relationship between lighting, man and Architecture can be summarized through several approaches to this topic. Regarding human performance, there are three main routes of analysis: through the visual, perceptive and circadian systems. The two former have some consolidated knowledge demonstrating how to illuminate in order to obtain visual comfort and stimulate perception. However, the knowledge of the relationship between lighting and the so-called human circadian system (24-hour daily rhythms) is still incipient. Exposure to light may have both positive and negative impacts on human health. These impacts may become evident shortly after exposure or only after many years. Understanding how light influences the human body helps describe the impact of lighting on building occupants.

The circadian rhythms can be regulated by a variety of external indicators, but light (light/dark cycle) is the primary and most important variable in the synchronization (or desynchronization) of humans with day or night rhythms (Gronfier, Wright, Kronauer, & Czeisler, 2008). he activity-rest rhythm, the body temperature rhythm and the hormone levels (melatonin and cortisol, see figure 1) are examples of light-regulated biological rhythms in the body that can be measured. When an individual is in a healthy state, all of his/her rhythms have a natural relationship, we say that said individual's phase is normal (Kaplan, Sadock, & Grebb, 1997). When the system is disturbed (by staying up at night, for instance), some biological rhythms become disarrayed (e.g., cortisol or melatonin rhythms) and are considered to be out of phase. The fact that the biological rhythms are out of phase contributes to the harmful effects experienced by the individuals. Some disorders have phase disturbances among their symptoms.

Melatonin is a very important hormone in the investigation of human biological rhythms regulated by the light/dark cycle (Kaplan,Sadock, & Grebb, 1997). The relationship between melatonin inhibition and light is direct, and melatonin responds to lighting only. Its rhythm is considered an excellent phase marker for the endogenous biological clock (Arendt, 2005), and it may also be a great indicator for the quality of lighting in relation to employees' health.

Cortisol is another hormone that takes part in the so-called adrenal axis. Cortisol shows a clear circadian rhythm, with its peak around the time the individual wakes up (Kudielka & Kirschbaum, 2003). Cortisol plasma concentrations are higher in the early morning (around 6 a.m.) and their values are lower in the afternoon and evening. As cortisol is controlled by the biological clock in the suprachiasmatic nucleous (SCN), cortisol rhythm and concentration are expected to be influenced by light.

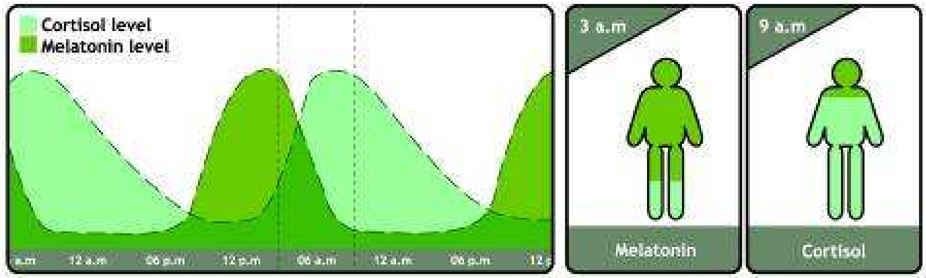

Figure 1: Relationship between melatonin and cortisol rhythms

The body also has an endogenous temperature rhythm called body temperature rhythm, which is considered to be the most stable body rhythm in relation to external variations (Noguera, Riu, Hortensi, & Cucurella, 2007). The hormones cortisol (stress hormone) and melatonin (sleep hormone) play an important role in the sleep/wake regulation, and there are some rhythm relationships between cortisol, melatonin and body temperature. In order to maintain one's health, it is important that these rhythms remain steady. Biologically, the time and duration in which light (or darkness) is received play a crucial role in establishing body temperature (Boyce, 1997).

Studies have shown that stress is also associated with lighting conditions. Stress changes rhythmically with diurnal regulation, as well as with cardiac regulation and neuroendocrine responses, which seem to be responsible for the higher rates of cardiovascular disease found in chronically stressed individuals (Monk, 1983).

Research goals and Methodology

The general goal of this study was to evaluate how lighting conditions interfere with the health and well-being of street retail store and shopping mall retail store employees in Porto Alegre, a city located in south Brazil. For this purpose, specific goals were also defined: to characterize the relationship between lighting conditions and emotional variables such as depression, anxiety and stress; determine if differentiated lighting conditions interfere with the biological rhythm (sleeping conditions, activity/rest rhythm, and body temperature rhythm); determine the levels of the hormones melatonin and cortisol in female employees' saliva in relation to different lighting conditions in stores; and verify female employees' satisfaction and preferences in relation to lighting systems at the workplace. The research was characterized as an exploratory study, with empirical investigation of phenomena in their actual context, with multiple evidence sources (variables).The study sought to assess and relate visual, biological and emotional aspects of lighting in the stores analyzed from the perspective of the individuals who worked therein (figure 2).

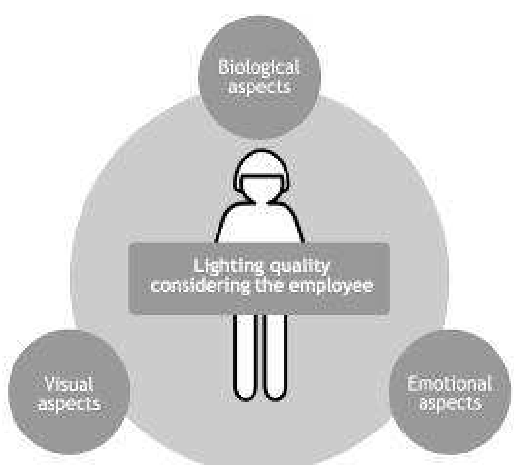

Figure 2: Lighting quality: visual, emotional and biological aspects should be considered

Subjects

Women aged between 18 and 65 years, who lived in the city of Porto Alegre, were selected. All subjects were employees in commercial spaces and must have been working for at least one year at the place and shift under study and could not be working double time. Despite minor variations in entry, lunch, break and exit times, female employees who worked for five to eleven hours on a daily basis were included. All of them volunteered for the study. They were divided in three groups:

- Group A: Ten street retail store employees with presence of daylighting and daytime work (8 a.m. to 6 p.m.).
- Group B: Ten shopping mall retail store employees, without presence of daylighting, and daytime working hours (10 a.m. to 6 p.m.).
- Group C: Ten shopping mall retail store employees, without presence of daylighting, and afternoon and evening working hours (2 p.m. to 10 p.m.).

Procedures and equipment

Evaluation of lighting conditions

Lighting conditions were evaluated by taking photos of the luminous environment and by completing a survey form in which the main aspects of the physical environment and lighting system were recorded: ground plan of the spaces under study, containing the shape and basic dimensions, description of materials and colors, list of light bulbs and luminaries. Items such as color appearance of light bulbs were obtained from the manufacturer's technical specification catalogue. The entrances were marked (if any) and the distance between the employees and the entrance was measured. The general illuminance of the space was measured at four points (to average general illuminance) and at work planes with a portable lux meter. The spaces with day lighting were measured at noon, within the climatic period referred to as spring/summer, on days without rain and at times without direct insulation into the space. All the spaces analyzed had an artificial lighting system activated throughout daytime or at least most of daytime, day lighting in these spaces being, therefore, only quantitatively complementary. The visibility of visual tasks was checked by using the Snelling Chart, which is a standard test to assess visual acuity at preset distances. Undesired reflections were evaluated by moving around the space and placing a reflective surface at different positions to check the presence of it. See synthesis of procedures in figure 3.

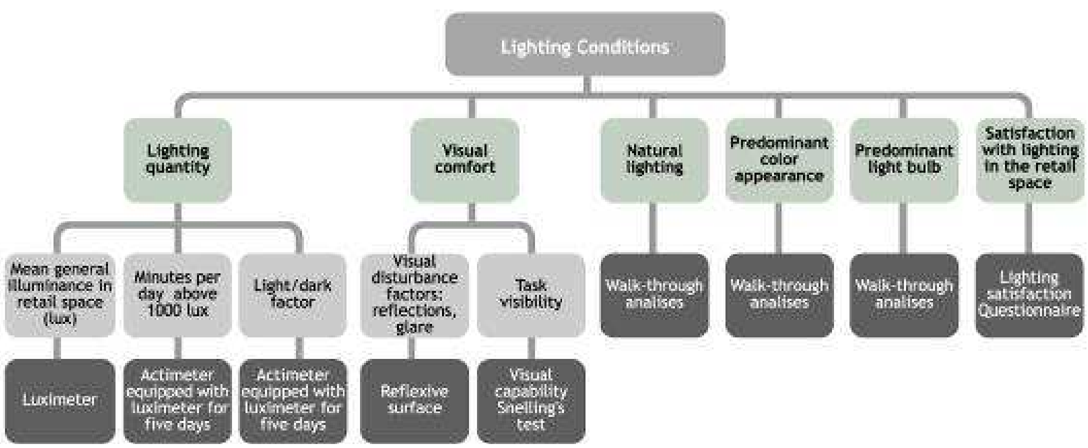

Figure 3: Synthesis of procedures for evaluating lighting conditions

Evaluation of satisfaction with workplace lighting

To evaluate employees' satisfaction with the store lighting, a questionnaire was applied which was developed from other lighting quality evaluation tools (Bean & Bell, 1992; Boyce & Eklund, 1995; Veitch & Newsham,1995; Veitch, 2001), as well as adaptations of part of the guide proposed by the Commission Internationale de l'Éclairage (Commission Internationale de l´Éclairage, 1986 &1972) to evaluate lighting in office environments, with adjustments to the type of existing visual tasks in commercial spaces.

Evaluation of emotional aspects: possibility of mental disorder, depression, anxiety and stress

To evaluate emotional aspects, the so-called psychometric scales were used, validated for Brazilian Portuguese. These are: Self Reporting Questionnaire -SRQ-20 (psychiatric disorder) (Mari & Williams, 1986), Montgomery-Asberg Depression Rating Scale (Dractu, Ribeiro,& Cal,1987), Beck Depression Inventory – BDI (Gorenstein, Andrade, Vieira Filho, & Tung, 1999), Hamilton Depression Scale (Hamilton,1967), State-Trait Anxiety Inventory –STAI (anxiety) (Spielberger,1983) and Lipp's Adult Stress Symptom Inventory (LSSI) (Lipp & Guevara) for stress assessment.

Assessment of sleep conditions

The Pittsburgh Sleep Quality Index questionnaire – PSQI (Buysse, Reynolds, MONK, BERMAN, & KRUPFER, 1999) and the Epworth Sleepiness Scale (Johns,1991) were used to evaluate quality and daytime sleepiness.

Assessment of the timing system: body temperature rhythm and activity/rest rhythm

Body temperature was measured continuously, for five days, by means of a thermistor (Ibutton, 2008) used together with an actigraph (Mini Mitter, 2007) to check if there were changes in the body temperature rhythm between the groups. It was fixed with an adhesive on the internal region of the forearm (figure 5 and 6). The Activity/Rest rhythm was measured by an actigraph with a coupled lux meter (figure 4), for a period of five consecutive days, always including the weekend. The use of an actigraph allowed the illuminance patterns to be analyzed for 24 h in each employee.

Figure 4: Actimeter placement on the wrist of the non-dominant hand.

Figure 5: Thermistor placement on the internal area of the wrist of the non-dominant hand.

Figure 6: Fixation of a thermistor on the internal region of the wrist of the non-dominant hand with skin-colored tape.

Melatonin and cortisol

The melatonin and cortisol levels were analyzed in the saliva, collected by the employee herself (participants were asked to rinse their mouth with water before collecting saliva) directly by expectorating into a collecting tube (12a.m,18 p.m.,12 p.m). After the collections, the saliva was frozen. For melatonin levels, a commercial ELISA kit from APCO Diagnostics® (ELISA kits, Buhlmann Laboratories, AG Swiss) was used. For cortisol levels, a Roche chemiluminescence kit was used. All the procedures for evaluating health and well-being conditions are synthesized in figure 7.

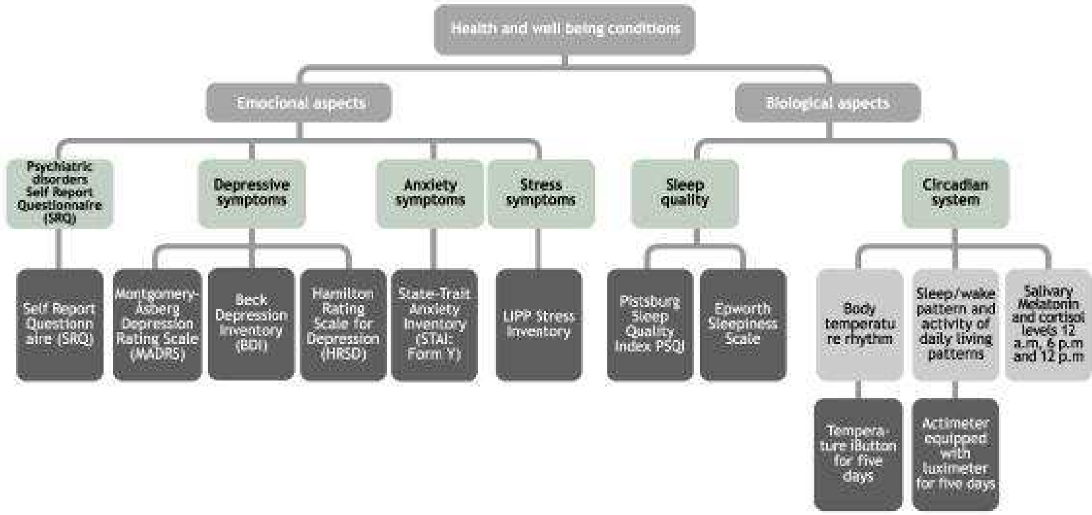

Figure 7: Synthesis of procedures for evaluating health and well-being conditions

Data processing and statistical analysis

Data were organized in a databank using the Excel software (Microsoft). The statistical analysis was carried out with the Statistical Package for Social Science (SPSS) program for Windows, version 13.0. A consistency analysis of the results was performed after the tools were applied by means of the Cronbach's alpha. The distribution of variables was described as mean and standard-deviation or frequency and proportion, when suitable. Stepwise multiple regression analyses were performed. Correlations between variables were analyzed using Pearson's Correlation Coefficient and variance analysis (ANOVA). The potentially confounding variables controlled in the statistical analysis were age, working hours and working shift

Results and Discussion

The results point to a greater dissatisfaction with the workplace lighting in the category shopping malls (groups B and C) than in street stores (group A). This dissatisfaction is highlighted in some aspects assessed, such as possibility of contact with the outside, lighting for the employee to feel relaxed, happy and motivated to work, in which the scores are far lower than in the street store group. The stores of groups B and C, where dissatisfaction with lighting in general is 20% higher than in group A, were the ones in which the employees reported greater dissatisfaction with the absence of visual contact with the outside, which was found to be inversely correlated with depression (Beck) in group C, specifically. The study in the stores demonstrated that the individuals who were more satisfied with the lighting system (independent of the type of lighting to which they are subject) are the ones having a greater light/dark factor and greater satisfaction with the possibility of visual contact with the outside, and these were in group A. In this group, the greater the satisfaction with the possibility of visual contact with the outside was, the lower the depression scores were (Montgomery-Asberg).

The most consist finding, which has a greater impact on the current lighting practice in shopping malls is the inverse correlation found between the average general illuminance of a store and the satisfaction with lighting, as well as the positive correlation of this variable with scores showing a possibility of mental disorder and depression, in group B, and with biological indicators (24-h temperature and melatonin acrophase) in group C. The shopping mall retail store groups presented greater average illuminance in the store (340 lux, group A, 478 group B and 666 lux group C), with predominance of words chosen by the employees describing illuminance as "bright and glaring", who showed a greater need for modifying the amount of lighting in the store, and the main change desired was a reduction in lighting during daytime. These results point to excess lighting for the employee, which may be related to greater stress, anxiety and tendency to cortisol rhythm loss in group B, and, in group C, higher scores indicating a possibility of mental disorder, depression and worse sleep quality, as well as changes in the 12-h melatonin level, with likely phase delay in the production of this hormone.

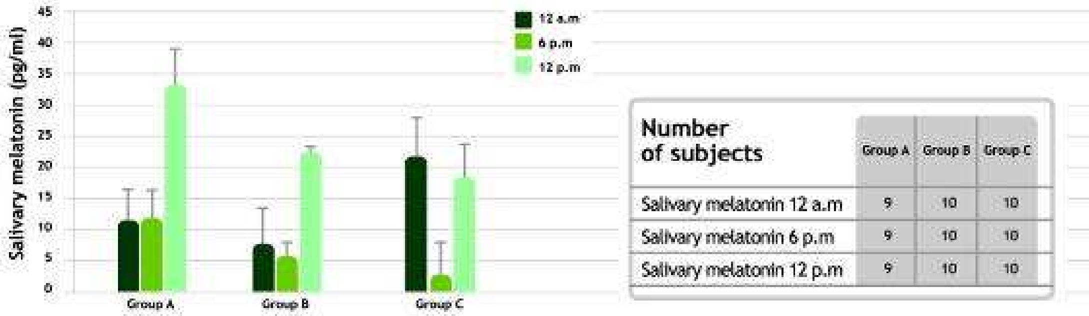

Figure 8: Salivary melatonin levels at 12 a.m, 6 p.m and 12 p.m by groups

The results shown in figure 8 suggest that individuals of group C suffer an alteration in melatonin rhythm, with probable phase delay (its peak is supposed to occur between 3 a.m and 4 a.m and decline significantly between 8a.m -9a.m, since, based on the level found at 12a.m and the relationship with the skin temperature rhythm, the peak must take place later than in the other groups. The observation of the melatonin production behavior in this group reflects directly the influence of the working environment lighting pattern of the store. These data, associated to the dissatisfaction with the average general illuminance of the store, in which the employees indicate a need for reducing daytime lighting, supports the hypothesis that the luminous environment is not suitable to meet the health and well-being requirements of the employees in these stores.

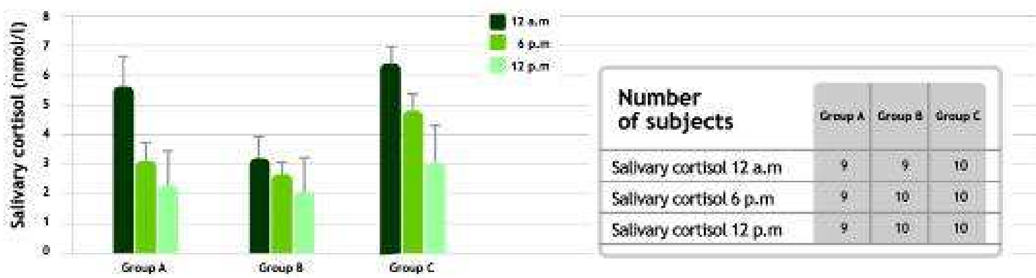

Figure 9: Salivary cortisol levels at 12 a.m, 6 p.m and 12 p.m by groups

Considering the situation of street stores (group A) as the optimal situation among the three groups, especially due to the presence of natural light and visual contact with the outside, groups B and C showed cortisol levels and variation between times different from the optimal ones (figure 9). The results found in the saliva cortisol levels (12 a.m, 6 p.m, 12 p.m) indicate a rhythm change (tendency to loss) in group B, in which a small variation between levels at three different times is observed, when a clear circadian rhythm is almost not perceived, with a peak around the time the individual wakes up (Kudielka & Kirschbaum, 2003). This may be explained by the absence of contact with more intense and natural light during daytime, because they are in a closed environment both in the morning and in the afternoon. Literature indicates that the exposure to intense light (preferably natural) in the morning is responsible for activating cortisol, more than at other times (Leproult, Colecchia, L'Hermite-Baleriaux, & Van Cauter, 2001). The group C employees spend the morning period outside the workplace, which enhances the possibilities of being exposed to higher and different illuminances (natural light). This may be associated to a better performance in relation to cortisol than the group that works in the morning and in the afternoon. Considering that other factors can change the cortisol rhythm, such as stress (Leproult et al., 2005), it is difficult to find a direct relationship between the tendency to cortisol rhythm loss in group B and lighting. Taking into account that in the groups without windows more than half of the employees are found to be stressed and that this percentage is higher in group B (60% stressed), it is necessary to evaluate more thoroughly the relationship between lighting, stress and cortisol rhythm loss detected here. There is a hypothesis that the need to adapt oneself to unsatisfactory lighting may lead to greater stress in this group and, consequently, to an alteration in the cortisol rhythm. The associations (positive correlations) of the cortisol level found with the SRQ, Hamilton and Epworth scores, in group B, support the hypothesis of a loss of cortisol production ability in these individuals due to stress, and the scale scores associate with the average general illuminance of the store positively (SRQ, Beck and Montgomery). As stress and depression are often part of the same disease situation, the hypothesis that the store illuminance is influencing health is suggested by the results found. Nevertheless, the results indicate that the luminous environment of the workplace, despite being influential, must not be studied separately, since workplace illuminance alone cannot explain variations in the circadian phase. The lighting in the workplace certainly influences the circadian effects, but it has to be interpreted in the context of the individual's full 24-h luminous pattern.

In all psychometric scales applied, the results pointed to higher mean scores for symptoms indicating a possibility of psychiatric disorder, depression and anxiety in groups B and C in relation to group A (figure 10). The higher absolute values in all variables analyzed showed that the more severe symptoms indicating a possibility of health alterations were also found in groups B and C, and that the environmental factor, including lighting, may be contributing to these results, which calls for a deeper analysis of these relationships.

	Group A	Group B	Group C
psychiatric disorder	**SRQ** lower No disturbance	No Disturbance	**SRQ** higher Disturbance found
depression	**Hamilton** lower 40% disturbance **Montgomery** lower **Beck** lower	**Hamilton** 50% disturbance **Beck** higher	**Hamilton** higher 40% disturbance **Montgomery** higher
anxiety	Lower	Higher	
stress	Lower 40% stressed	higher 60% stressed	50% stressed

Figure 10: Synthesis of psychometric scales

Since circadian rhythm regulation depends on the time and duration of exposure to light, the workers in group C seem to be more influenced by the light in the workplace, perhaps because they are exposed to high illuminances until a later time than the other groups. Group C was the one that differed from the others in the light/dark factor (lighting pattern), activity rhythm, mesor of skin temperature rhythm and acrophase behavior of activity and body temperature rhythm. The latter aspect is directly related with melatonin mechanism, which seemed to be altered in this group. These data, associated to the dissatisfaction with the average general illuminance in the store, through which the employees indicate a need for reducing lighting during daytime, support the hypothesis that the luminous environment is unsuited to meet workers' health and well-being requirements in those places.

The pattern of exposure to light provided by the actigraph lux meter did not find any difference in the amount of time of exposure to lighting between the groups, since the mean exposure time in minutes per day above a 1000-lux illuminance was similar between them, ranging from 62 to 68 min/day. A difference was found in the light/dark factor, which was lower in group C, which also differed from the others in the activity rhythm. This can be explained because, even though the times of exposure to certain illuminance is quantitatively similar, the type of light received is different (as regards spectrum, color temperature, visual access to the outside), which is quite important to people's health, as also shown in literature (Figueiro, Rea & Bullough, 2006; Farley & Veitch, 2001).This is an issue that needs to be discussed, because the regulations pertaining to lighting standards regulate the amount of light only, and not the quality or type.

The issues of uncomfortable noises and heat produced by light sources appeared in different correlations with the psychometric scales (anxiety in groups B and C), demonstrating that the non-visual aspects of lighting also have an influence on employees' well-being. In group A this correlation is not observed to appear, although their lighting systems have a worse quality than in shopping malls. This may be explained by the greater external noise found in street stores, masking the noise from light sources, which may make it more harmful. Similarly, the dissatisfaction with the heat produced by the light sources seems to be correlated with emotional variables in shopping mall groups B and C, in which the greater illuminances account for the greater discomfort with this aspect.

Conclusions

The study demonstrated that the female employees in the retail stores responded differently to lighting conditions in the three groups analyzed. There is a high degree of dissatisfaction with the lighting system in the three groups and satisfaction with lighting design was demonstrated to be associated to emotional and biological factors. By demonstrating this relationship, one can encourage entrepreneurs to invest in female employees' satisfaction with lighting and, indirectly, in their productivity.

The employees in street retail stores (A), where we found lower illuminances (up to 300 lux), showed higher drowsiness during the day and higher dissatisfaction with issues related to task visibility. Probably, it would be necessary to increase general illuminance in the category street stores, since dissatisfaction with lighting and daytime drowsiness may be indirectly associated to low illuminances (likely little circadian stimulation). The presence of windows and visual contact with the outside was an important factor for this group to present better conditions in the assessment of depression and stress, as well as the normal behavior of cortisol and melatonin levels.

The female employees of shopping mall stores working in the morning and afternoon shifts (group B) showed the worst conditions in the assessment of anxiety and stress among the three groups because they had no contact with natural light during the day as a result of their work time. The altered cortisol levels may be related to the high stress in this group and the lack of contact with natural light to stimulate it. Allowing them to have visual contact with the outside and access to natural light, whenever possible, is a precondition for health and well-being, since the results indicate direct and indirect correlations between this factor and higher depression and anxiety scores. This means that the project must prioritize the presence of windows, employing technical resources currently available to deal with issues of potential color fading caused by light, such as placing filters and special films on window panes.

The female employees of shopping mall stores working in the afternoon and night shifts (group C), where the highest average general illuminances were found (up to 700 lux) and the time to which they are subjected is later than the other shifts, showed physiological alterations in melatonin production and worse conditions in the assessment of depression. It is necessary to reduce general illuminance, since the alteration of the hormones melatonin and cortisol and the dissatisfaction in the shopping mall groups are directly and indirectly associated to high illuminances in the workplace. It also seems to be advisable to avoid using only one type of light bulb (same spectrum), reducing, thus, the risk of the existence of only one type of wavelength in the environment that may be harmful to the circadian system, until we learn what kind of spectrum is the most suitable and how these spectra interact with one another in a real environment. We must be careful so as not to use sources that are more suppressive of melatonin at night time and pay attention to new technologies, such as LED sources, until their influence on people is confirmed.

The results for the amount of light in stores indicate a need for adopting lighting techniques that incorporate intense light spotlighting the merchandise – which is the key to the process of attracting customers to buy – and milder general lighting for employees, light sources with reflected or indirect light being the most suitable for this, which is important for their health and well-being. It is crucial to review the international legislation that dictates high general illuminance for this type of stores.

The shopping mall typology must be reviewed since the lack of visual contact of employees with the outside is related to higher depression scores in these groups. In stores without visual contact with the outside, the variation and control of artificial lighting systems by employees or the use of a programmed system should be enabled, varying the amount of light and color appearance, since great dissatisfaction was found with the lack of variability in the luminous environment of stores without openings.

An important question raised by this study was that of the methodology used, which tested the variables to assess the quality of lighting focusing on human needs (visually, biologically and emotionally), as well as the tools brought from the fields of Psychology and Medicine. The methodology was deemed to be appropriate, since countless associations (correlations) were found between the variables under study, and the results were convergent and coherent between the different tools used. However, the methodology was found to be too complex and long for the employees, which resulted in a high number of drop-outs (12 people) after the start of the evaluation.

Lighting design needs to be regarded as a multidisciplinary field of knowledge aiming at developing and applying information on human behavior and physiology to environment lighting. The conceptual-theoretical base that is being established in the field of lighting design allows us to point out that, as human requirements become understood, a new paradigm is needed for contemporary lighting design. The technological solutions of lighting systems will remain of key importance, but it will be necessary to learn how to reorganize design guidelines in order to render them user-centered.

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Interactive Tools and Online Communities that support Media Literacy

Discussions about online media often neglect the engagement and interpretation of these technologies. The Internet has become a primary resource for learning, but schools are often not prepared to train students to understand online content. Outside of the classroom teenagers are active online. Conversely, many schools rely solely on analog tools to teach this already digital generation. This disconnect may result in teenagers who are not prepared to be critical digital citizens.

According to research by the Massachusetts Institute of Technology and Stanford University, teenagers tend to rely on the look of online information to determine credibility. As design software and image manipulation tools have become more available, average users can create content that looks professional and therefore trustworthy. Online content facilitates public discourse, but positions amateurs and experts at the same level. This flattening of source credibility is problematic for teenagers with limited cognitive abilities and life experiences to make judgements.

As online participation in inevitable we must determine ways for students to practice communication and collaboration in activities that are facilitated by an educational framework. We cannot simply ignore participatory communities and reject interactive tools as learning strategies. Educators have an opportunity to encourage new media literacy by leveraging existing social participation into teachable moments.

Based on literature, field interviews, persona development and research, we have identified five main challenges that merit pedagogical shifts to address media literacy. We propose two speculative case studies to address these five challenges.

What is Media Literacy?

Media Literacy has become a buzzword, much like design thinking, resulting in a need to clearly articulate our interpretation. We follow Marshall McLuhan's definition of media as any extension of our selves through technology. (McLuhan, 19) Media or (Mediums) include, but are not limited to, television, newspapers, books, articles, blogs, web sites, portable devices, games, computers, cell phones, digital videos, photographs, illustrations, text messages, e-mail and the printed word.

Literacy refers to the ability to read and write and the thinking that goes into that work. It is a social, cultural and historical activity. (Finders, 8) School literacy is associated with the reading and writing in education, determined by a set curriculum, with specific outcomes and objectives. (Kelly, 8) Activities related to literacy evolve and are altered by media. We see media literacy as addressing the need to educate teens and adults about the interpretation and understanding of media they confront everyday.

As participatory communities like Facebook, Flickr, and YouTube have grown in popularity more attention has been given to media literacy. In a white paper authored under The John D. and Catherine T. MacArthur Foundation, "Confronting the Challenges of Participatory Culture: Media Education in the 21st Century;" the concept of new media literacies was explored:

> *"We call the new media literacies: a set of cultural competencies and social skills that young people need in the new media landscape. Participatory culture shifts the focus of literacy from one of individual expression to community involvement. The new literacies almost all involve social skills developed through collaboration and networking. These skills build on the foundation of traditional literacy, research skills, technical skills, and critical analysis skills taught in the classroom"* (Jenkins, 4).

These new media skills include play, performance, simulation, appropriation, multitasking, distributed cognition, collective intelligence, judgment, transmedia navigation, networking, negotiation. (Jenkins, 4)

Digital Natives

Urs Gasser and John Palfrey, authors of *Born Digital: Understanding the First Generation of Digital Natives,* explain that this unique generation has had lifelong exposure to online technologies, which has lead them to view digital information as malleable. Teens do not view technology simply as a tool or a means to an end, they sometimes view the technology as the end in itself. As technology, tools, and online spaces are embedded in a teens day to day life, educators must assess if they are comprehending and critically engaging with media.

Many young people are members of online communities and their participation is increasing. Social networking sites like MySpace and Facebook are "virtual malls," where today's tweens and teens can commune together, without the annoyance of observing teachers and parents. A study conducted in 2006 by The Pew Internet & American Life project found 55% of online teens (ranging in age from 12 to 17) had profiles on social networking sites. (Boyd 119 –121) Not only are teens participating, they are immersed in media engagement.

Accessing these communities has become increasingly fluid with the introduction of smart phones and other portable digital devices. "Without question, this generation truly is the media generation, devoting more than a quarter of each day to media. As media devices become increasingly portable, and as they spread even further through young people's environments — from their schools, to their cars, to their pockets — media messages will become an even more ubiquitous presence in an already media-saturated world" (Roberts 60). A Kaiser Family Foundation study released just this January showed dramatic growth in young people's use of media.

> *"Over the past five years, young people have increased the amount of time they spend consuming media by an hour and seventeen minutes daily, from 6:21 to 7:38—almost the amount of time most adults spend at work each day, except that young people use media seven days a week instead of five.*
>
> *Moreover, given the amount of time they spend using more than one medium at a time, today's youth pack a total of 10 hours and 45 minutes worth of media content into those daily 7½ hours—an increase of almost 2¼ hours of media exposure per day over the past five years" (Rodgers, 2).*

Teenagers today are not digital observers, but are full participants of the digital landscape growing up in what Lawrence Lessig calls a "read-write culture." Unlike previous generations that existed during the 20th century, they not only consume media, they author it. (Lessig, TED 2007 Conference) "Some 57% of online teens create content for the internet. That amounts to half of all teens ages 12-17, or about 12 million youth. These content creators report having done one or more of the following activities: create a blog; create or work on a personal webpage; create or work on a webpage for school, a friend, or an organization; share original content such as artwork, photos, stories, or videos online; or remix content found online into a new creation" (Lenhardt & Madden).

As more teens become online media authors and participants in their social lives, we must ask how these activities can, and should, be employed within the classroom? Educational instruction that incorporates online resources may provide teens a broader spectrum of information on a subject. Textbooks go out of date quickly and provide one point of view, that of an author, editor or publishing company. Educators now have a challenging opportunity to teach subjects such as history from current, multi-faceted points of view.

As new media is integrated into classrooms, textbooks and other old media do not disappear. The most successful technological integration in classrooms support a convergence of old and new media. For example, in Ken Ellis's video, *Media Smarts: Kids Learn How to Navigate the Multimedia World*, teachers use a variety of old and new media resources, including textbooks, newspapers, posters, film and online tools to teach about media literacy.

This media convergence helps students make a bridge between real-world problems and those created in the classroom. In addition to brick and mortar schools, what if teaching about media could take place in the very environment in which teens encounter new media?

Online environments offer teens a space to converse with their peers without being scrutinized by adults. Despite the lack of direct supervision by teachers, there is no doubt that these spaces can result in learning. Independently, teens transform social spaces and interactions into learning situations. A recent article in *The New York Times* interviewed several teens and found that many preferred reading and researching online because they "crave the ability to quickly find different points of view on a subject and converse with others online" (Rich). According to a study done in 2005 by the US Department of Education, roughly 94% of instructional classrooms have internet access compared to only 3% connected in 1994. (US Department of Education) Online access is not only used for instructional support. 71% of online teens used the Internet as the primary source for major school projects or reports. (Lenhart, 44) This rapid growth in usage results in great shifts in our social and cultural behaviors. It is important to address how online resources are used and understood by students.

Online Challenges

Teens and adults face many challenges online and teens are particularly at risk. We see five main challenges that merit pedagogical shifts to address media literacy. First, teens engage with media on their own, often without the involvement of their parents or teachers. When teens use technology in the privacy of their own bedrooms, parents lose the ability to supervise activities. Wireless handheld devices bring the challenges of independence to the forefront. In 2007, 84% of teens owned at least one mobile device; a laptop, cell phone or PDA (personal digital assistant). (Lenhart, 30)

Second, online environments offer multiple perspectives and diverse narratives, but not all content goes through an editorial process. The web has changed the terms by which we judge sources. With print media, a source may be viewed as single and authoritative, such as an editor or author, and is often spotlighted. Online content often has multiple sources and the original sources are often buried under trails of hyperlinks and commentary. Contextual relationships between things such as hyperlinks and supporting articles become important online due to users' reliance on more than one source. This lack of editorial vetting and clarity of source is a challenge for teens when they are trying to determine who and what to trust online.

Third, technology allows amateurs to create content that looks and feels as trustworthy as content created by experts. A traditional diagram of the message cycle places the audience only in the perception and consumption phases (figure 1). Historically and sometimes currently, design is limited to the creation and reproduction phases. Digital media, online access and current trends invite participatory audiences to operate in every step of the message cycle. Free online tools are readily available, for instance Picnik.com allows users to create and share visual information that may look very professional and therefore credible to teens.

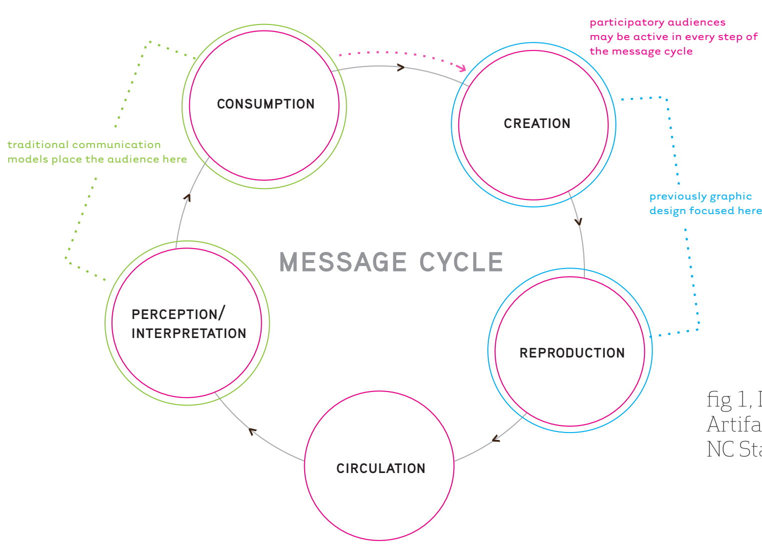

fig 1, Design as a Cognitive Artifact,Meredith Davis, NC State

Fourth, teens tend to rely on the look and feel of information to determine credibility. Researcher B.J. Fogg at Stanford University cites four types of credibility assessment that relate to human computer interaction: reputed, presumed, experienced and surface. While the internet gives us the ability to find multiple perspectives, it also requires more care when determining credibility. S. Shyam Sundar states that credibility assessment tools that leverage teens' desire to judge content by the look and feel may be more successful than tools that try to steer them away from these surface characteristics. (Sundar, 76)

Reputed credibility is "the extent to which a person believes someone or something because of what third parties — people, media, or institutions — have reported" (Fogg, 135). This type of assessment is common in online environments, and can be based on links from one website to another, user commentary and expert endorsements.

Presumed credibility is "the extent to which a person believes someone or something because of general assumptions in the person's mind" (Fogg, 132). Media based assumptions are common and some users trust online information without much thought. "Defaulting to a medium-based judgment is perhaps cognitively less demanding than other strategies … Assessments at the level of medium are crude, and while they may be appropriate for government or industry related content such as that offered through television and newspapers, they may not be appropriate for online content that is freely offered, altered by anyone with technological access and skill, and subjected to no or very little governmental regulation" (Eastin, 39). Audiences often assume that what they are able to see is true and find photography and video to be mirrors of the truth rather than glimpses of perceived realities. Culturally based assumptions also influence presumed credibility assessment. New technology is often associated with credibility because users assume that the creator has a high level of skill.

Experienced credibility is based on user experience over time and is perhaps the strongest type of assessment as it depends on the development of a user's experience with one source. Experiences vary among audiences, but being aware of a person's individual experience can play a role in personal assessment.

Surface assessment refers to initial reactions to the look and feel of information and is the fastest and most common type of assessment. The study, "How Do Users Evaluate the Credibility of Web Sites? A study with over 2,500 participants" found that 74% of participants relied primarily on the design of the website to determine credibility. (Fogg, Soohoo, Danielson, Marable, Stanford, Tauber, 5) The participants stated that credibility was signaled by cues such as a "balanced composition of information" and "soothing color palettes."

Finally, there is a risk of information overload. How do teens cope with all of this digital information? Print media offers a beginning and an end, a front and back cover to mark the experience. The internet is infinite, but there are limits to what teens can absorb and comprehend. Most research on information anxiety focuses on adults, whereas affects on teens are just now beginning to be explored. Researchers have found that "One of the primary reasons to be concerned about too much information being accessible to young people is the possibility of negative effects on decision-making" (Gasser and Palfrey, 192). Balance needs to be struck between getting enough contextual information to make judgements and getting too much information that can overwhelm and paralyze a teen's ability to think critically.

Teens face more challenges online than adults because they are basing decisions and judgments on limited life experiences. Adults have the experience to make comparisons and informed decisions about who and what to trust online. Teens are often left to sort through the complex landscape without a guiding compass. As online environments become more complex, the cognitive challenges increase. Matthew Eastin, from The University of Texas at Austin, states that "Lacking a reference base can create confusion and lead to inaccurate interpretations"

(Eastin, 30). Teens lack the skills to manage and organize complex information that they confront online, as an average Google search returns millions of results, the challenge is knowing what information is credible, authentic and useful.

Evolving View of Media Literacy and Education

"Media change is affecting every aspect of our contemporary experience, and as a consequence, every school discipline needs to take responsibility for helping students to master the skills and knowledge they need to function in a hypermediated environment" (Jenkins, 57). Often, if media literacy is taught at all, it is by librarians in isolated environments. A cross-curricular approach may provide a richer experience for students.

In schools, students are not taught how to be critical when engaging with visual language in the same way that they are taught to evaluate verbal and written language. The arts tend to focus on creativity while English-based classes focus primarily on the written word, rather than on text and imagery, motion or sound. As more and more people become visual communicators, new media literacies are required to analyze visual communication.

Participatory communities can act as "affinity spaces;" as they have the potential to motivate peer-to-peer teaching and learning. (Jenkins, 9) Affinity spaces are communities focused around a common endeavor, masters and amateurs share a common space, content organization shifts according to interaction among the users and participants, knowledge gathering and dissemination is encouraged and there are multiple facets to participation. (Gee, 85 – 87) Affinity spaces are successful as they actively engage participants through shared tasks, goals, objectives and ultimately successes.

These spaces allow experimentation, and open ended answers. The activity is only limited by the participants own motivation to use the system. In schools, teachers are required to keep a tight rein on student activity. Teachers are bound by school calendars, schedules, learning assessments, and government enforced testing, as we have seen with No Child Left Behind. The addition of digital tools and spaces would allow a traditional classroom to blossom, as the environment would expand, and be flexible to an individuals learning preferences.

While the research regarding young people and new media is flourishing, there are few models on how to successfully move forward and apply research findings. We propose two case studies that aid in critical media engagement and assessment, inspire participation, and prepare young audiences to become critical digital citizens.

Case Studies #1: Video Book.

Video Book is a component-based, web application to be used by multiple users. A web application exists online and allows users to complete tasks together. Unlike traditional software applications, web applications usually do not require users to pay for access. They are open source, and do not require a site license to run. Examples include Yahoo Mail or Google Docs. The *Video Book* interface supports direct correspondence between students and educators. Student groups work together and share their findings as they complete class projects. All participants can save, share, and delete their work. Each study focuses on specific curriculum goals, as referenced in *The Content Knowledge; A Compendium of Standards and Benchmarks for K-12 Education, for Language Arts Level III, Grades 6-8*. This source served as a means to ground the design in practical, real-world educational objectives.

Video Book supports peer-to-peer learning as the space encourages collective intelligence and the transfer of ideas. Design studies were used to form a system of tools that together create a participatory community focused on objects and interactions in time. The community is named *Video Book*, as it integrates various types of media content into a digital video format. At the center of the interface is the time line and the stage. These are the previewing and performance spaces for content and student activity (see figure 2, next page.)

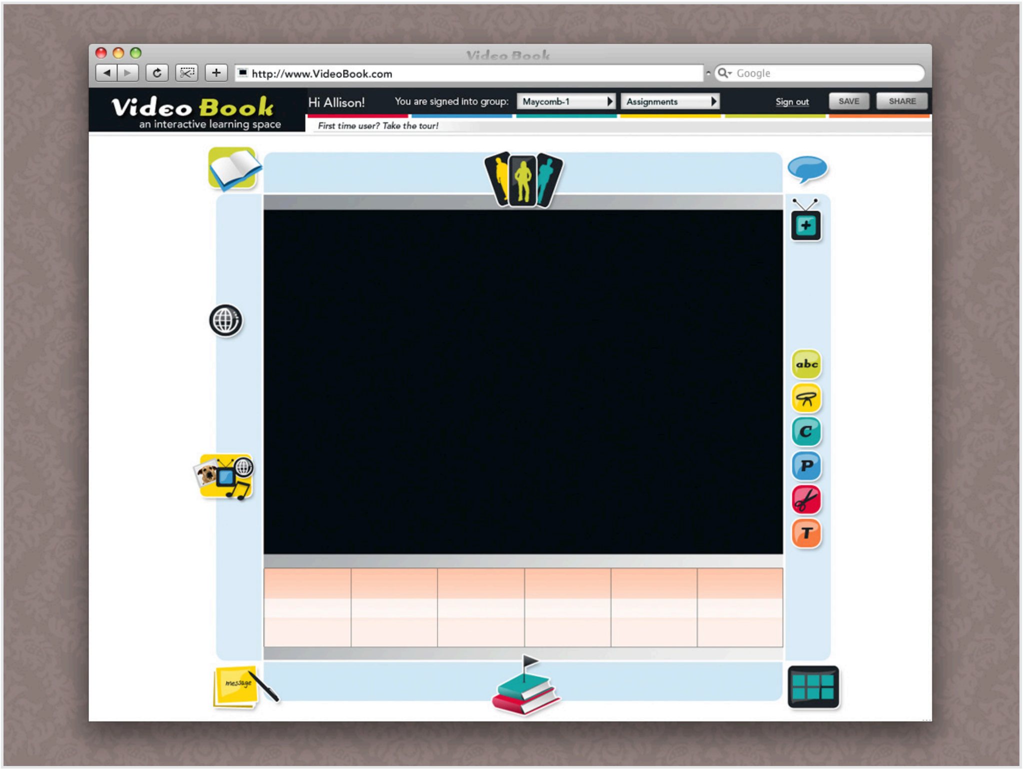

fig 2, the Video Book interface

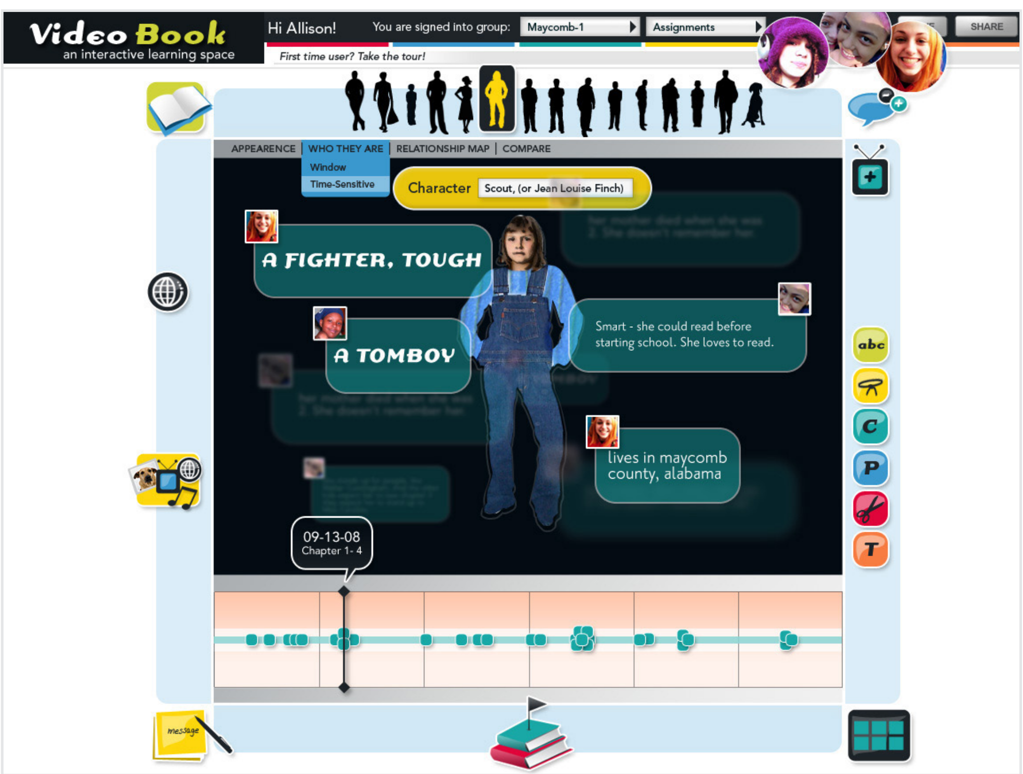

fig3, character building in a time based format

The *Video Book* prototype is demonstrated through four scenarios that represent students working through distinct clusters of components. Each component enables a set of interactions. Students can complete a diverse set of tasks and create various digital learning objects that take shape as digital avatars, storyboards, research collections and movies. Students may use *Video Book* in a remote setting, working from a home computer with Internet access, a mobile device or on a computer at school. Teens are clustered into groups of three or four students, and their work is primarily collaborative. These scenarios follow Allison, a seventh grader, as she works with her group in *Video Book* to complete school assignments.

In scenario one, (figure 3, previous page) Allison builds a character from the book *To Kill a Mockingbird, by Harper Lee*. Allison begins by building the appearance of Scout, the main character in the novel. She selects her facial appearance and her clothing. This function allows the student to visualize the physical character. The interface responds to the Allison's movements. As she wands over the character with her mouse it invites her to select a face from a given set of actors. This virtual character is a concrete representation, which the student can save into the class database. This capability allows the students to practice collective intelligence as the students can each contribute notes and ideas about a character to the whole group. Each student has access to the character database as they build storyboards and make movies. The character analysis changes over time, and is recorded by the system. The emphasis is on the relationships between characters and the story structure.

Allison finishes by posting her comment, and viewing the comments of her group members. A few weeks in the future, when the class is several chapters ahead, Allison may look back in the time line and sees how Scout's character description has evolved throughout the book. The system documents participation, archiving the class activity for later retrieval.

In scenario two, Allison works with her group to build a storyboard illustrating chapter ten from *To Kill a Mockingbird*. (figure 4) The students gather actors from the character bank and compose them to visualize the key moments in the chapter. The interactions taking place in scenario two emphasize meaningful play.

fig 4, storyboarding and captioning of a key moment in a novel

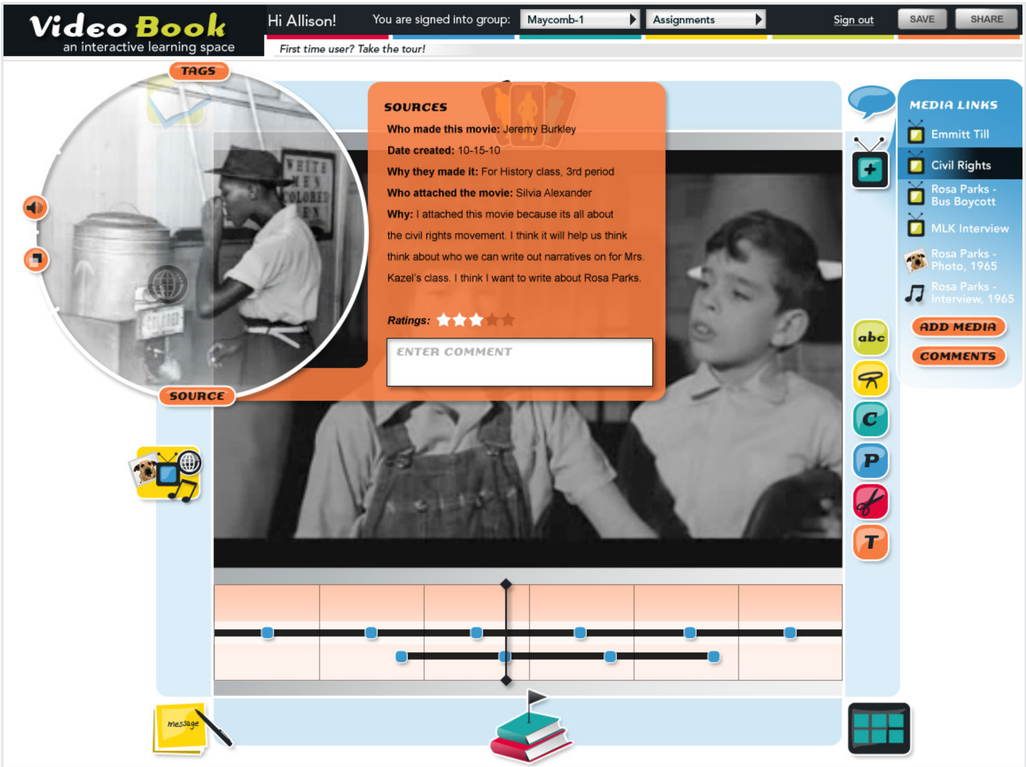

fig 5, conducting research, using and contributing to the media links

fig 6, movie making tools being employed on the stage

Students reveal to each other the intricacies of the plot as they collaborate. Teachers may view individual participation and quickly assess if students comprehend the novel and its literary themes. Storyboarding allows students to view the narrative in a concrete, chronological format. Students understand the story visually as they share their mental pictures with one another.

In scenario three Allison and her group work to compile research for an informational report. In history class the students are studying the Civil Rights movement, in addition to reading *To Kill a Mockingbird*. This scenario reflects their progress as they work through ideation and brainstorming. (figure 5, previous page) Using the attachment tool the students connect media content from the Internet and their collective gallery. They make connections between related media objects. They may also edit out what they find to be inappropriate, making judgments and negotiating what is relevant to their topic. The tools allow the students to compile information quickly, and to see assigned tags, and the facts behind the media; where it was created, who authored it and when, as well as comments attached to the file. The tools act as educational framing devices.

Scenario four shows Video Book functioning as both an individual work space and as a community. (figure 6, previous page) Allison works independently, developing an informational video report incorporating video, photography, graphics, audio and text-based information. Allison imports her own recordings. Her amateur movie demonstrates not only what she has learned about Rosa Parks, but also reveals her creative and expressive talents. It allows her to perform by sharing her movies with her group members, her teachers, and her class. This exercise encourages Allison to become an author, building her confidence, as she shares work within a safe learning space. By allowing students to share work through an online learning space, critique and assessment will be focused on the learning object, not on the physical presence of the student.

Case Studies #2: Trust It?

Our second case study, *Trust It?* explores how online interfaces can encourage students to analyze, interpret and judge the credibility of visual language. *Trust It?* is a plug-in that approaches credibility assessment from different angles, is a bridge between controlled and independent experiences and would be available on aggregated websites such as Flickr, You-Tube and Google Images. *Trust It?*, is a movable tool set (figure 7 , 8, 9) that is managed by an area called Home Base. Students may choose where to put the tool, how large or small it is and when is visible. Putting credibility assessment tools in the hands of students encourages independent judgment. *Trust It?* presents three scenarios in which Alex, a 15 year old, uses the system to do research for assignments related to her Language Arts Class.

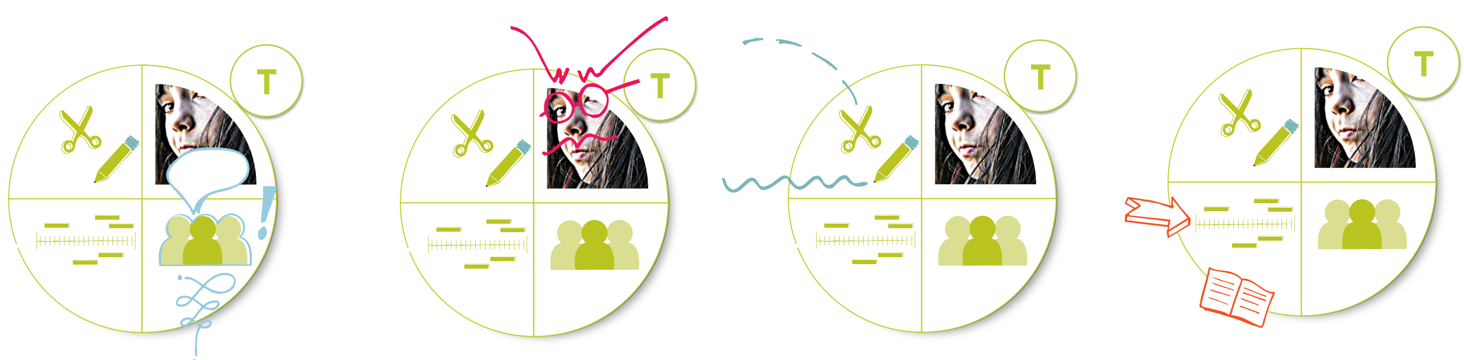

fig 7, three states and the Home Base of the movable tool set

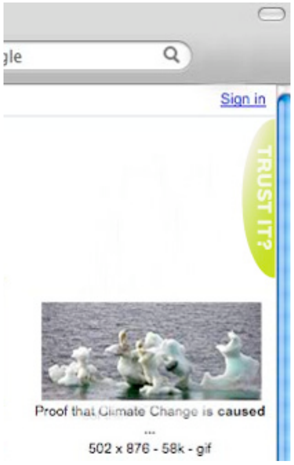

fig 8, plug-in in static state

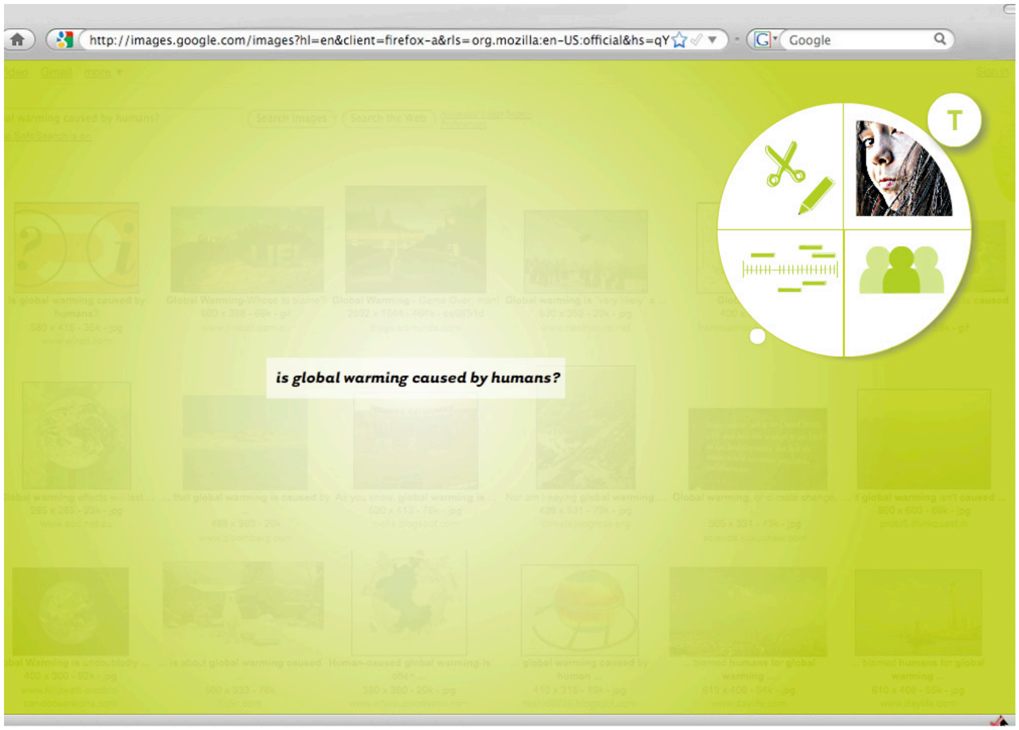

fig 9, tool in active state

In scenario one Alex explores aspects of visual language and originating sources that inform and educate her to the credibility of information. Because teens rely on look and feel to determine credibility, *Trust It?* explores how specific visual cues can infer credibility. Alex is searching for information regarding the causes of global warming. *Trust It?* search results are categorized by genres such as journals, blogs, news media and academic libraries. (figure 10) These categories include contextual information that is often lost in web searches that yield millions of results. No categories are considered entirely credible, so Alex is encouraged to make credibility assessments in all genres. The dynamic nature of the images hints at the level of credibility assigned by a team of experts: teachers, professionals and mentors who support the Home Base.

fig 10, categorization

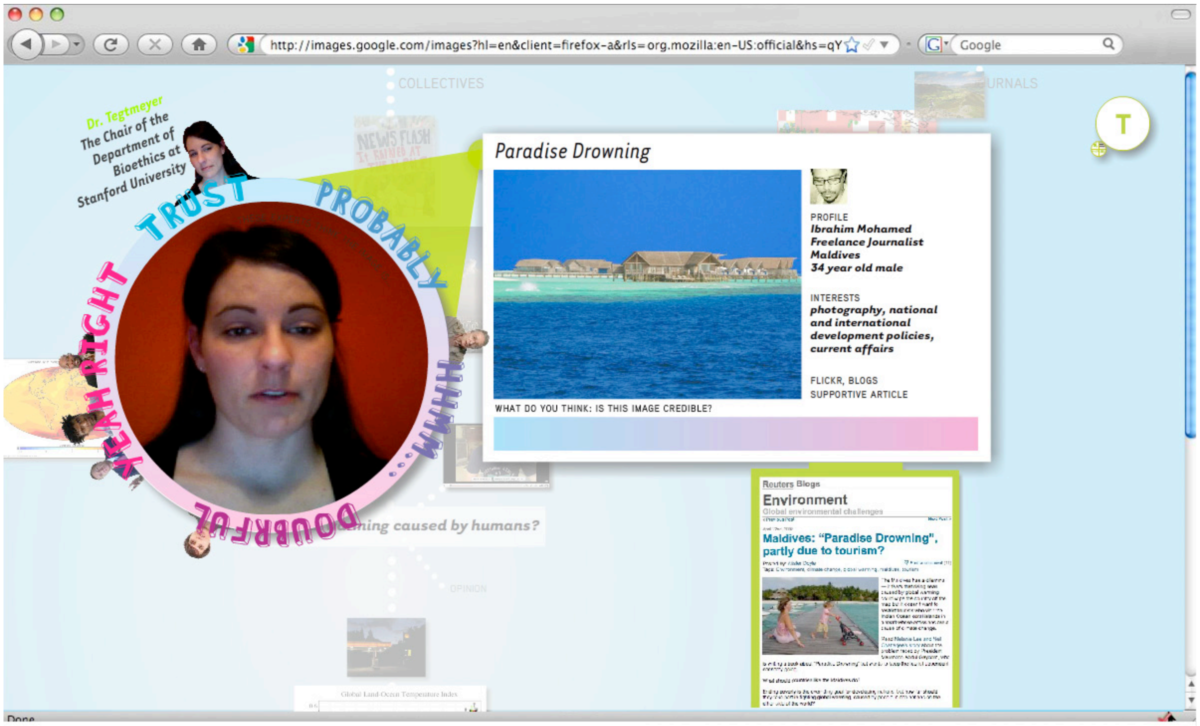

fig 11, detailed source information, supportive content and expert testimonials

With participatory sites many authors use nicknames, further complicating source assessment. Using *Trust It?* Alex may view detailed source information as well as supportive content without leaving the space. (figures 11) Participatory assessment in *Trust It?* relies on contributions from teens and experts rather than on a system or single authoritative voice, allowing students to understand that people perceive images differently. Alex is shown what several experts think about a photo. (figure 11) Credibility is determined by the group and by giving teens tools they become a part of the process.

Scenario two addresses what online activities encourage students to critically analyze the visual language they view, create or alter on informal learning environments. Alex searches for images related to three subjects for her class research assignments: global warming, domestic violence and US presidents. *Trust It?* functions as a prompt for interaction and learning. When Alex chooses to roll over different parts of the tool set or an image, open-ended questions are revealed that hint at larger educational goals. (figure 12, next page)

Visual language is constructed, just like written language. Formal choices in photography — whether made in the moment of capture or later when editing — affect the understanding of the message. Little research has been done on how teens understand the concept that visual language is constructed, however, tools are widely available for teens to alter images. A simple cloning tool allows a teen to change the background of an image. This type of alteration affects the meaning of the image and the message. While searching about global warming, Alex is confronted with an image and when she rolls over the image, the cloned snow appears; when she rolls off the image, the snow goes away. Making a connection between time-based comparisons and Alex's explorations, is meant to inspire further investigation into what the message means. A chat area in the same space as the images allows discussion among teens. In surface level exchanges, social interaction may be limited to conversational chatting. However, in more specialized knowledge areas, such as researching global warming, more in-depth dialogue may occur. The 'thoughts' area in the toolbar gives Alex a space to construct an argument about the poster advertising the documentary film "An Inconvenient Truth." Alex is questioning the appropriateness of a manipulated image to promote a documentary film. (figure 13, next page)

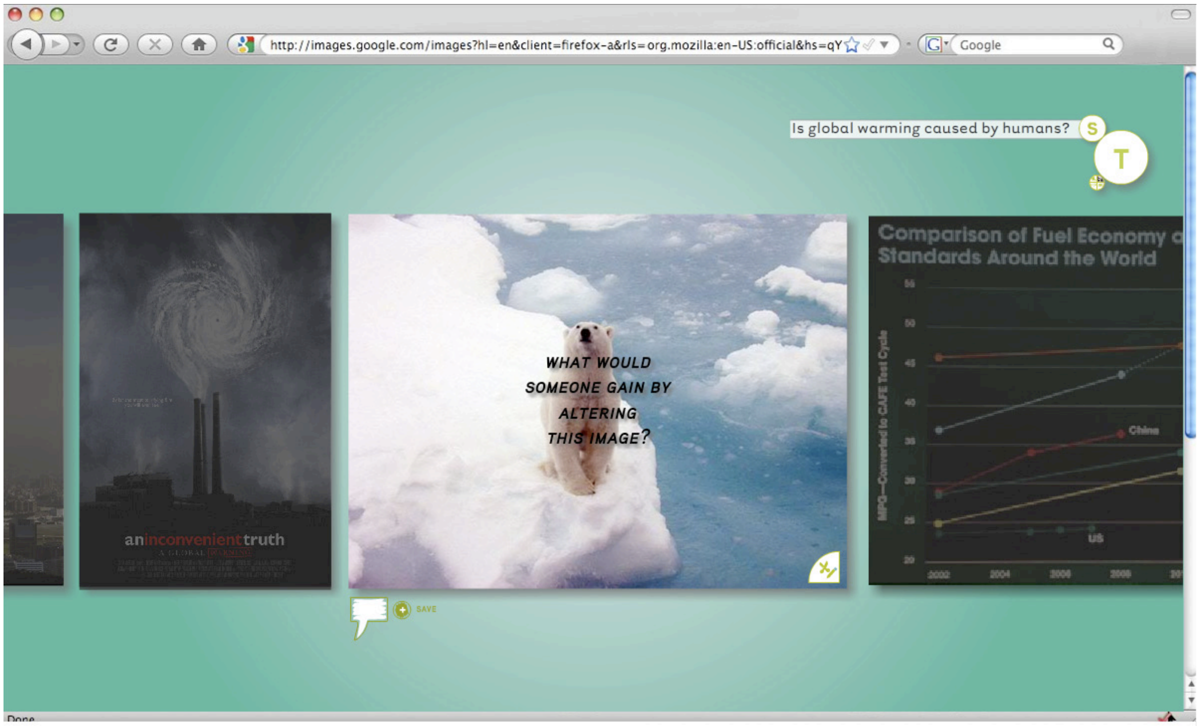

fig 12, prompt for interaction and learning

fig 13, in-depth writing space for teens to construct arguments and add content from their library

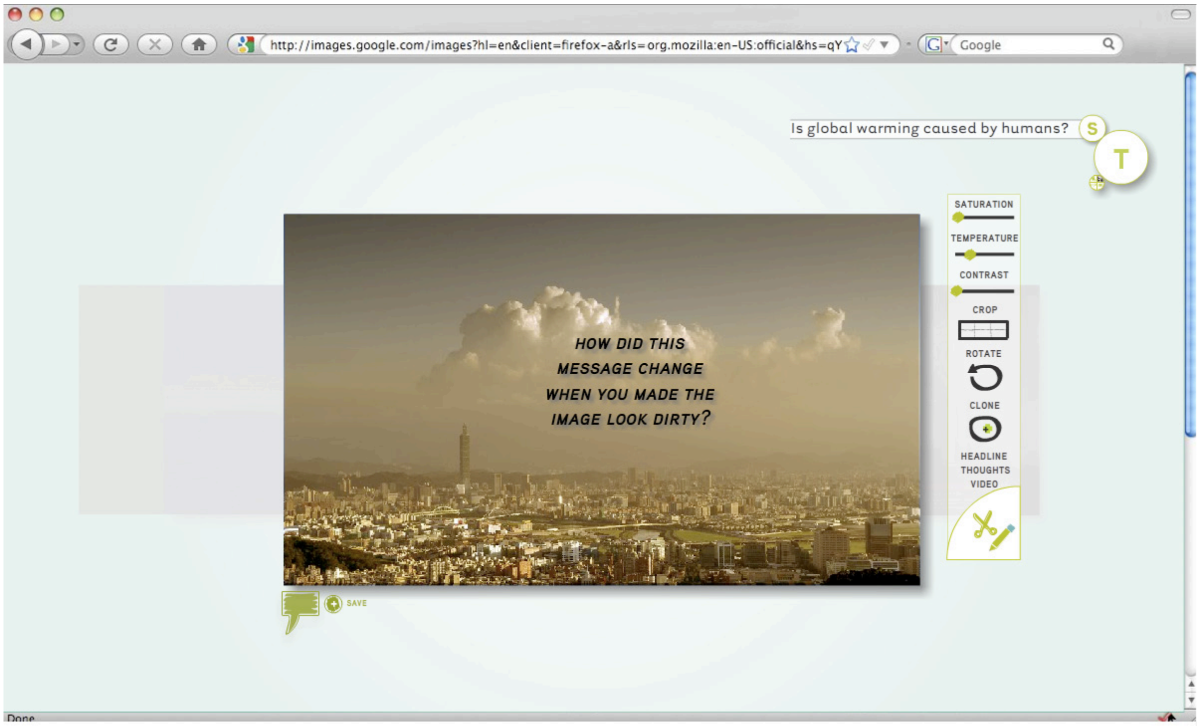

fig 14, questions regarding editing

As Alex continues to scroll through images in her global warming search, she comes to an image of a cityscape. As she rolls over the manipulation tools, a question appears: "How would this message change if you made the image look dirty?". She chooses to adjust the temperature of the image, which makes the scene look polluted. The system then prompts her with another question, "How did this message change when you made the image look dirty?". (figure 14) The goal of active editing is to reveal that images are constructed and easily manipulated.

Alex now chooses to search "domestic violence" and "rihanna." She stops at an image of Rihanna and Chris Brown that she has seen a lot in the news. As Alex hovers over the 'headlines' tool, she is prompted by the question, "How do these headline treatments affect your perception of this photo?" The headline, "Teenage girls stand by their man" from the attached *New York Times* article is presented on top of the image. She has the ability to play with typefaces, positions, angles and colors. Textbooks lack the ability to address such recent cultural occurrences as the Rihanna case that could be teachable moments for teens.

Alex continues and finds a video from the Video Music Awards in which Chris Brown and Rihanna perform a duet. The visual language of this spectacle is seductive, so the system narrows the focus. Alex can explore five formal properties: light, pose, special effects, cropping and props. With a prompt to focus on lighting, Alex continues to watch the video as other images of the couple appear over time. (figure 15, next page) The juxtaposed images are accompanied by textual analysis. The goal is to bring attention to the role that lighting and juxtaposition play.

Alex now searches for information about US presidents. Framing is used in advertising, pop culture and news media. Like most public figures, presidents have teams working for them to ensure that they are posed in a desirable way and surrounded by the necessary props to reinforce their image. Perhaps most importantly, undesirables are excluded from the frame. In her search, the middle image is from a speech given by President Bush at Mt. Rushmore. Upon rollover, she is confronted with user annotations that show alternative framing options, resulting in varied messages.

In scenario three, we address the history and context of images. Two types of history are relevant to this scenario: the way that an image has been used over time; and the context within which an image was created. Continuing

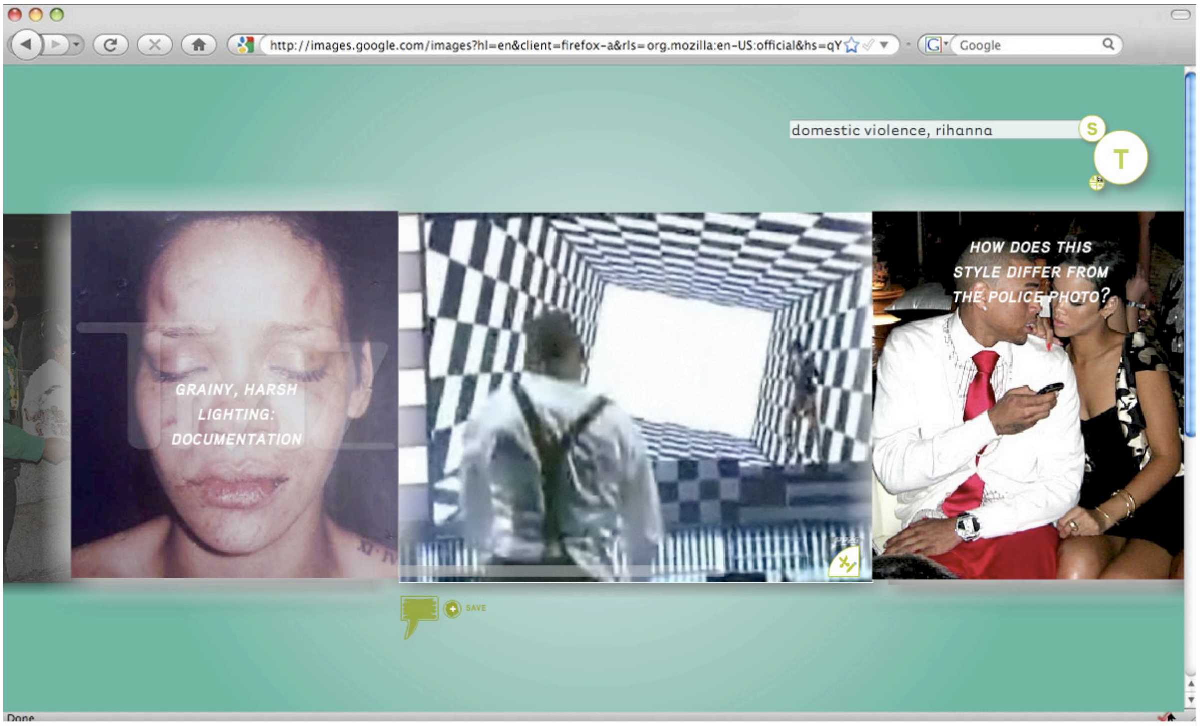

fig 15, textual analysis and questions regarding juxtaposition and lighting

fig 16, framing choices and use in media with her presidential search, *Trust It?* provides Alex with a collection of iconic images, subject matter, locations and dates. (figure 16, previous page) The goal is to reveal the original context by providing a variety of images. Building on the framing tools from scenario two, she may now see how the images were used in newspapers three days later. Alex can zoom out to find a large timeline expanding to the current day, or zoom in to access more information. When she is in the full-timeline view, the system points out significant moments in time regarding the image as well as questions, such as: "Do you know that this image has been used as satire?", "How has this image been used to convey a positive myth?" Through interaction with the images, Alex may gain an understanding of the entire event and see how an image has been used overtime for various ends.

Final Thoughts

As technology becomes less expensive and increasingly more available, graphic design has a great deal to offer the educational landscape. Perspectives are often shaped not by what students read in textbooks, but from what they see and read in the media, even by content their peers create. Designers have a means to create tools, interfaces, and systems that allow the convergence of media content and alternative educational strategies that afford the student endless learning experiences.

We are moving forward with these case studies, developing functional prototypes in order to conduct user testing, classroom trials and in depth analysis.

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The ASD Friendly Classroom – Design Complexity, Challenge and Characteristics.

Keith McAllister, Queen's University Belfast, United Kingdom

Abstract

As architects and designers we have a responsibility to provide an inclusive built environment. For the Autistic Spectrum Disorder (ASD) sufferer however, the built environment can be a frightening and confusing place, difficult to negotiate and tolerate. The challenge of integrating more fully into society is denied by an alienating built environment. For ASD pupils in a poorly designed classroom, their environment can distance them from learning. Instead, if more at ease in their surroundings, in an ASD friendly environment, the ASD pupil stands a greater chance of doing better.

This paper sets out the triad of challenges faced by designers when considering the ASD friendly environment and then examines lessons to be learnt from 9 studied ASD friendly classrooms in a Northern Ireland context. The objective is straightforward. By increasing the awareness of the ASD friendly classroom it will hopefully facilitate greater inclusion of the ASD pupil into mainstream education and society at large.

Keywords

Architecture; Autism; Children; Design; School Environment

Autism Spectrum Disorder (ASD) is a term that covers the many sub groups within the spectrum of autism. Autism can be termed as a lifelong complex developmental disorder. It is characterised by a triad of qualitative impairments in social communication, social interaction and social imagination. (Wing & Gould, 1979) In addition to these problems, sufferers often struggle with sensory sensitivity to visual, auditory, tactile, proprioceptive, gustatory and olfactory stimuli. (Hinder 2004) The range of the spectrum is such, that while some sufferers may be able to live relatively independently, others will require lifelong continuous support.

Accordingly, one of the very difficulties for the ASD sufferer can be to simply fee lat ease in their own environment. For such people, the built environment can become difficult, confusing and even threatening. (Grandin, 1995; Harker & King, 2002; Williams 1998)

For architects and designers, this is indeed a stark reality. The architectural profession has long been entrusted with the duty, responsibility and privilege to provide a built environment that will promote well-being, be inclusive and enrich life. By contrast, the disorientation and fear experienced by many ASD sufferers is very far removed from this ideal and greatly distances them from the possibility of feeling the "pleasure and protection when the body discovers its resonance in space." (Pallasmaa, 1996, p.67)

To add to this concern is the fact that recent statistics suggest that the incidence of ASD is on the increase and even growing at alarming levels. The UK National Autistic Society has put the current incidence of ASD at around 1% of the population. In Northern Ireland recent figures match this. In an interview with Martin Clarke, the Principal Educational Psychologist of the Belfast Education and Library Board (personal communication, April 14, 2009), he gave the following statistics. At that time he stated, there were 283,803 pupils between the age of 5 and 16 in Northern Ireland. Of these, 1.2 % had a diagnosis of ASD. 63% were educated in mainstream schools, 16% in special schools and 21% in special language, learning disorder and autism support units.

Despite this, ASD has so far, been largely ignored by the architectural profession. In the UK there are no specific guidelines when considering ASD. Those guidelines that do make mention of ASD, tend to do so in general terms only and in less detail than other learning difficulties and special needs. With regard to the school environment, the 2005 publication *Evaluating Provision for Autistic Spectrum Disorders in Schools,* co-authored by the Department of Education in Northern Ireland and the equivalent An Roinn Oideachais in the Republic of Ireland outlines three-performance indicators for consideration. These are that,

1 The learning environment is supportive of the child with autism: lighting, sound and colouring are sufficient to encourage the child to relax and settle to work.

2 There is sufficient personal space for the child with autism to find comfort and to distress when necessary.

3 The learning environment contains areas of high interest to reflect the particular interests of the child with autism.

Similarly the recently 2009 published UK government Building Bulletin 102 (BB102) *Designing for disabled children and children with special educational needs,* lists the design issues for children with ASD as;

> Simple layout: calm, ordered, low stimulus spaces, no confusing large spaces; indirect lighting, no glare, subdued colours; good acoustics, avoiding sudden / background noise; robust materials, tamper-proof elements and concealed services; possibly H&S risk assessments; safe indoor and outdoor places for withdrawal and to calm down. (DfEE, 2009, p.199)

The widespread exclusion from, or when included, the general nature of the design considerations listed in the current guidelines is in no doubt due to the difficulties and challenges presented when dealing with a spectrum of disorders. (Khare & Mullick, 2008; Mostafa, 2008; Young, 2004). Not only may sufferers exhibit different sensitivities and personal difficulties, the severity of these too can vary. In effect, the design parameters are fluid and variable. There is of course the danger when dealing with autism, that prescriptive design guidelines or single rules will not take into account variations among sufferers and their different levels of ability. Therefore, the challenge is both complex and difficult. But the need to confront these difficulties is huge. This, it could be argued, is especially true in a school setting. Feeling ill at ease in the classroom environment can hamper learning, thereby further alienating the ASD sufferer in society.

Design Complexity and Challenge

With regard to the classroom (environment), the ASD suffer and writer Donna Williams outlined her ideal environment as;

> ..one where the room has very little echo or reflective light, where the lighting was soft and glowing and upward projecting rather than downward projecting lighting. It would be one where the physical arrangements of things in the room was cognitively ordered and didn't alter and where everything in the room remained within routine defined areas. It would be an environment where only what was necessary to learning was on display and there were no unnecessary decorations or potential distractions. It would be one where nobody unexpected would enter without everyone getting a cue and processing time to expect the change. (Williams, 1996, p.284)

This description helps illustrate the many concerns the writer had when at school. She makes the case for constancy, structure, with neither the unexpected nor superfluous. In many ways, Donna Williams is advocating a potential solution for classroom design for the ASD pupil. If designing for the 'worst case scenario' then all children would be catered for on the autistic spectrum. Why not have a classroom environment that is totally calm, quiet, without distraction and enclosed from external influences. Would that not constitute an inclusive design solution?

However if we consider inclusive design as ***better design*** this is not the case. The classroom is a learning environment for life, a place of preparation for the challenges and negotiations we all face in our everyday life. Cocooning the ASD pupil from all external factors will not necessarily help them reach their full potential in life. Maximising a pupil's ability to cope with change and external factors is an important and vital consideration for teachers in the ASD classroom.

Therein lies the most difficult challenge for the designer when dealing with the ASD pupil in the classroom – that of trying to provide an environment where change can be introduced, where the ASD pupil can be challenged, encouraged and supported to maximise their potential. Dominic Cullinan, makes this point stating;

> A recent seminar for teachers at the Institute of Education, looking at the relationship between buildings and behaviour, explored the idea of designing spaces specifically for children with autism. Underlying the discussion was the belief that certain criteria could hold true; setting a desk facing a blank white wall, for example, might give the child the visual calm they need for concentration. However, it was also argued that such spaces do not help the child learn to live in the world at large. This refinement neither helps the child to cope, nor those who support them. (Cullinan, 2009, p.51)

So in effect, just as the ASD sufferer has a triad of impairments to contend with, so too do we as designers, have a ***triad of challenges*** to overcome. Not only are there the challenges firstly of the differing severity of the autism inherent within the spectrum and secondly the varying and differing range of sensory difficulties of individual ASD sufferers to contend with, there is the third difficulty in the classroom setting to consider – how best to promote and bring change and subsequent independence for the ASD pupil in that environment. Overcoming the triad of challenges for designers will hopefully then allow, in a school setting, the design of the best possible and most appropriate learning environment that will aid in pupil performance. With increased pupil performance and corresponding ability to cope with the challenges of their environment, the ASD pupil is more likely to manage to integrate more fully into mainstream education and society in general.

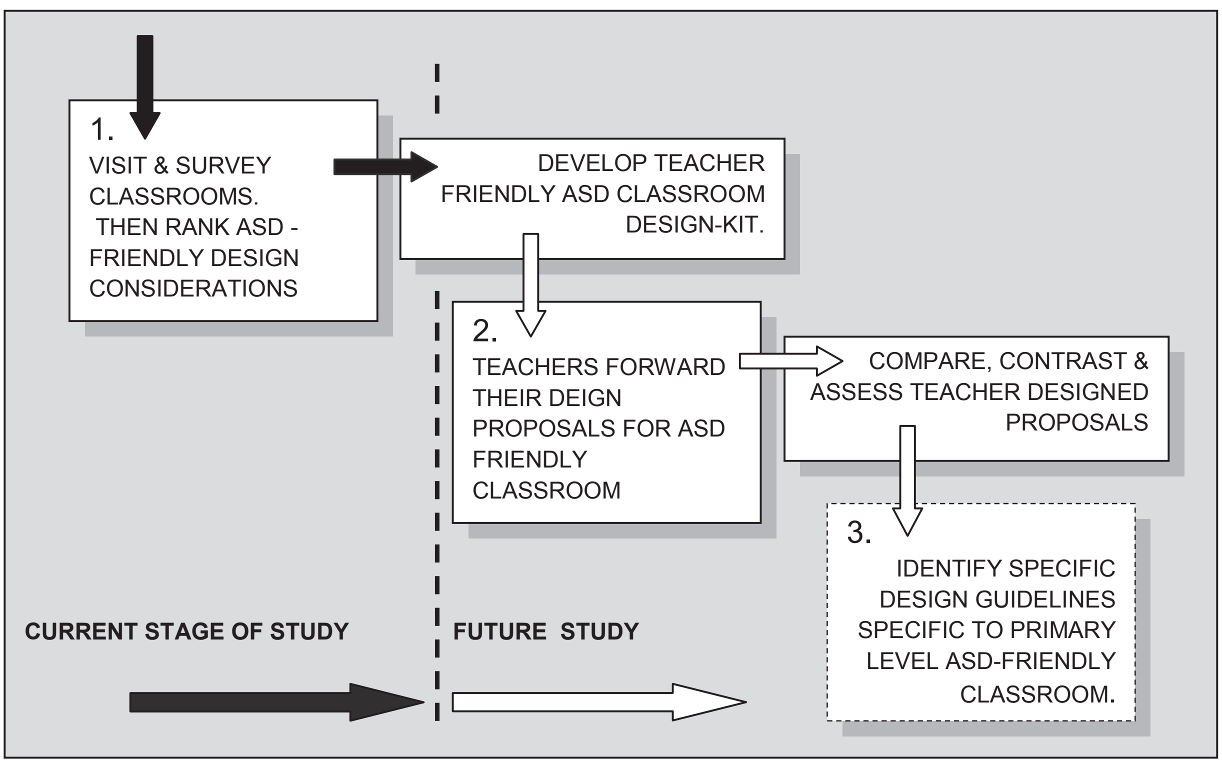
The Study

There is widespread consensus that an appropriate classroom environment will aid the performance of the ASD pupil. (Khare & Mullick, 2008; Whitehurst, 2006a) Therefore, this study seeks to identify what environmental factors and considerations contribute most to the ASD friendly classroom. It will be carried out in two stages. In this the first stage, 9 ASD friendly classrooms were visited, surveyed and the teaching staff asked to rank and give consideration to a number of autism friendly design criteria for the classroom. It is these results that are represented in this paper.

This, the first stage of the study, will then be followed by a future second stage where the teaching staff will be asked to design their ideal ASD friendly classroom environment. This will be in an attempt to further evaluate the environmental and built design considerations in an ASD friendly learning environment.

Ultimately it is hoped that this will then facilitate a third stage when ASD-friendly guidelines and design considerations specific to the primary level classroom will be developed.

Table 1 – Proposed Study Stages



In 2005, as a response to the report *Evaluating Provision for Autistic Spectrum Disorders in Schools*, (DoE(NI) 2005), the Northern Ireland Southern Education and Library Board (SELB) implemented as scheme where existing school accommodation in ten different schools would be converted and refurbished into ten ASD friendly classrooms. The SELB is currently one of 5 Education and Library Boards covering Northern Ireland. It spans 1,450 square miles and is responsible for providing education for 75,000 pupils in an overall population of 322,000 residents in its area. Refurbishment and conversion of the classrooms took place in 2005 and 2006.

This means that after three or four years working experience in the classrooms, the teaching staff have had time to formulate their opinions and evaluate the effectiveness of the interventions. All ten of the class refurbishments were carried out in mainstream schools, nine at the Key Stage 1 level (age 5 – 8) and one at Key Stage 3 level (age 12-16). Moreover because the conversions to ASD friendly classrooms were taking place in existing accommodation and were not new build solutions, it afforded the opportunity to better understand what worked and what did not work since, by their very nature, the refurbishments and conversions were in some ways constrained by existing the structure and fabric of the former accommodation. Also, because 8 of the 10 conversions were done in previously used mainstream classrooms, it might facilitate with the consideration of transfer of ASD friendly criteria into the mainstream classroom. If this was the case, it might aid in ASD pupil integration or transfer into the mainstream classroom.

To compose a set of criteria for the ASD friendly classroom teachers to rank, existing available literature was appraised (Harker & King 2002, Humphreys 2005, Whitehurst 2006, Mostafa 2008, Vogel 2008,) 16 design criteria for ranking were then compiled These consisted of combining the 8 considerations detailed by Vogel (2008) in *Classroom Design for Living and Learning with Autism,* with 8 of the less classroom specific criteria suggested for consideration by Humphreys in *Autism & Architecture* (2005). For purposes of comparison and understanding afterwards, the 16 chosen criteria were broken down into four category bands – control and safety, classroom character, classroom usage and classroom physical factors. These are listed below in Table 2. To allow further analysis, a checklist of factors was also developed, based largely on Tufvesson & Tufvesson (2007) and used to gain a greater understanding of each classroom environment visited. This is shown in Table 3.

It was decided at an early stage not to interview the children, but instead the teachers. This was done for three reasons:

1. As commonly noted (Khare & Mullick, 2008;Tufvesson & Tufvesson, 2007, Woodcock, Georgiou, Jackson & Woolner, n.d.), because of their disability, ASD-suffers can find it hard to communicate freely.
2. The age of the majority of the children, 5 to 8 years old, would render objectivity extremely difficult, and
3. As noted by Whitehurst (2006b) – environments designed for the ASD sufferer not only impact upon the sufferer but also for the teacher / carer. An environment where staff too can feel at ease is extremely important. That too can have a profound effect on the ASD

sufferer. As highlighted by Plimley (2004), autism friendliness is a combination of both a human component and the built environment.

Staff were asked to score each of the chosen sixteen classroom criteria in terms of importance from 1 (low) to 5 (high). All classrooms were visited at the end of the day when the children had left for home. On each occasion, when asking the teachers to score the classroom criteria, the order of the criteria for consideration was randomly selected.

Table 2 – Design Criteria for ASD friendly classroom. (H -after Humpreys, V after Vogel)

		Classroom Criteria	**Brief Description**
CONTROL & SAFETY	H	CONTAINMENT	Secure boundaries to stop the child running off or getting lost.
	H	GOOD OBSERVATION	To put staff and helpers at rest without infringing upon pupil's space.
	V	SAFE	Both in terms of physical and emotional safety. ADS-children commonly have little concept of danger.
	V	NON-THREATENING	A restful and secure setting to help foster encounters and relationships.
CLASSROOM CHARACTER	H	SENSE OF CALM + ORDER	Complexity can cause stress. For the ASD sufferer, this can be especially upsetting and confusing.
	H	GOOD PROPORTION	Might the sensory sensitive ASD sufferer find well proportioned space inherently more comfortable.
	V	NON-DISTRACTING	To decrease the chance of sensory overload for the ASD pupil.
	H	PROXEMICS (PERSONAL SPACE)	Many ASD sufferers need more 'personal space' around them or they can feel threatened.
CLASS USAGE	V	FLEXIBLE + ADAPTABLE	An ability to adjust the classroom to suit the ASD pupil's needs
	V	CONTROLLABLE (FOR PUPIL)	A degree of choice for the child to help promote independence
	V	PREDICTABLE	Clearly legible for the ASD pupil who is often reliant upon visual cues.
	V	NON-INSTITUTIONAL	Not sterile but welcoming and comfortable. A place where the ASD pupil can relax.
PHYSICAL FACTORS	V	SENSORY-MOTOR ATTUNED	Providing a range of sensory experiences in the classroom
	H	GOOD QUALITY ACCOUSTICS	Many ASD sufferers can be sensitive to noise and find it difficult to differentiate between different sounds.
	H	NATURAL LIGHT	The use of natural daylight in preference to artificial lighting.
	H	REDUCTION IN DETAIL	Both in terms of reduction in detail and palette of materials. ASD sufferers can get absorbed in minutia.

Table 3 – Survey Checklist for Classroom Visit

CLASSROOM		**PHYSICAL FACTORS**		**INTERIOR**	
	LENGTH	**VIEW**	BACKGROUND		PLANTS
	WIDTH		BUILDINGS		AQUARIUM
	SHAPE		GREENERY		QUIET SPACE
	HEIGHT		SKY		SENSORY SPACE
	No. of DOORS		PLAYGROUND		COMPUTER(S)
	No. of WINDOWS		NO VIEW		WALL DECORATION
	% OF GLAZING				SHELF STORAGE
	ORIENTATION	**NOISE**	INFILTRATION		BOX STORAGE
			EXTERNAL		CUPBOARDS
FINISHES	FLOORING		BACKGROUND		COLOUR
	HEATING	**LIGHT**	SUNLIGHT	**EXTERNAL**	
	CEILING		DAYLIGHT		
	LIGHTING		ARTIFICIAL LIGHT		ACCESS ARRANGEMENTS
		SENSES	SMELL		PLAYGROUND
WINDOWS	CURTAINS		TEXTURES		DINING
	BLINDS		PATTERNS		GARDEN
PLUS	NUMBER OF STAFFIN CLASSROOM – TEACHERS & CLASSROOM ASSISTANTS				
	NUMBER AND AGES OF CHILDREN IN CLASS				
	TEACHING METHODS EMPLOYED – ONE TO ONE; GROUP; BOTH				
	POSITION OF CLASSROOM IN RELATION TO REST OF SCHOOL				
	WC PROVISION FOR CHILDREN				
	PREVIOUS USE OF ASD FRIENDLY CLASSROOM				
	ANY SHARED CLASSES WITH THE REST OF SCHOOL				

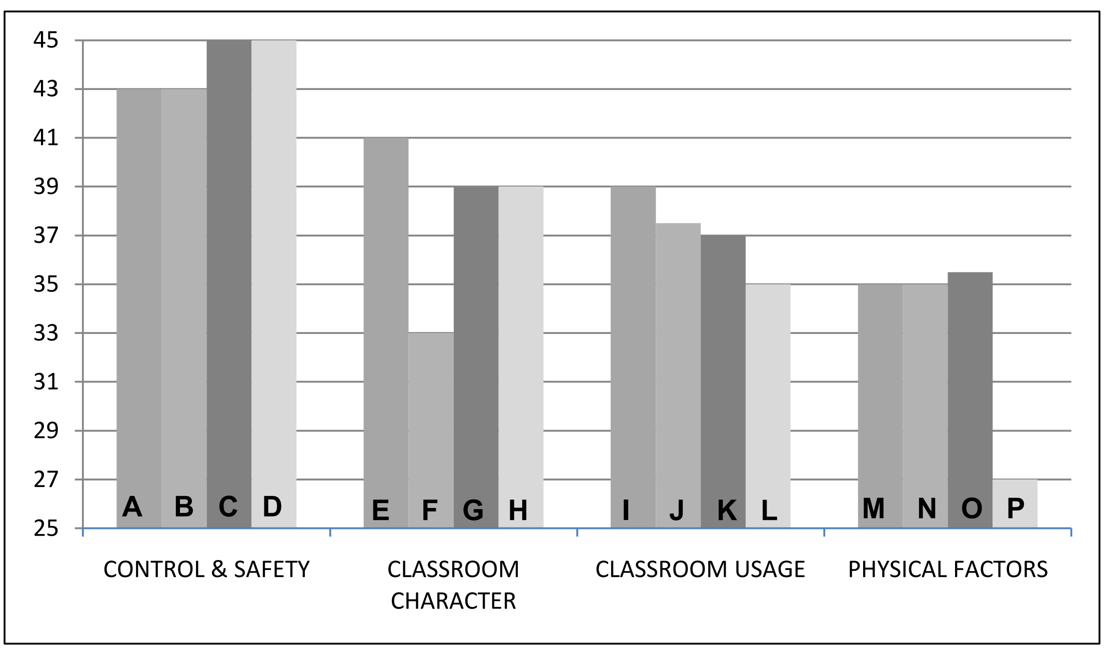
The Study Results

Between November 2009 and January 2010, nine of the ten ASD friendly classrooms in the SELB region were visited and their staff interviewed. Interview results were recorded and then combined together under the headings of the sixteen ASD friendly classroom criteria. The results are shown below in Tables 04 and 05. The results will now be further expanded in turn under the four category headings of control and safety, classroom character, classroom usage and physical factors.

Table 4 – Ranking Scores for ASD Friendly Classroom Criteria.

	Classroom Criteria	Score (out of a possible 45)
Control & Safety	**A.** CONTAINMENT	43
	B. GOOD OBSERVATION	43
	C. SAFE	45
	D. NON-THREATENING	45
Classroom Character	**E.** SENSE OF CALM + ORDER	41
	F. GOOD PROPORTION	33
	G. NON-DISTRACTING	39
	H. PROXEMICS	39
Classroom Usage	**I.** FLEXIBLE + ADAPTABLE	39
	J. CONTROLABLE	37.5
	K. PREDICATABLE	37
	L. NON-INSTITUTIONAL	35
Physical Factors	**M.** SENSORY-MOTOR ATTUNED	35
	N. GOOD QUALITY ACCOUSTICS	35
	O. NATURAL LIGHT	35.5
	P. REDUCTION IN DETAIL	27

Table 5– Bar Chart of Ranking Scores for ASD Friendly Classroom Criteria.



Factors of Control and Safety

Perhaps unsurprisingly, it was the criteria concerned with pupil safety and teacher control that scored most heavily in terms of importance overall. Regarding pupil safety, it was stressed that sharp edges and angles should if at all possible be avoided in the classroom. Climbing opportunities should be limited - bookcases, shelving and radiators are all likely candidates for climbing opportunities. The bookcases and units favoured by staff to sub-divide the classroom into different zones are potentially troublesome in this regard.

To aid with containment, most doors in and out of the classrooms were fitted with double handles, one at normal height and one at high level out of the reach of the children. Both had to be turned for the door to open. Of the 9 classrooms surveyed, 7 had direct access to adjoining WC facilities. For the 2 that did not, it meant staff had to leave the classroom to accompany the pupil to the WC. This was seen as a major disadvantage. A clear benefit liked by the staff where in operation, was direct access to a secure external play area. This could be used as a reward, as an incentive, for external teaching or for pupils unwilling to join larger numbers in the school playgrounds. It was also stressed that accessing playgrounds was best done over a small distance and that at all times the playground must be secure.

The importance of pupil observation was stressed. This was not only to help evaluation of the child in the classroom but also to prevent any pupil 'meltdowns' if the pupil was growing agitated or distressed. To this end, 2 of the classrooms visited had their quiet withdrawal space actually in the classroom, separated from the teaching and play spaces by fixed 1450mm high partitions behind which the children could withdraw into tents or fabric tunnels. Separate quiet areas accessed directly off the classroom commonly had glazed vision panels into them.

To aid with a non-threatening environment, easy access for the pupils to their visual timetables was stressed as essential. To facilitate with this it was preferred if possible that a separate cloakroom area outside the classroom or in the classroom if space allowed, be provided. Having the cloakroom area in a main corridor outside the classroom was not felt to helpful – ASD pupils benefit from 'transitional space.' This is very true for the transition from the hustle and bustle of the school circulation space into the classroom itself. In this regard, a well considered cloakroom area for coat and shoe storage can help.

Factors of Classroom Character

Regarding the character of the classroom, having an environment of calm, order and simplicity was ranked highest. (see Table 3) This was felt by staff to be most critical around the children's individual workstations when demands upon concentration would be highest. There, pupils have screened, separate cubicle-like workstations with minimal possible visual distraction. When able to cope in that environment, pupils would then be encouraged to work alone at a desk and if able to cope with that over time, would be encouraged to work at a group desk or table. To aid in this, a clear structure within the classroom is important.

The importance of having a non-distracting environment varied dependent upon what areas of the class were being considered. In the pupils' workstations, it was considered vital, less so in other areas. What was consistent however were the similar comments regarding what was most difficult for staff to combat in terms of visual distraction in the classroom. The necessary flexibility of being able to move or screen off the visually distracting computer(s) in each room was not possible with the fixed surface mounted radiators and pipes occurring in 8/9 of the classrooms. Even worse was the one instance where the classroom was fitted with recessed blow heaters. These proved to be both noisy and uncomfortable to be near. Furthermore, the grills provide an opportunity for the pupils to play with them.

The distractions of views-out were best dealt by having blinds or curtains in the classroom. Two of the classrooms kept the blinds closed at all time being described by one teacher as ‘the only way.’ Others closed the blinds when necessary. What was clear was that if low level curtains or blinds were closed, staff in classrooms with high-level clerestory glazing really appreciated having a visual connection to the exterior and the natural daylight that brought. However, orientation of windows was also a factor as direct sunlight entering the classroom was problematic.

The need for the pupils to have extra personal space in comparison to other pupils was recognised. To this end the maximum number of ASD pupils in each classroom was eight. One teacher and two classroom assistants accompanied this.

Less important to the staff was the concept of proportion. This is due in part to its very qualitative and subjective nature. Interestingly, the teachers whose ASD classroom had previously been diagnostic and learning disorder accommodation and therefore consisted of a collections of rooms of differing sizes rather than one primary classroom, reported that the children’s behaviour was different in different room volumes – the children tended to be calmer in smaller rooms. This is an observation shared by Myler, Fantacone & Merritt. (2003) Similarly in the one classroom of differing ceiling heights where the ASD classroom was a combination of former 2350mm high flat ceiling circulation space and a mono-pitched sloped classroom rising from 2670 mm to 4930 mm, the teacher reported that the pupils felt more comfortable in the lower ceiling area (whereas for the staff the opposite is true!)

Factors of Classroom Usage

Concerning the usage of the classroom, the two most common topics of concern for staff were storage and flexibility of classroom layout. The classrooms that were visited were sub-divided into different teaching zones such as work, group, play, computer, reading and story-telling areas. This was commonly done by using screens or shelving and storage units. Having a number of these on lockable castors was of great benefit in quickly changing the classroom layout to suit different needs and also bring change into the classroom. The one major variant from this came from the staff of the one converted Key Stage 03 classroom. Here when dealing with older children and especially boys between the ages of 12 and 16 rather than the 5 to 8 year olds of the other classes, the staff were adamant that furniture needed to be fixed and secured to the floor to prevent the possibility of it being thrown by an upset, physically stronger pupil.

In every classroom, the staff stated that they did not have enough storage. This might well be a complaint from most teachers but in the ASD friendly classroom it can be very significant. Firstly there is the huge range of non-standard equipment used by the pupils. This can include bulky equipment used in occupational therapy sessions or in individual lesson plans. Secondly, clutter can of course be potentially distracting and tempting to the pupil to access it when not appropriate. It is much better for the staff to have adequate storage so that they can decide what to bring out and when to put on display, again responding to the pupils' needs. This then overlaps with giving the pupils a degree of control in the classroom, important when trying to encourage pupil independence. Having some open shelves or accessible drawers and cupboards can help foster this, if considered appropriate by the staff.

Factors of Classroom Physical Factors

Physical Attributes within the classroom were thought by the staff to be the elements that the pupils could with help and time, come to terms with. Accordingly, they were ranked as the least important design considerations in the classroom. Having good levels of natural daylight in the classroom was popular. However what was raised by staff as a more important issue was the quality and type of artificial light in use. This was especially important if the blinds or curtains were closed. In 8/9 classrooms, the lighting was supplied via fluorescent strip lighting with diffusers to minimise flicker while the other class (in the most recently built school) was fitted with spotlights. In all cases, staff favoured variable lighting rather than the constancy achieved by the lighting systems currently in use. Dimmable lighting, separate lighting circuits and a range of task lighting as alternatives were all suggested by staff. In fact, in some of the classrooms, the staff themselves were using personally supplied free standing task and mood lighting to add contrast to the classroom.

Regarding acoustics, it was noted by all staff that background and infiltrating noise could be distracting for the pupils. However it was also explained that different types of noise could have different levels of impact. For instance, distant passing traffic (especially the sirens of emergency vehicles) could grab a pupil's attention for a short time, as would grass cutting or hedge trimming. However, this was part of everyday life. More problematic was sound infiltration from nearly music classrooms, playgrounds, sports halls or nearby corridors where noise might not only be prolonged but could also vary suddenly in volume. In this regard, the positioning of the ASD friendly classroom within a mainstream school can be an important initial consideration.

Considering sensory-attuned features, the main factor that all staff stressed was the need to have an immediately accessible quiet withdrawal space for the pupils to use if getting distressed or needing to 'recharge their batteries'. These ranged from converted small stores off the classroom, space under an adjoining staircase to the partitioned areas in the class. The two classrooms who did not have these reported it as a major negative. In one case this was because the school had converted their quiet room into a sensory room, something they now in retrospect wish they had not done. This is because a distressed pupil might be agitated and run the risk of hurting themselves on some of the installed lighting and sensory equipment. In the second example, the quiet area was not accessed directly off the classroom, instead via an adjoining link corridor. Therefore the pupil had to be accompanied to the quiet area out of the classroom. All staff expressed the view that they felt the quiet area was more important than the sensory area – the latter was more of a luxury whereas the quiet area was absolutely essential. If needed, staff suggested, if finances allow portable sensory equipment could be set up in a play tent or part of the classroom if required.

Of all the factors considered, it was the minimal detailing in the classroom that was ranked as the least important by the staff. In all the classrooms, the floor covering was a mixture of carpet and slip-resistant vinyl. These tended to be single colours. Geometrical patterns, because of their distracting qualities, always avoided. Walls were painted in 8/9 classrooms, usually muted colours and then used as a backdrop for pupil's work and occasional notice-boards. Having the children's work on view was thought to be very important by the staff as the pupils derived great pleasure from seeing their work exhibited. In the one remaining classroom the internal walls were not painted plaster but instead (as was the case in the majority of classrooms throughout the school) exposed brickwork, this was problematic. The teacher felt the brickwork would be better painted because the multi coloured natured of the brickwork was a distraction for the pupils. Finally, with regard the ceilings in the classrooms that did not seem to be an issue, these either smooth-finish painted plaster or suspended ceiling tiles. The latter were sometimes popular with staff because it allowed them to hang occasional displays easily from the ceiling.

In all cases, staff felt it important that the detailing and finishes in the ASD friendly classroom be as much like the mainstream classroom as possible in order to facilitate into it by the ASD pupil. In short, because the mainstream class had painted walls, work and notice-boards on show, with specific floor and ceiling finishes, as far as possible, so too should the ASD friendly classroom.

Conclusion

It should be stressed in concluding that it is important that not only architects and designers make the decisions for ASD friendly environments, but instead listen to teachers, educational psychologists, therapists, parents and if possible the ASD sufferers themselves. The built environment needs to be more inclusive, particularly when considering the needs of the ASD sufferer. Similarly, the ASD classroom is only one component of promoting integration of the ASD pupil into the mainstream school. The relationship of the ASD classroom within the school is one that needs consideration. The importance of not building something in isolation but 'also repairing the world around it' in order to make the whole more coherent is eloquently made by Alexander (1977, p. xiii)

Both the human and built environment interactions with the ASD pupil can make a meaningful difference. The classroom is an important environment. As the place where learning takes place, it needs to be considered very carefully. It is the environment where progression from more sheltered and protective surroundings can be, with help, peeled away gradually introducing the ASD pupil to greater challenges. This process can be further enhanced by using the school at large, where the ASD pupil can mix with their mainstream colleagues in shared playgrounds, sports, dining and class activities.

But it needs to start with the classroom itself. There, pupil safety and teacher control cannot be compromised. The class needs to be flexible whilst having a sense of calm and order. It is important to recognise the need for additional area in space allocations, both for storage and pupil personal space. Directly off the classroom, WC's and a quiet withdrawal space should be provided. There are benefits to be derived from direct access to an external secure play area. If the classroom is structured into different zones, different qualities of lighting should reflect this. (Beaver, 2006) High level clerestorey glazing is advantageous when curtains and blinds often need to be closed. Under-floor heating would do away with the need for surface mounted heating. Giving careful consideration to the position of the ASD classroom within the overall school could help nullify the effects of auditory distractions from music, external play and sports.

Conflicts are inevitable, but the potential rewards of initiating genuine change for the better are huge. Well considered and designed ASD classroom spaces can be creative and genuine 'environments for learning.' (Scott, 2009; Vogel, 2008). Recognising the design complexity and challenges involved when considering the ASD friendly classroom is the important first step to towards providing a better learning environment for the ASD pupil.

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Collaborative Design Pedagogy: An Examination of the Four Levels of Collaboration

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Abstract

This paper reexamines research conducted with more than a dozen authorities in architectural education on collaborative methodologies over a three year period. The focus of initial study, a doctoral dissertation entitled: Collaborative Design Pedagogy: A Naturalistic Inquiry of Architectural Education (McPeek, 2009), examined the apparent disparity existent between the practicing profession of architecture and the academic preparation of its future members. In this paper, a condensed examination of specific findings from the previous data set point to four key levels of pedagogical collaboration (community, institution, faculty, and student) that are critical components to the implementation of collaborative architectural curriculum. These levels contain both inhibiting and facilitating elements that appear in all types of higher educational institutions (public, private, liberal arts schools, land grant universities, etc) and in varied curriculum settings. Thus, while the authors' main emphasis lies in enhancing the pedagogical scope of architectural education, this data may also be pivotal in facilitating and/or inhibiting collaborative endeavors in any major field of study, particularly those which incorporate collaborative methods in the context of situated learning.

Keywords

Architecture; Collaboration; Pedagogy; Cross-disciplinary; Trans-disciplinary; Multidisciplinary; Interdisciplinarity; Intradisciplinary

Background & Purpose

The research presented in this paper is based on original work conducted by McPeek from 2003 to 2009 which resulted in the completion of a dissertation entitled; Collaborative Design Pedagogy: A Naturalistic Inquiry of Architectural Education (McPeek, 2009). The focus of the initial study was to examine the apparent disparity existent between the practicing profession of architecture and the academic preparation of its future members.

> Historically, the education of an architect has been a highly individualized pursuit, focused on the development of an individual skill-set (Boyer and Mitgang, 1996) that seldom required collaboration beyond that of student and professor. While this individualized, hands on approach to education has been highly revered by many (Cossentino, 2002; Shaffer, 2003; Kuhn, 2001) it often falls short of its potential and fails to recognize that the greatest design accomplishments of humankind have been the undertaking of collaborative enterprise (Bennis and Biederman, 1997). Furthermore, architecture students are being prepared in a manner that is contrary to the highly collaborative nature of the architectural practice they will enter (Crosbie, 1995) (McPeek, 2009, pg 3).

This paper examines, in specific, the portion of research which highlights critical factors (inhibiting and facilitating) which can impact the implementation of collaborative teaching within American schools of architecture by focusing on four key levels of collaboration (community, institution, faculty, and student) that exist in American universities, both public and private. The purpose of this condensed examination is to provide a platform for discussion and ideation regarding the implementation (and support) of collaborative pedagogy. While the authors' main emphasis lies in enhancing the pedagogical scope of architectural education, it is important to understand the role that the four levels of collaboration (community, institution, faculty, and student) play in facilitating and/or inhibiting collaborative endeavor.

Methodology

The research analyzed within this paper is based on a series of interviews conducted by McPeek over a three year period with several leading architectural educators. Participants were selected based on published academic literature as well as personal referrals. Interviewee's included past and present deans, department heads, and professors of all rank. Although a variety of institutions (public, private, liberal arts schools, land grant universities, etc) are represented within the data, interviews were limited to participants employed by schools of architecture with full member status in the Association of Collegiate Schools of Architecture [ACSA]. The only exception to this standard was the inclusion of interview responses from a limited number of associated research professionals employed outside of ACSA member institutions.

The data collected and cataloged was based on qualitative research via naturalistic inquiry techniques. These techniques were based on a variant of Rubin's (2004) outlined methods and followed the format known as "Ethnographic Interpretation." This method was particularly well suited for the one-on-one interaction and dialogue desired for study. Although the data was derived from independent and unique conversations, each discussion followed a standardized interview guide which sought to identify key norms, rules, values, and traditions commonly associated with collaborative teaching and learning in architectural education (McPeek, 2009). It is important to note that in order to ensure confidentiality and enhance candid dialog, all of the quoted participants have been given pseudonyms to protect personal and institutional identity.

Overview of Findings

The findings of the original research were categorized into five general themes: Levels of Collaboration, The Role of Collaborative Pedagogy, The Collaborative Skill Set, Implementation of Collaborative Methodologies and Collaboration in the Design Studio (McPeek, 2009). Collectively, these themes provided a basis for outlining impacts to collaborative design pedagogy in architectural education. However, throughout the course of interviews, respondents engaged in consistent discussion centered around four key groups: community, institution, faculty, & student. Each of these groups (while at times inherently interrelated) brought forth a variety of distinct factors impacting the success, or failure, of collaborative architectural education.

The community

Service to the community is a central focus for many schools of architecture across the United States and there are numerous examples of architectural programs actively engaged with their communities. Some higher profile examples include The Studio at Large (Palleroni and Merkelbach, 2004) out of the University of Washington and The Rural Studio (Oppenheimer-Dean and Hursley, 1998, 2002) at Auburn University. Collaborative community based projects tend to focus primarily on working with groups who often lack funding for, or access to, architectural services. Groups such as Habitat for Humanity, Native American tribal communities, the local farmers market, and outreach programs for disadvantaged youth were all cited by respondents in the initial research as examples of collaborative partners at the community level. Respondents overwhelming emphasized the importance of community involvement in the collaborative educational process. In particular, respondents felt that student interaction within the community yielded a greater awareness regarding the importance of shared ideas. "I think another important dimension to this is the discovery that others pull, insights and wisdom and other points of view, that we don't hold as individuals" (Thompson, 2005 as cited in McPeek, 2009, pg. 91). Respondents also concluded that creating a foundational attitude and basic skill set of community collaboration during formative academic years was critical to future professional attitudes. "As future professionals, they're involvement with the community, it starts here. Because if it doesn't start here, it doesn't happen…" (Connors, 2005 as cited in McPeek, 2009, pg 90).

However, a critical factor involved in collaboration at the level of community is that of preconceptions (or even simply, personal perceptions). Even the most well intentioned collaborative efforts can be stymied if the participants involved are not alert to the potential motivators (culture, economic, religious, political, linguistic, etc) that impact participants from all sides.

> …we decided by working with the Singapore, we thought that we would kind of erase these kinds of cultural differences that would exist…And Singapore having this kind of large Chinese population, and Hong Kong, again, being Chinese, we thought that we would have some kind of cultural thinking so to speak, and that they would be in tune…actually, what we have discovered is there are huge cultural differences, and all sorts of misunderstandings that took place during that semester (Jones, 2005 as cited in McPeek, 2009, pg 117).

Unlike the traditionally fictitious, individually competed architectural academic projects, community collaboration often involves real life scenarios with real life participants. Thus, while educationally vital and foundational, such projects must be executed with extreme care due to the high potential for causing misunderstanding and genuine harm.

The institution

At the level of institution, respondents spoke of interaction between their respective academic units (University, College, School, and Department) and the internal intellectual community in which they served. Shared experiences associated with collaboration between units on a campus highlighted the role that institutional and departmental structures play in either facilitating or inhibiting the collaborative educational process. In particular, financial pressures and course structure were often cited as critical factors. "We are a much more integrated, interdisciplinary in research than we are in instruction, and that's largely because of the centers and the fact that there still are powerful incentives for people to collaborate which basically is money." (Connors, 2005 as cited in McPeek, 2009, pg 96). As institutions face growing demands to increase revenue streams beyond state appropriations or the individual donor level the focus shifts to financial gains found through research grants. However, the fiscal emphasis on collaborative interdisciplinary research often fails to include teaching. This is because interdisciplinary teaching is often viewed as a potential expense and/or resource drain, rather than a strong source of financial expansion. "…whenever an administrator speaks to unifying and collaborating and going across to institutes across campus or whatever the complexity begins, who should use the resources…" (Smith, 2004 as cited in McPeek, 2009, pg 97). This struggle over division of resources is particularly acute when examined in terms of distributing academic credits.

> You're work in the university, so you know that if you were to teach a class with a colleague from another department, the immediate question that you will get from the department heads will be, okay, how do we divide the credit units…So in other words, is it going to be 50 percent committed to architecture and 50 percent attributed to whatever, either mechanical engineering and so on? So there are these kinds of institutional barriers that have to do with the funding of the various educational activities. (Jones, 2005 as cited in McPeek, 2009, pg 121).

Respondents noted that collaborative skills are a fundamental requirement amongst architectural practitioners and a skill that should be learned in the classroom. Several respondents noted that the ability to work well with others and lead teams in professional practice were amongst some of the most important skills that the architect has in professional practice and the earlier they can be developed the better. However, many comments reflected a frustration with departmental structures, particularly regarding the congestion of accredited curriculum, which can significantly hinder collaborative efforts. This is due in large measure to current course structures that are simply too overloaded to allow for any additional courses or the development of dual degree programs with other majors on campus.

> … What would architecture and public policy be up there, if you came in as a hybrid degree? But we've created our curriculum in such a way that you cannot take anything like that…You can't take dual degrees of architecture in most of the schools in the country. You can barely play hockey once a week… (Wilson, 2005 as cited in McPeek, 2009, pg 109).

Another inhibiting factor discussed by many respondents focused on the structure, duration, and curricular emphasis placed on design studio courses. The average architectural studio course in American institutions of higher education runs in three to four hour blocks of time, three to four times weekly. This amounts to upwards of 12 hours of class time per week (every semester for four or more years) dedicated to predominantly solitary project work.

> I think also we need to become more flexible about this idea that we are giving studio anywhere from a third to a half of your load and two thirds of your life, has got some potential to be reconsidered…the backbone of this mythology about this simultaneous presence of design every semester and that its ever-present nature is a place to pursue, synthesize the other learning that is done in the curriculum. I don't think of it as a kind of theological truth…(Thompson, 2005 as cited in McPeek, 2009, pgs 110 - 111).

In discussing ways to overcome and/or manage collaborative issues at the institutional level many respondents noted the need for faculty, administrators, and departments to be both opportunistic as well as holistic. "It raises questions about how should we be teaching; how pertinent that is that we maintain these divisions within the university if they are starting to radically blur out in the field…" (Phelps, 2005 as cited in McPeek, 2009, pg 126). Some respondents found opportunity in bridging the financial gap through expansion of their publication efforts into alternative professional groups. "One of the interesting things is we're finding, I think if we applied to any conference in the country - nursing conferences, neonatal care conferences - we are the anomaly. 'You're a designer? Oh, we'd love to!'" (Wilson, 2005 as cited in McPeek, 2009, pg 127). By generating connections with other disciplines outside of the realm of "institution" many educators are finding not simply receptive audiences, but potential partners for both research and pedagogical collaboration. Bridging the gap, it appears, may be better accomplished from an outside-in approach. Other responses exposed that it can be much easier to facilitate collaboration between units in the same college than between units of different colleges. "…we wanted to collaborate with engineering and we have tried of course, but we've been more successful collaborating between the two disciplines inside the college, which is architecture [and] landscape architecture…" (Phelps, 2005 as cited in McPeek, 2009, pg 100). This seems to be due, in large measure, to the existence of common pedagogical goals and administrative policies which can be much easier to navigate at the department level than at the college or university level. Additionally, overlapping job site interaction, which takes place in later professional practice, is viewed as a strong incentive for interdepartmental teaching strategies between units.

Respondents also point to the vital importance of collaborative educational 'buy in' from higher levels within the institution. Communication is critical and many departmental chairs and college deans are beginning to understand that, for true cross disciplinary collaboration to occur at the course level, they must initiate the dialog. "Right before the holidays the dean of our liberal arts college and I got all of her school chairs and all of our directors together for a half day talking about collaboration. What are you doing of interest to one another?" (Connors, 2005 as cited in McPeek, 2009, pg 99). Additionally, the thread of inter (and cross) disciplinary collaboration must be holistically embraced at the curricular level. "The University of Oregon, there's a lot of collaborative work. They built it into their culture in every course, so it's not just collaborate, 'Oh, we'll do a little bit of collaboration here,'…It's pervasive. It's a given" (Wilson, 2005 as cited in McPeek, 2009, pg 132).

The faculty

When considering collaborative interaction between individual faculty members, respondents pointed to a number of critical issues which directly impacted collaborative endeavors including: teaching load, the tenure process, time commitment, grades, and faculty personality. A central concern on the part of faculty and administrators is co-teaching. "…co-teaching does it count as a full course? Is it part of the full load or is only part of the course, you get into teaching or work load issues with faculty which is also a kind of can of worms" (Phelps, 2005 as cited in McPeek, 2009, pg 122). When there are shared teaching responsibilities how does the department evaluate course loading of co-teachers relative to those that do not have shared teaching responsibilities? The perception among those not engaged in co-teaching course work might be that their colleagues are potentially skirting full time responsibility. However, respondents often disputed this notion. "…if you talk to faculty they tell you know that co-teaching can be just as hard as teaching. Even though you might be only teaching half the courses, you were still putting in all the work of a full time class" (Phelps, 2005 as cited in McPeek, 2009, pg 125). But the dilemma extends beyond personal or departmental perceptions and can have implications regarding the process of tenure and promotion. Some of the respondents felt that this was simply a convenient excuse for not doing collaborative work that is readily accepted by many. However, most agreed that collaborative work is difficult for many institutions to assess due to a lack of clear 'ownership' over course material, outcomes, etc.

> Because most schools it's very difficult to do, from not tenuring the people who are in multiple disciplines to not valuing the courses that do that…we still do things where you have to have ownership and who did it and why did you do it, it has to be attributable to an individual (Wilson, 2005 as cited in McPeek, 2009, pg 121).

As the instigator of collaboration, faculty members are charged with creating an environment conducive for collaborative work, fostering collaborative relationships between the students, and assessing the collaborative work produced by the students. It can often be a laborious process, particularly when beginning such work for the first time. "Just as an observer, interdisciplinary instruction is not easy. It's very, very difficult, and you have to have the patience, you have to have the time, and you have to invest in the infrastructure…" (Connors, 2005 as cited in McPeek, 2009, pg 121). Additionally, there is a very real challenge to establishing clear methods of assessing group work. Many faculty find this portion of the collaborative equation to be particularly difficult to overcome. "Collaboration also creates certain kinds of tensions because it seems invariably in every team there are some students who work more than others you know and so you just have to make sure you not penalizing the hard workers by kind of giving shelter to ones that aren't working as hard" (Phelps, 2005 as cited in McPeek, 2009, pg 130). This sentiment is further underscored by broader institutional pressures, "We are always struggling with the demand of the university that we give individual grades to individual students…" (Phelps, 2005 as cited in McPeek, 2009, pg 129).

Although the pressure to produce individual work based on individual effort exists for faculty in both their own academic careers as well as with student project work, many respondents expressed a belief that these factors need not be the last word in collaborative pedagogy. In the case of student grades one respondent explained,

> …the idea that grades come, let's say at the end, and they are anointed by a divine perspective is part of the problem….more important than the grade I think, ultimately, is the feedback and if you cultivate feedback not as something only you award but something that exists among peers then collaboration is a lot more present…(Thompson, 2005 as cited in McPeek, 2009, pg 127).

Respondents also expressed the need to be actively engaged in student group dymanics.

> I keep close track of who's doing what. I employ intelligence gathering techniques… I would actually interview - informally interview students asking them who's doing what. Asking them if they have complaints about the group; Pointing out to students that are not doing work that they should do work and contribute…(Jackson, 2005 as cited in McPeek, 2009, pg 128).

Beyond the rigors of tenure, course load, and grading dilemmas, many respondents also cited faculty personality as a pivotal factor in collaborative efforts. In some instances this was attributed to longstanding departmental routine and "…older faculty who have been doing things a certain way for a long time…" (Smith, 2004 as cited in McPeek, 2009, pg 120) who were not always willing to undertake group projects. There was also a sense among some interviewee's that perhaps inherent in the aspect of 'teacher' was a notion of individuality. "Often people who go into academia go into academia because they're mavericks, and so you want team players, you've got to go to industry" (Wilson, 2005 as cited in McPeek, 2009, pg 103). But, as one respondent pointed out, sometimes these inhibitors can be avoided through common observation. "I have learned in tons of settings that were collaborative over the years that it still simplistically comes down to individual chemistry and my best collaborations have always been when I really wanted to work with somebody…" (Smith, 2004 as cited in Author, 2009, pg 103).

The student

Each of the preceding levels of collaboration serves to enable, or hinder as the case may be, collaboration at the level of the student. By insuring that the preceding levels of collaboration are in place the likelihood of successful collaboration in the classroom is greatly enhanced allowing the instructor to prepare the students for the rigors of collaborative learning. An important consideration when pursuing collaborative learning in the design studio is to understand how design students differ from students in other disciplines and how these differences affect collaborative endeavors. When discussing collaboration at the level of the student the respondents frequently noted the “nature” or “type” of students that pursue an architectural education. A great many of students entering into schools of architecture have a “maverick” personality and as a result are not intrinsically predisposed to the social nature of collaborative efforts.

> I think that the students who are attracted are the same students that were attracted 20, 50, 70, 80 years ago, and they’re makers, but they may not be social mavens…When we have students who are great public speakers, or very involved with student council, they often are not our strongest students in architecture, and we run them off…it’s very interesting (Wilson, 2005 as cited in McPeek, 2009, pg 106).

In discussing facilitating factors for collaboration at the student level, respondents cited the impact of observational learning. Because many students lack social or collaborative expertise, the need for “learning” such behavior is paramount. Effective co-teaching was noted as a primary, and mutually beneficial, means of observational learning regarding the collaborative process. Observation of community based collaboration within organizations (i.e. Habitat for Humanity) also provides excellent opportunities for exposure. Observation can then be followed by emulation, where the students mimic behaviors previously observed followed by increasingly complex collaborative challenges.

Another primary focus in teaching students to be good collaborators is to help them develop a common dialogue. This common dialogue is the primary tool, in a collaborative skill set, needed for sustained collaboration. The ability to establish and maintain an ongoing dialogue is mandatory for successful collaboration and this requires the establishment of a common language. It has also been determined that the process of establishing a common language is one that can be taught or coached in the classroom environment. It is this common dialogue that serves as the foundation for a collaborative social construct.

One respondent in the study described this in the following way.

> Collaboration is functional. …part of that is getting over your own vocabulary and beginning to understand and have empathy for the vocabulary of the collaborator. These perceptions that students from management bring, or engineering bring, or our own architecture students bring, it has to be overcome before we can get meaningful collaboration and partnering and the joint exercise of problem solving, alternative generation and so forth. (Connors, 2005 as cited in McPeek, pg 114).

Yet another respondent noted

> There’s also the greater danger of them just finding having no common language. … [For example] the generalist can’t even speak with the specialist anymore. Peterson, 2005 as cited in McPeek, pg 114).

It was determined that like design ability, the development of a common dialogue, requires practice and repetition. This is a skill that on the surface may appear to run counter to the "maverick" tendencies of the typical design student actually complements and enables the natural abilities and tendencies of the design student.

Conclusions

This paper offered a compressed overview of research from an original data set, focusing on four key levels of collaboration that exist in American educational institutions: the community, the institution, the faculty, and the student. Based on research conducted to this point, it appears critical that, in order to facilitate successful collaborative exercises in the classroom, these key collaborative levels must be working in concert. In particular, if the levels of community, institution, and faculty have not been addressed, then achieving a positive outcome at the level of student becomes an even greater struggle. Successful collaborative engagement is dependent upon the interplay of these four levels and, with the proper facilitation (McPeek, 2009), can greatly enhance the educational experience, for architectural education as well as many other increasingly collaborative fields of study.

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The Construction of Complexity in Design and Public Policy Contexts

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Abstract

This paper explores the nature of complexity and how it is manifest in the practice of design research and public policy given their unique contexts. This comparison is made by examining the tools and approaches that are used in understanding problems and creating outcomes in each field. This paper is based on a recently conducted action research study at a state legislature in the United States and is supported by foundational literature on modern problem theory, decision making, methods, and process in the two fields.

Complexity emerges from the many stakeholders that surround and define our issues, the enigmatic nature of our ill-structured problems, and the multiplicity of variables that confound progress towards one solution. An interdisciplinary opportunity is presented; the study suggests tools are a function of the complexity in any given context and provides examples of varying modes of managing complexity in design and policy environments. By juxtaposing the similarities and differences in how design practice and policy development construe and manage complexity, this paper frames the overlap between the two areas of practice and builds a mutual space for learning and collaboration.

Keywords

Design practice, participatory approaches, politics, policy, human / user-centered design, methods, complexity, decision making, design thinking

Complexity is very familiar to designers and policy makers. It is present as we struggle to generate acceptable solutions for as many people as possible, as we ceaselessly reevaluate the goals of our outcomes and when we carefully seek the sources of the problems our outcomes attempt to address. We look towards broad strategies, ranging from implicit to explicit, like collaboration, interdisciplinarity, data analysis, or brainstorming as a means to apply our thinking in order to acquire a better understanding of our complex environments. Yet, these strategies have emerged out of the distinct cultures and work contexts of design and policy. An assessment of the complexity management strategies from each discipline creates a mutual space for learning and is telling of how our end products are shaped by our approaches and the way they steer complexity.

This paper suggests that the complexity faced in the design process and the policy making process is not merely shaped by an existing complex natural state but also by our modes of management. Complexity emerges from the many stakeholders that surround and define our issues, the enigmatic nature of our ill-structured problems, and the multiplicity of variables that confound progress towards one solution. This paper, based on a survey of literature and an action research study at a state legislature in the United States, actively examines these characteristics in design and policy by investigating policy tools and exploring how design tools might be incorporated in the policy context. The transferability of design methods, and approaches, to the policy making realm has recently achieved great acclaim (DFFN, 2003; Owen, 2007; RED, 2006), yet there is a paucity of research that has explored this topic in its real-life context. This examination of complexity becomes particularly valuable in the search for better public decisions and decision making.

Research Approach

This study explores complexity as a boundary spanning phenomenon by asserting that the tools employed in design and policy are a function of their respective decision-making contexts and that these tools might be able to be applied across boundary. It weaves together a recently conducted action research study that explored how design methods might be used in state-level policy making with relevant literature on problem theory, decision making, methods and process in the two fields. This mixed approach appropriately poises this research to ask how issues are constructed and what instrumental roles methods play in the definition and resolution of the inherently complex problems across contexts (Meierling, 2009).

The primary research used a state legislature as a case study as per Yin (1994) and directly engaged key stakeholders in the policy process through observation, interviews, and collaborative modeling of political processes. The research strategy for this study combined evaluative and applied methodologies in a qualitative approach. The evaluative study assessed information from a literature review and initial interviews with lobbyists, community members and legislators to analyze the intersections between design methods, legislative methods and citizen issues. The applied study introduced nine representative design tools to eight state legislators in order to explore the relationship to legislative methods. The nine design tools are as follows:

- **Personas** are rich narratives that describe a person's unique experiences.
- **Storyboards** are visualizations that represent a sequence of events and their imbedded relationships.
- **Mind mapping** is a type of diagramming where a person intuitively places related and potentially related ideas around a central concern in order to classify concepts and to generate new ideas.
- **Systems diagramming** helps understand how complex systems work by visualizing networks of interrelated issues, their lifecycles, and how they interact with other inputs
- **Prototyping and evaluation** involves testing an idea before full-scale implementation. This can lead to greater success in the full-scale project.
- **Research frameworks** segment collected information into relevant, pre-established categories; this aids in seeing relationships among many issues and ensures all aspects of a research target have been accounted for.
- **Co-creation workshops** gather a group of people to create their own solutions to problems side by side with expert moderators who keep real-life constraints under consideration.
- **Make kits** allow an individual to show their own experience using words and images without the imposition of another person. After completion, they are returned to the research team for analysis.
- **Visual representation**, as opposed to verbal, facilitates a different understanding of a problem through diagramming and explanation, and is adept at clearly showing relationships.

This phase was also accompanied by in-depth interviews with advocates, interest groups and policy organizations and a number of observations of legislative processes. A dialogue was created that collaboratively explored the potential currency of design tools in the policy context and a path towards design-policy integration.

This paper builds upon established discourse in problem theory and planning. Design and policy making are both planning activities; they are locked into the transition from 'what-is' to 'what ought to be' (Buchanan, 1992; Schön, 1994; Simon, 1969). It is within this discourse that complexity and politics are found to be similarly intrinsic to design and policy (Rittel & Webber, 1969; Dubberly & Rith, 2007). Yet, two different institutions prevail: the design process and the political process, each corresponding to their own unique methods, or set of tools, and unique issue contexts. Robert et al. 's (2002) systems framework suggests that disparate systems can share a common dialectic between the constitution, outcomes, *processes*, actions, and *tools* of each system. By framing design and policy contexts as separate systems, it is possible to compare the manifestation of complexity in design and policy development through an examination of tools.

Problem Complexity as Common Ground

Though little literature explores any sort of collaboration between the design fields and the policy development world, they are frequently paralleled in terms of problems and their solutions. Both areas of practice are involved in the development of knowledge surrounding social interactions, are significantly influenced by the social sciences, and are equally entrenched by the same root issues (Birkland, 2005; Schön, 1994; Owen, 2007). These root issues are best characterized by the ill-defined, wicked problems faced in planning activities (Rittel & Webber, 1969). Different from tractable problems involving measurement and direct relationships, many of the problems that designers and policy makers face are fraught with complexities outside our comprehension, leaving us only with tools, ranging from intuitive approaches to explicit strategies, as vehicles to apply our thinking to complex problems. For both designers and policy makers, complexity is a result of a confluence of multiple variables, the interplay between problem and solution, and diverse, irreconcilable stakeholders (Buchanan, 1992; Schön, 1994).

A Multiplicity of Variables

A multiplicity of variables is central to complexity for designers and policy makers. Subsequently, complexity arises from the level of facility we have in evaluating these variables and our ability to generate solutions sympathetic to those variables. In this case, complexity is often a question of how variables interrelate, coalesce and compound as part of a larger system (Weaver, 1948; Sarewitz, 2000). In fact, the development of systems theory is an indelible result of the identification and recognition of complexity as a phenomenon in our world. Warren Weaver, a founding thinker in complexity science, characterizes it as the predictability of outcomes of the variables within a system (Weaver, 1948). He juxtaposes disorganized complexity, with measurable properties and predictable outcomes, with organized complexity, "dealing simultaneously with a *sizable number of factors which are interrelated into an organic whole*" inherent to physiological, economic and political pursuits (Weaver, 1948). This same juxtaposition comes later from the more familiar language of Simon and Rittel in their conception of the ill-defined, wicked problems faced in planning activities. Different from the “tame” problems involving measurement, this type of problem is marked by unmanageable variables, conflicting stakeholder perspectives, interdependencies with other problems, and ultimate unsolvability.

The Interplay Between Problem and Solution

A second aspect of complexity comes from our inability to identify root causes and definite solutions to problems and the exchange between problem and solution. Many designers and policy makers might find that “the information needed to understand the problem depends on one’s idea for solving it” (Rittel & Webber, 1969, p. 225). That is, the process of identifying a problem yields a solution. Additionally, every wicked problem is an indicator of another wicked problem and solutions are coupled with other solutions (Rittel, 1970; Keeney, 1982). Given the difficulty of 'taming' these wicked problems and the plurality of problems and solutions, a problem has many unknown sources and a solution reveals other issues. This problem-solution quagmire and the aforementioned multiplicity of variables brings us to the limits of our cognition or our 'bounded rationality' leaving us only tools and strategies to cope (Farnham, 1990; Simon, 1969; Weiss, 1982).

Irreconcilable Stakeholders

While the multivariate, wicked nature of complexity indeed plagues much of decision making, additional difficulty arises out of the diversity of stakeholders that these decisions intend to represent. In this vein, complexity can quickly be traced to the social interactions between stakeholder groups surrounding an issue. Value trade-offs, multiple objectives and the absence of an overall expert among stakeholders are all characteristics of complex contexts (Keeney, 1982). When weighing the benefits of one decision over another and identifying what might be the most desirable outcome, the diverse, heterogeneous groups around issues can entrench our decision making contexts with competing values. Designers and policy makers diligently seek a "transcendent solution because…it is the only strategy which serves all of the values involved in a decision no matter whether they are assessed in terms of their intrinsic worth or in terms of the importance of interests behind them" (Farnham, 1990, p. 100). Therefore, complexity is inherently a social phenomenon and a result of the different perspectives and goals of actors in the decision landscape.

Policy makers are aware of these unclear solutions and understand them through the interconnectivity of the many symptoms of wicked problems (Connors, 1996; Easton, 1965; Lloyd, 1978; Stone, 1988; Susser, 1992; Verduijn, & Brugge, 2001). The uncertainty that is described in policy development is also manifest in the design process through the designer’s inability to determine one definite, successful solution to a problem (Buchanan, 1992; Margolin, 1996; Owen, 2007; RED, 2006). Policy makers and designers share the same wickedness and deep uncertainty of their problems yet different approaches to cope with them have risen out of each area of practice. Similarly, both fields address these problems with a continuum of temporary solutions that only tame issues without resolving root problems. The insolvability of these root problems emerges as a point of departure for comparing complexity in design and policy development via the tools in each discipline.

Design and Policy Tools as Complexity Management Strategies

Design and Policy Tools

The problems and work context in design and policy do indeed share similar complexities; yet, we take different *approaches* to managing variables and use different *tools* to navigate our complex environments. These approaches and tools are agents of impending decisions that help us better understand the landscape of our problems. A tool has multiple uses and takes on different meanings depending on its operator, the intended task, and the work environment.

However, tools also represent the thinking and intent behind actions in each discipline and are actively used in an instrumental fashion. This research draws from the tool sets of designers and policy makers and compares how complexity is framed and managed in each.

The nine identified tools described earlier can be expanded to cover many other methods and approaches and represent the core values of design tools such as user-centeredness, the development of alternatives, a strong capacity for visual thinking, and an orientation towards collaboration. The primary operating paradigm for designers has its roots in the much discussed dichotomy of the designer as an "analyzer" and as a "creator," to use Heiko Sacher's (2002) terms; this contextualizes the types of tools that are used in design and can describe how designers engage in practice (Frascara, 2002; Owen, 2007; Sacher, 2002) using tools for analysis and tools for creation. Thus, design tools are used in a flexible, interpretive fashion, strikingly dissimilar from traditional representations of the design process characterized by step-by-step, discrete occurrences that arrive at an outcome (Dubberly, 2005). This mode of structuring design tools refrains from implying any temporality and allows decisions, and therefore the tools implemented, to be made in an intuitive and non-linear way. This research broadly discusses design tools and acknowledges that variations of each tool exist across the design silos and other related disciplines. The toolset was a vehicle to express the approaches of designers, the values and intents of the design process, and the apparent methods that are strategically used by designers.

Based on observation of the legislature and initial interviews with stakeholders in the policy cycle, nine tools were identified to represent the larger policy tool set used by state legislators in understanding issues:

- **Expert consultation** brings in a specialist perspective on a particular issue whose advice is considered reliable.
- **Evaluation of current law** in respect to a proposed bill can be vital. The elected official upholds and interprets current statutes and regulations.
- **Analysis of other policies** and case studies from other states offer insight into the potential success of newly introduced legislation.
- **Stakeholder meetings** provide a forum to voice concern or support on an issue. These focused meetings are intended to address the specific concerns of affected stakeholders and bring clarity to conflicts.
- **Town hall meetings** are public gatherings where community members voice group concerns, gather grassroots support, or receive feedback from public figures.
- **Debate** and deliberation amongst individuals representing multiple perspectives is useful to understanding the facets of an issue.
- **Committee meetings** gather advisory committees to consider bills of similar subject matter prior to being passed. Testimony from experts and the lay are invited to these public meetings.
- **Constituency outreach** can shed light on the varying viewpoints surrounding an issue. It can involve communication with the media, being a part of the local fabric, or attending community meetings.
- **Staff research** is useful to gain a complete understanding of a proposed bill, its history, and any related bills.

The underlying political philosophy supports these findings and characterizes the policy context and the approaches therein as adversarial, competitive, agenda-driven, participatory, and discursive. Not to be confused with 'policy tools' or 'policy instruments' which are "method[s] through which government seeks a policy objective" (Salamon & Lund, 1989, p. 29) such as a public education program or a new water use program, each of these tools embodied steps taken by a legislator during policy development that shape the way issues take form. Some of the tools are procedural requirements that are a part of the policy cycle such as committee meetings, others take place on an as-needed basis such as town hall meetings, and still others are a part of a legislator's daily activities such as expert consultation. While, these tools are employed at varying points through issue development at the legislature, the implementation of the tools is closely tied into the formal ebb and flow dictated by the policy process from issue recognition to the formalization of a policy in the state's revised statutes.

Using Tools to Frame Complexity

> Actors in the policy drama design policy much as architects or engineers design material artifacts. They compete and cooperate to set policy problems, and they invent policy solutions that evolve as a result of the actors' transactions with the policy situation. When policy objects are put out into the larger environment, they tend to take on meanings unanticipated by their designers, as other actors see and respond to them in the light of their own frames and, often, in a changing policy context (Schön, 1994, p. xix).

The way in which tools frame complexities, namely the variables, problems, solutions, and stakeholders of each professional context is revealing of manifestations of complexity. This paper suggests that the tools are used to manage and organize the aforementioned aspects of complexity and that they effectively become complexity management strategies that have emerged from the differing cultures in the two fields. An analysis of these tools reveal four key areas that are of central importance to design and policy practice yet differ in how complexity was framed in each field: context, problem definition, value orientation, and participation. The following accounts describe these areas with specific examples from the aforementioned primary research as well as secondary sources.

Context

Perhaps at the heart of the differing approaches to complexity are the underlying structures and contexts in which designers and policy makers work. Private and public sectors impose different constraints on actors and lead to different motivations and actions in practice. A key observation of the legislature was that it cultivates a short-term mindset even when policies have long lasting implications. While legislators recognize the value of longitudinal thinking, they want a quick return on their investment in terms of pushing bills successfully in as little amount of time as possible. This incremental pattern of policy creation might be prompted by motivations of being re-elected the following election cycle, the need to see the results of their work for continued support from their constituency, and the imbedded disposition of a part-time legislature (they are not salaried enough to live without a secondary income). Issues with long-term consequences are more difficult to understand and support. It is possible to conclude that this disposition for the short-term is transferred to stakeholders, thus propagating a cycle of incremental policy development.

The most generative design tools such as brainstorming might be perceived as counter productive to developing policies and misconstrued as creating unnecessary risk. The generation of ideas complicates the approaches taken to gather support from opposition and other stakeholders and works against the grain of policy development. The context presented in design is that of selfless dialogue for the sake of generating better ideas, while the context presented in policy development is that of incremental adjustments that accommodate stakeholders, yet, both result in collaboratively created outcomes.

An example of these differing contexts can be seen in the way prototyping takes place in design and policy contexts. When presented with this tool, legislators closely associated it with the use of pilot studies that are initiated by legislators as a means to test a policy idea. Prototyping or piloting a policy is valued as a way to bring unforeseen issues to light prior to full adoption of a bill and as a way test the efficacy of a potential bill. In design, the value of prototyping comes from quick feedback loops, iteration, and refinement. There are a number of impediments in the policy process that cause the use of this tool to take a different course: When pilot studies are introduced to the legislature they need bill approval. In this situation, one legislator would need to successfully introduce a bill for a pilot study and then reintroduce the bill as a full-scale policy the following legislative session or after the study period is complete. This process is too slow when legislators' concerns lie within one singular session. A pilot can lose support if: another issue takes prominence; if the sponsor leaves; if money dwindles; or if an idea does not fit well with the current legislatures concerns. Moreover, long-term projects are difficult to sponsor when legislators are motivated by quick results that contribute to their reelection. This example shows that the differing operating paradigms of design and policy are tied to the same need for testing out an idea and incorporating feedback into a future iteration, yet two distinct ways have emerged from different manifestations of complexity.

Problem Definition

Just as our professional contexts shape the landscape of complexity, so do they dispose the problems that we face to the constraints, opportunities, and affectations of each field. That is, problems are identified and defined uniquely to the contexts in which they arise. Problems in the client-based, business-driven professional model of the design world are shaped somewhere in between the client, customer and designer. In contrast, the body of individuals who actively appeal to policy makers characterizes the public context of the policy world: they compete for a voice in the policy process and for representation in the policy outcome. Problems are effectively shaped by the voices represented and heard in this process. The significance of how problems are defined is evident in the manifestations of complexity, the management strategies of our tools and the outcomes that result.

Problem definition is widely recognized as a contributor to the successes and failures in policy formulation and carries a long-standing tradition in policy discourse. In part, this discussion revolved around the notion that issues and problems are shaped by the way people individually or socially define them and result in policies that are inherently linked to the original problem construction. For example, homelessness can be considered the result of a shortage of housing, the result of economic strife, or the product of the deinstitutionalization of mental hospitals (Rochefort & Cobb, 1992). However, more salient in terms of how complexity manifests itself is the concept of problem ownership. Rochefort and Cobb (1994) conclude that some problem definitions may be under complete control of one body of authority. For example, the judiciary defines the severity of a certain crime through its enactment of retribution and therefore owns a problem. Another example can be seen when a community organization represents the many voices of the gay, lesbian, bisexual, transgendered community to the legislature, effectively owning and taking responsibility over an issue, and as a result omits outlying needs and leaves them unrepresented. Schattschneider (1960), well-cited for his work in political analysis, concludes that those who own a problem at the point of definition and through deliberation will successfully define the solution to it.

Equally important are the means in which issues come to the attention of legislators. Observation in the research revealed four types of transactions that provide starting points for problems in the policy context:

- **Special interest lobbying** includes the presence of any type of lobbying effort; it can be ongoing or issue specific.
- **Personal experience** refers to any event, either casual or organized that a legislator personally experiences. These experiences tend to build empathy and can be catalysts for bill sponsorship or the recognition of an issue by the legislature.
- **Proactive citizens** can band together or act individually to voice their needs and opinions on a particular issue. This may be referred to as citizen lobbying.
- **Policy analysis** is undergone by research staff, policy organizations, think tanks, public interest groups, and other private organizations and serves as a measurement of efficacy of previously created legislation; policy analysis directly sways which issues will be heard and which will not.

While paying clients usually represent the origin of problems for designers, the design team must champion the needs of a user group to encourage a client to take a certain course of action. However, in the policy context there are numerous ‘clients’ with differing agendas and there is proactive representation that results in uneven depiction of a population's needs. The divergence of actors and roles of stakeholders delineates how problems are defined and how our tools shape and are shaped by complexity.

Value Orientation

Different value systems have also emerged out of the contexts of design and policy. The competitive, adversarial nature of the policy world bears a two-value dynamic that permeates the underlying political structure and the policies produced by these regimes. The design context puts great weight on people's stories and interactions around a given circumstance and is implicitly open to the subtleties of people's experiences with design products. Designers create a multifaceted depiction of potential outcomes through the use of drawings, stories, and words. This is evidenced by the systems bent of many design tools such storyboards, mind maps and brainstorming and emphasis towards understanding the interdependence of variables and inclusiveness within a user group.

The two valued orientation in politics can be traced to the literature in a variety of ways, however, it is well-articulated by the preeminent linguist Hayakawa; he writes, "This penchant to divide the world into two-opposing forces-- "right" versus "wrong," "good" versus "evil" -- and to ignore or deny the existence of any middle ground, may be termed the *two-valued orientation*." (Hayakawa, 1990, p.113). Originally coined by philosopher Alfred Kozybski, this value orientation is endemic to our two-party political system and can be seen in the political positions that each party maintains and in debate, a cornerstone of politics. Take for example the emergence of 'pro-life' and 'pro-choice' as the two predominant positions on abortion. The two-valued system is also tied to policy makers expectation of rational decision-making, attempting to remove emotion from decisions, and the legacy structures of the political system that attempt to whittle problems down to a single interest, chosen from two. However life is not this simple, nor are we rational actors; we have aspirations, emotions, and needs and react to our world with scales of judgment, not with "right" and "wrong." It is in this convergent policy process that a reactive political culture is bred and the tools of debate and discourse manage and temper complexity.

This fundamental difference is exemplified by exploring the use of mind mapping, a design tool, in the policy context. Mind mapping or webbing, as several legislators knew it, was a familiar concept to interviewees at the legislature and was interpreted as a method of structured brainstorming. However, mind mapping would ultimately not be able to be utilized as a tool to generate policy ideas for two reasons. First, legislators simply do not feel they spend their time creating new, original legislation; they manage bills. Second, in the context of argumentation and adversarial relationships, the generation of ideas, a key aspect of the design process, complicates the approach of garnering support on an issue from opposition. The generation of alternatives as it is construed in design happens in a more dispersed, ambiguous fashion in policy making, somewhere between legislators' agenda and the interests of those represented in the policy process.

Participation

In exploring how complexity is framed in design and policy, it is important to understand how we engage people, the end-users (and sources of inspiration) of the products that we work towards. Design tools typically come from a grounded perspective, treat problem areas as unique, and are inclusive by involving stakeholders at the stage of their own experiences. Quite different, the organization of legislatures include salient issues, stakeholders, and variables that are represented proactively while quieter voices fall by the way-side. For example, interest groups and lobbying efforts often represent specific issues or larger ideologies in place of direct citizen involvement (Kingdon, 1989). Complexity in policy manifests itself through the proactive voices of lobbyists, interest groups and citizens incited by the structure of representative democracy. In the design context, complexity is proactively sought by designers through inclusive tools in an attempt to preserve ambiguity of variables until constraints require convergence on an outcome.

The paradigm in policy development is that of representative democracy where a legislator represents a group of people, their needs, and their expectations for the legislative outcome. Legislators are primarily reactive in their actions and handle issues as they present themselves. In the same vein, legislators have limited opportunity to engage in proactive policy making. While design practitioners must be reactive when responding to client expectations, they remain proactive in the process of understanding the needs of end users and stakeholders. As the designer is situated between the expectations of consumers and the expectations of a client, they act as an intermediary and communicator between both sets of actors. Therefore, the operating paradigm in managing complexity in design is the designer as expert interlocutor who proactively reaches out to stakeholders and incorporates their needs and expectations into the design outcome.

Design practice heavily relies on the experiences of individual people during the design process to achieve desirable outcomes (Arnold, 2005). In contrast, the research made it clear that citizen viewpoints and opinions were often solicited late in the policy development process, after issues had been formed and agendas were set. Evidence of this is also seen by legislators interpreting personas as a tool to understand other legislators (as opposed to members of the public) given that representatives and senators represent a defined segment of the state's population. This coincides closely with the verbiage consistently used by legislators that embodies a tone of appeasing and even placating stakeholders. For example, one representative endorsed town hall meetings because they make "people feel like you're listening." Another representative suggested that stakeholder meetings are "more of a PR move," that they "make sure people don't complain." The everyday citizen holds a unique place at the legislature where "they are typically reached after the damage has already been done."

Conclusion

This paper tracks issues of complexity in design and public policy contexts and proposes that differences in context, problem definition, value orientation, and participation are at the root of the differing constructions of the same types of complexity. The research found that the aforementioned variance in values is brought on by different management approaches of stakeholders, styles of defining problems, and methods of accounting for variables. This leads to different representations of complexity and ultimately different types of outcomes. It is clear that the different cultures have produced different systems to handle complexity and vary in the way they approach problems. Strategies such as collaboration, the development of alternatives, iteration and participation assume different forms depending on the context in which they are present. Tools also result in different outcomes, whether they are used in a competitive, representative and reactive environment or an inclusive, participatory, and proactive environment. Now more than ever, designers and policy makers are becoming familiar with the complexities brought by our ill-structured, wicked problems. This research serves as a foundational discussion by shaping a common language between design and policy practice and is a starting point to begin sharing best practices and exploring interdisciplinary collaboration.

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Sustainable Alternatives to Industrial Printing Practices: A Case Study Analysis of *Esquire* Magazine and Electronic Paper Display

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Abstract

In October 2008, *Esquire* magazine became the first commercial publisher to utilize electronic paper display technology (EPD) for mass production and distribution of printed ephemera. Initially developed at the MIT Media Lab in 1997, E Ink displays have been integrated into a variety of hardware devices, including the Amazon Kindle and Sony Reader. However, the *Esquire* cover represents a milestone achievement in the evolution of a more sustainable, paperless print solution due to the medium's flexible nature, low power consumption, and limited circuitry requirements. 100,000 copies were sold on newsstands for the regular cover price of $5.99 USD, proving both the economic viability and flexible application of the technology, which is impervious to ambient lighting conditions and adaptable to multiple modalities. This paper outlines the key features and benefits of E Ink, as well as the critical challenges impeding widespread adoption of EPD.

Keywords

Sustainable design (primary keyword); design and society; eco-design; communication and information; case study/studies

In response to political and consumer pressures, traditional print industries have increasingly adapted production methods to utilize more ecologically conscientious practices. Transitions to vegetable dyes, post-consumer fibres and dissolved air flotation de-inking processes have contributed to reduced environmental consequences from the paper and printing industries, but the overall output of ephemera has remained largely unchanged. The secondary carbon offset resulting from energy consumption and chemical disposal in the recycling and transportation of printed matter needs to be reconciled with advancements made in material technologies, and our cultural desire for tangible media. Clearly, a new paradigm for mass dissemination of content is required to bridge the gap between consumer demand and industrial production practices.

Challenging the Archetype: Sustainable Print

Environmental Impact and Transitional Phases

Pulp-based printing presents a number of environmental concerns, relating mostly to material pollution and energy consumption—issues that have been troubling environmental activists and earth-conscious consumers for decades. In recent years, many proactive solutions have been developed and implemented to lower the impact of mass printing. Toxic inks can now be effectively substituted with water-based pigments and vegetable dyes, with minimal investment or retrofitting of existing equipment. Virgin paper is also falling out of favour with designers and clients, steadily being replaced by post-consumer hybrids or 100% recycled paper products. Even within the recycling process, traditional bleach-based de-inking employs the use of toxic solvents and detergents. However, as the emergent technology of dissolved air flotation becomes a more economically viable proposition, it is expected that this practice will become an industry-regulated standard. The devastating effects of clear-cutting have been partially ameliorated through public acceptance of post-consumer products, as well as through remote forestry and replanting activities. Paper processing and pulping is an unmistakably significant contributor to negative environmental consequences, as is the transportation of the paper product from the manufacturer to the consumer—both unavoidable aspects of paper production.

With an increase in recycled paper production, certain perceptual shifts have occurred in paper and printed matter consumption. The negative connotations and cut-rate image of recycled products have diminished, as the technologies for reconstituting pulp continue to improve the quality of goods. Product lifecycle is more commonly taken into account when selecting papers for specific print applications; for example, paper with degraded quality is often used for printed ephemera expected to have a shorter cultural currency. Consumers have also naturally adopted multi-modal reading practices, given the abundance and accessibility of news and other texts on the Internet. Although the advent of digital technology was thought to have lead to reduced literacy rates, it seems that greater numbers of individuals are reading online, thus demonstrating increased reading rates due to the convenience and availability of reading materials.

Adoption of Digital and Paperless Print

A logical next step in the evolution of print is a transition to digital and paperless print displays. It would be naïve to suggest that traditional printing process will be completely eschewed in favour of digital modes of dissemination, but the balance is beginning to shift.

E Ink and electronic paper display technologies have been heralded as sustainable solutions to the proliferation of printed artifacts. Their key environmental benefits include the modest power usage, the reduction of printed material, the general inertia of the chemical substances used, the volume of storage available and the flexibility of application, being embedded or standalone. However, numerous economic, technical, and marketing challenges must be addressed before this technology presents a viable alternative to traditional publication. Chief among these concerns is the perceptual shift required among user-communities, who must adapt lifelong reading habits to accommodate new hardware devices and modes of content purchase or acquisition.

Case Study: E Ink Corporation

Overview and Features

E Ink was established in Cambridge, MA in 1997 as a commercialization of research incubated at the MIT Media Lab. It was, and still is, considered a proprietary technology and not an industry standard. The primary innovation of the E Ink material is that it is able to produce a digital image without the use of a constant power supply or a backlit display. The technology, as described by the E Ink corporation website, is as such (see figure 1):

> The principal components of electronic ink are millions of tiny microcapsules, about the diameter of a human hair. In one incarnation, each microcapsule contains positively charged white particles and negatively charged black particles suspended in a clear fluid. When a negative electric field is applied, the white particles move to the top of the microcapsule where they become visible to the user. This makes the surface appear white at that spot. At the same time, an opposite electric field pulls the black particles to the bottom of the microcapsules where they are hidden. By reversing this process, the black particles appear at the top of the capsule, which now makes the surface appear dark at that spot. (E Ink Corporation, *How it Works*, n.d.).

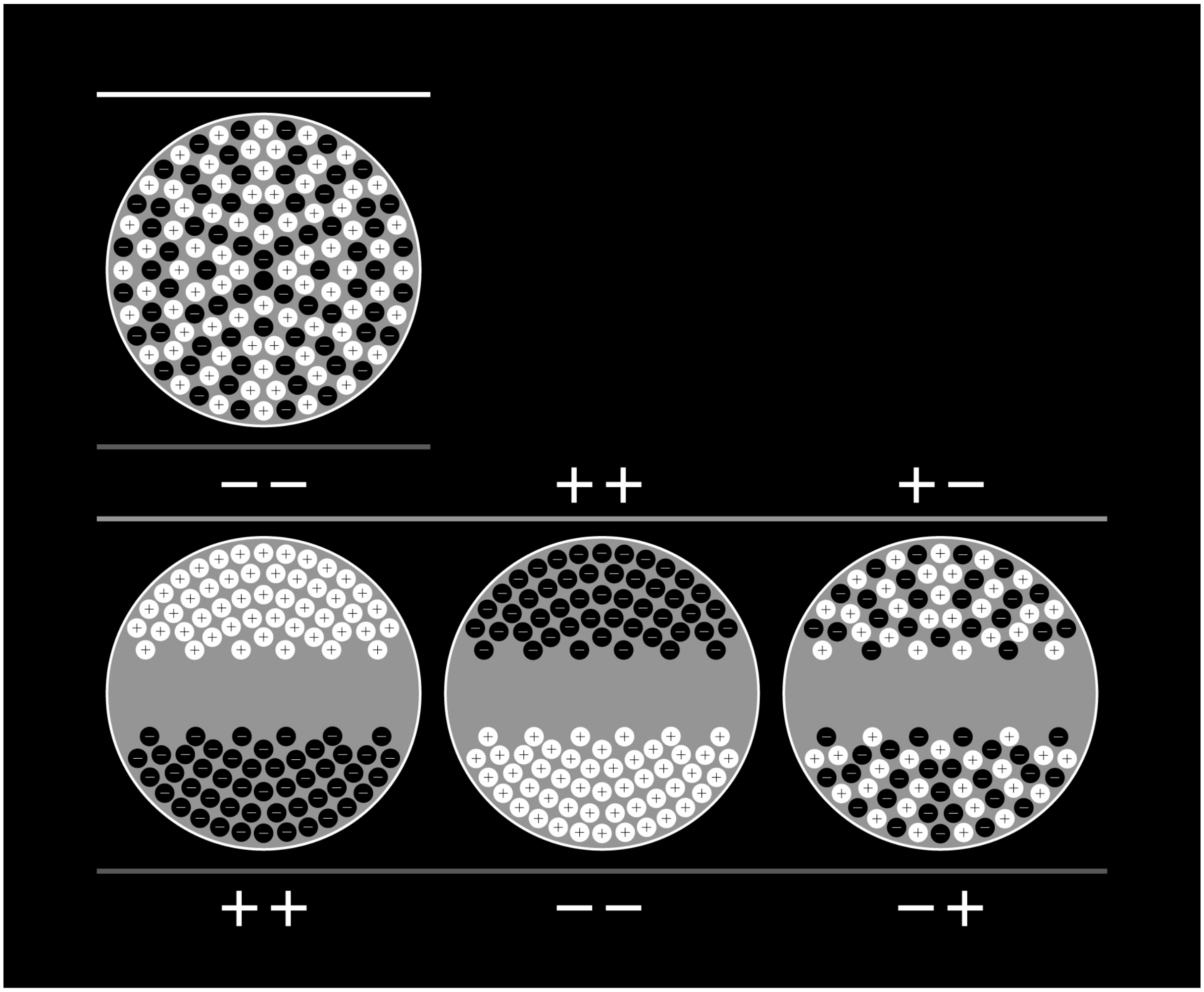

Figure 1. Charged Microcapsules, adapted by author from E Ink Corporation (*How it Works*, n.d.).

The scientific term used to describe the process making E Ink possible is electrophoresis. This refers to the separation of electrically charged substances in a solution under the influence of an electric field. It is based on the difference between the rates of migration of pigmented particles, typically Rutile, Anatase, Barium Sulfate, Kaolin, or Zinc Oxide (Albert & Gates, 2008). The microcapsules function as de-facto binary pixels, turned on or off by transmitting surges of power through embedded circuitry (see figure 2). The output is controlled by a display driver, which is activated only when the image display needs to be refreshed. Suspended in a liquid "carrier medium," the capsules may be screen printed onto a variety of surfaces, thus freeing the electronic image from bulky hardware devices. The flexible nature of the E Ink material permits virtually any substrate to function as a display, including glass, plastic, or paper (E Ink Corporation, *How it Works*, n.d.).

Figure 2. Booken Cybook Gen3 Display Magnified 6x (Genuth, 2008)

Quality and Readability

Few reliable studies have been conducted on the legibility and long-term physiological impacts incurred from sustained use of E Ink displays. Despite dissenting research and opinions, it is widely believed that there is a reduction of eyestrain, as no backlighting is employed by the system. At the consumer level, E Ink is currently available only in black and white, although Samsung is developing colour prototypes (Unidym, 2008). In terms of output quality, the current technology can support a 3- or 4-bit greyscale display, and simulates a resolution of 150-200 DPI, depending on the display size (E Ink Corporation, *Visplex Imaging Film*, n.d.). It is said to demonstrate qualities of paper, exhibiting high contrast and reflectivity, and is not subject to legibility impairments as a result of ambient lighting conditions, unlike liquid crystal displays (Comiskey, Albert, Yoshizawa, & Jacobson, 1998).

eBook Readers: The Amazon Kindle

Market Dominance and Sales Figures

eBook readers persist as the principle commercial application of E Ink technology. Amazon Kindle is currently the leading device in this product category, although there are others—its prime competitors being the Sony Reader, the iRex iLiad, and the Plastic Logic eReader. It is estimated that around 380,000 Kindles were sold in 2007 during their first year on the market (Jackson 2008), and estimated revenues of $1.2 billion USD are expected for Amazon, as of 2010 (Galante, 2009). These figures clearly indicate that sales have crossed the threshold of early adopters, gaining more widespread acceptance among the general consumer market.

Available exclusively in the United States during its introductory years, the Kindle was recently launched internationally in over 100 countries, offering upwards of 400,000 titles, as well as applications for personal handheld devices (Amazon.com, n.d.). In the first 14 months after Kindle's 1997 release, 10% of Amazon's sales were eBook titles, although Amazon has not been forthcoming with exact figures regarding sales of its proprietary device.

From a marketing perspective, convincing a skeptical public to invest in an underdeveloped technological platform with little seeded content, and the potential to be rendered obsolete, presents significant challenges. Elevated price-point, limited content availability, usability issues, and mixed user testimonials have primarily hindered the widespread adoption of eBook readers. Such issues are not unique to this product class, but are further amplified as the consumer's financial investment increases. One need only examine the history of photographic cameras and other durables to detect similar promotional encumbrances.

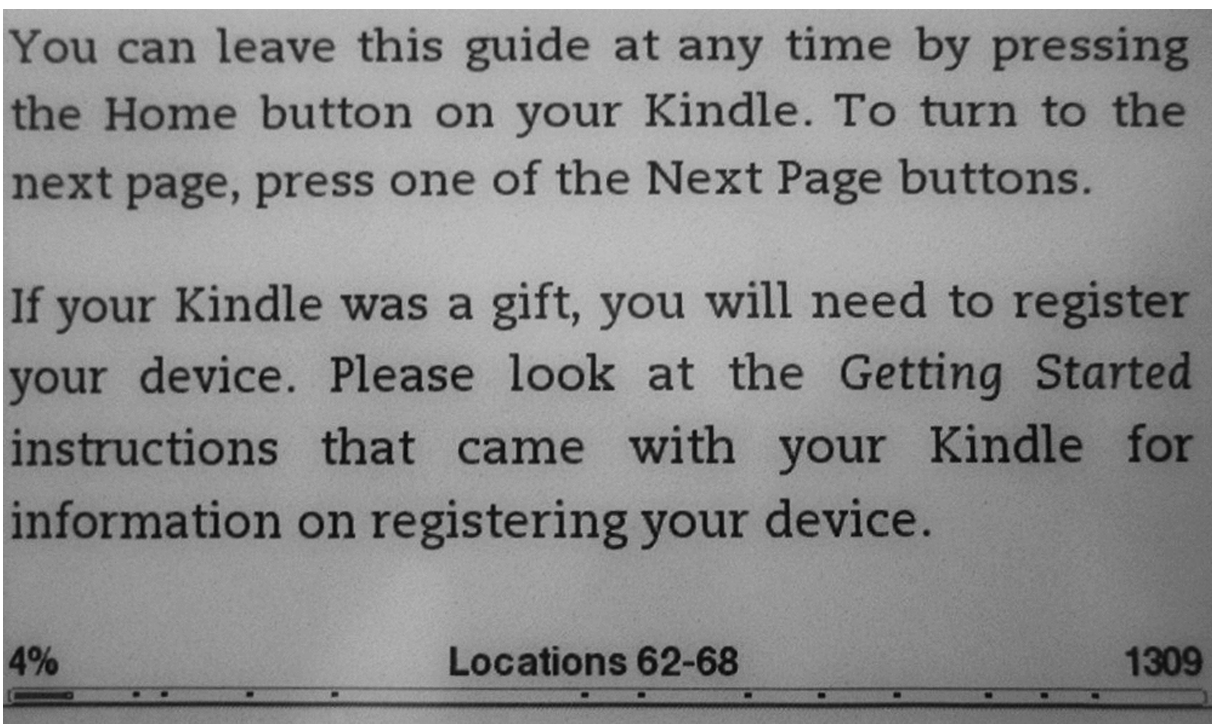

Figure 3. Kindle 2 Display (Evans, 2009)

Device-Based Applications of E Ink

As with most emergent technologies, immediate concerns regarding the viability and longevity of such a technology present major marketing problems. E Ink reinvents the paradigm of reading, and requires a pricey initial investment, both challenges on the road to public acceptance. Many readers have reported experiencing eyestrain and fatigue from reading eBooks, as it is more taxing on the eyes than scanning a traditional printed page (see figure 3). However, this comparison does not take into account netbooks, laptops, or other self-illuminating digital displays, which incite similar criticisms. The output quality is simply not as clear as the printed counterpart, principally due primarily low resolution and reduced screen contrast.

In terms of physical design, it has been difficult to miniaturize the technology to a weight and size conducive to convenient transportability. Combined with questions of durability, the designed obsolescence of the technology has forestalled many potential consumer audiences. Inevitably, the eBook reader will need to be upgraded or replaced as new functionalities and content formats evolve. Other challenges to address include limited availability of content, as well as legislation of digital copyright and licensing, which preclude copying or lending. The latter point negates the ethos of reader culture, which predicates itself on knowledge sharing and a discursive exchange.

Usability and Accessibility Issues

The major content limitations associated with eBook readers are largely attributable to digital incompatibility and copyright issues. There has been extreme market segmentation caused by multiple proprietary file formats and limited interoperability between devices. Digital rights management software also imposes another layer of restrictions on content (Clark, Goodwin, Samuelson, & Coker, 2008), setting limits on copying, lending and reselling of eBook purchases.

There are also some issues with the look, feel and interface of the device itself, which present practicality issues for the consumer. Users have reported experiencing wrist pain caused by holding the Kindle device for prolonged periods of time, claiming it is too narrow to hold comfortably with both hands (Clark, Goodwin, Samuelson, & Coker, 2008). Other general concerns with the physical device are that the buttons are placed awkwardly, neutral space is lacking, the scroll wheel is overly sensitive and the touch screen lacks functionality. The interface is also problematic, including the inability to change the font and style of the text, the poor display resolution, and the reduced contrast caused by a middle-grey background. Practical concerns include the reportedly flimsy case, its insecure closure and the inconvenience caused by flight travel restrictions disallowing use of electronic devices during taxi, takeoff and landing (Clark, Goodwin, Samuelson, & Coker, 2008).

In Kindle’s defense, it is said that use on exercise machines is more effective than books, as it lays flat more easily than a paperback. That being said, it does not provide the full immersion experience that books do, attributable to its slow response time, accidentally pressed buttons and other technical difficulties (Clark, Goodwin, Samuelson, & Coker, 2008).

Commercial Print Applications: *Esquire* and E Ink

Background and Overview

E Ink technology was employed in the production of a cover and overleaf feature for the October 2008 issue of *Esquire* magazine—a 75th Anniversary special issue that was published in an edition of 100,000 copies. Integrating a black and white E Ink display and coloured plastic overlay into a heavyweight cover, a series of words flashed on and off in a linear sequence (see figures 4-5).

Figure 4. *Esquire* Magazine Cover, October 2008 Issue (Image by author)

Figure 5. Detail of *Esquire* Magazine Cover, October 2008 Issue (Image by author)

Figure 6. Detail of *Esquire* Magazine Internal Electronics, October 2008 Issue (Metzger, 2008)

Prototype for Commercialization of E Ink Technology

The October 2008 *Esquire* magazine cover presents a model case study alternative to embedded device-based applications of E Ink technology. Utilizing a self-powered, standalone display panel and programmed microchip, the *Esquire* cover demonstrates the possibility of implementing electronic paper display without the requirement of specialized, external hardware. As a prototype for mass dissemination of electronic content, this application signifies a shift in design approach. By divorcing the rigid structure of a device from the flexible presentation of media, the language of traditional printed matter becomes highlighted, while the technological aspects are diminished. The relationship between reader and artifact becomes reinforced, while the disintermediation of the electronics is sublimated into the tangible, material qualities of the interaction.

The paradox of the *Esquire* proposition is that it presents a pragmatic application of E Ink as a sustainable solution, but its manufacturing process results in devastating environmental consequences. With research and development sponsored by the Ford Flex SUV/mini-van, *Esquire* hired a Chinese engineer to develop a battery small enough to slip into the cover, involving a six-figure investment. The custom-designed battery carries a limited charge to power the display for a mere 90 days (Paul, 2008), and cannot be replaced, rendering the display dormant and the electronics obsolete (Carnoy, 2008) (see figure 6). Due to the fragile nature of the battery and components, each volume was hand-assembled and subsequently shipped in refrigerated vehicles throughout all stages of the product's lifespan. From the parts manufacturing in China, to Texas and on to assembly in Mexico, then to the distribution centre in Kentucky and finally, to display and consumption on the newsstand, it is estimated that the total carbon output topped 150 tons of CO_2. This amount is roughly equivalent to the output of fifteen Hummers or twenty Americans per year (Kamenetz, 2008), and does not account for the CO_2 emissions produced during the manufacturing of the devices. Given that the batteries are single-use, they will no doubt end up in a landfill, as they are nearly impossible to recycle.

Comparison and Conclusions: Disposable Versus Device

Challenges and Promises

There are benefits and disadvantages to both embedded (*Esquire*) and device-based (Kindle) applications of E Ink technology. Currently, eBook readers present a more viable, efficacious model than standalone uses, and are simply more functional. They feature rechargeable, rather than single-use batteries. They perform more complex functions, such as mobile Internet access and document editing capabilities, as well as a boasting a larger storage capacity. The *Esquire* cover benefits from having a flexible form, but the lightweight Plastic Logic eReader from Barnes & Noble will challenge traditional eBook models when it is released to the general public in 2010.

Some current consumer challenges facing content and device providers include the high price of eBook readers and their duplication of services already available on other more widespread devices. The emergence of Apple's iPad and powerful portable netbooks that have the added functions of eBook accessibility have made it difficult to sell the eBook readers as a monofunctional technology. The unfamiliar interface does not replicate the familiar look and feel of paper, bringing consumers far out of their comfort zone when it comes to reading habits. The resolution requires enhancement and the screen contrast is too low. In fact, the device cannot be read in dark or even dim lighting conditions, due to the lack of a self-illuminated display. The breadth of content selection is quickly improving, but distributors will need to address licensing and copyright issues that inhibit lending or sharing, as one would with a traditional book. Furthermore, there are fragility and durability concerns, as with any electronic handheld device. All of these factors only add to consumer skepticism regarding perceived design obsolescence—a concern similar to the iPod paradigm of rapid and successive product releases. To broaden the consumer market from early adopters to a general public, manufacturers will need to establish product confidence while responding to accumulated usability data. Positioned at a luxury goods price-point, consumers demand reassurance that their purchase is robust, and will not be superseded by a revised model in an unduly rapid product launch cycle.

Conclusion

Consumer and Sustainable Benefits Analysis

In summary, there are many promising consumer and sustainable benefits involved with the evolution and adoption of paperless print and electronic paper display. For one, the reduction of paper-based ephemera would be a significant environmental benefit if the technology were to become widespread enough to lessen traditional printing. This would result in a reduction of CO_2 emissions from the pulp and paper industry and recycling plants, as well as a reduction in solvent contamination from the de-inking process necessary in recycling. eBooks consume less power than laptops, and if one were to replace some of the functions of the laptop with an eBook reader, additional power would be conserved. Furthermore, the text size can be adjusted on an individual basis to suit readers' needs, which is especially useful for visually impaired consumers, and would eliminate the need for large print book editions. There would also be a long-term cost reduction for students, educators and other voracious readers, providing them with easier access to library collections. Ergonomic benefits include the storage of multiple titles on a single device, doing away with transportation of weighty books that can lead to back strain and related injuries. Future applications will also undoubtedly exploit E Ink's flexible options for display formats and signage, as it can be printed on any surface.

While the *Esquire* design methodology is fundamentally flawed, as a case study analysis, it provides concrete evidence and material data to assess the possibilities of an alternative to existing green printing practices.

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Designing Design Learning: A Case Study

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Abstract

As 'designerly' ways of thinking and knowing are increasingly understood to be relevant in fields outside the traditional design disciplines, there is need to conceive of and design appropriate pedagogy. The challenge is to successfully negotiate disciplinary crossings in ways that simultaneously respect the discipline of design and provide a space for exploration and innovation, while at the same time produce results that satisfy individual disciplinary standards as well as the institutional standards of the university. The paper presents a case study of a novel graduate course in design research in the University of Toronto's Knowledge Media Design Institute (KMDI) – a multidisciplinary community in which the design has been largely grounded in models from human- computer interaction (HCI). The model of pedagogy that emerged out of this experience and reflection is then situated in terms of prior work on interdisciplinary pedagogy. We propose that our model of pedagogy grounded in what we call *disciplined transdisciplinarity* has the potential to generalise to other settings.

Keywords

Pedagogy, interdisciplinarity, multi-disciplinarity, transdisciplinarity innovation, human-centred design

The complex and interconnected nature of many contemporary problems is increasingly recognised, and the need for more systemic approaches for addressing them increasingly understood. This understanding will resonate with designers and design scholars as this framing respects the now half century of scholarship on design research and design thinking. 'Designerly ways of knowing' (Cross, 1982) are increasingly part of the public conscience and being taken up by business schools, and in various ways by scholars in other fields.

In principle there is much to recommend increasing the knowledge flows across disciplines, and the value of disciplinary crossings has been recognised by bodies such as the National Academies of Science (*Facilitating interdisciplinary research,* 2005) and the US Council of Graduate Schools (2007). This is not, however, easy to do either intellectually or institutionally, and there is an ongoing debate on what constitutes interdisciplinarity; the term used to describe both disciplinary crossings in general and a specific form of practice (Moore, 2009). As well, the myriad challenges of engaging faculty and students from different disciplines in the traditional university have not yet been resolved (Moore, 2003). The Report of the US Council points specifically to the need for an increase in interdisciplinary training stating that: "interdisciplinary research preparation and education are central to future competitiveness, because knowledge creation and innovation frequently occur at the interface of disciplines" (2007, p.18).

This brings to the fore the importance of pedagogy, the need for experimentation and the development of innovative new approaches that foster the kind of productive collaborative outcomes that interdisciplinary engagement is argued to generate. Our paper is motivated by these concerns.

We set out to explore this complex set of relationships through reflection on the origins and development of a graduate course in design research. The process whereby the course emerged was highly informal, but on reflection and through the subsequent design of new course materials and the writing of research papers that came out of this engagement, we began to understand the potential of this case to inform a model of pedagogy for graduate education grounded in what we call *disciplined transdisciplinary.* Reviewing the literature with this framing in mind, we found others who have taken up the challenge around the design and delivery of 21st century graduate education to support interdisciplinarity.

The paper begins by situating our case study in its institutional context, and in the context of the intellectual ideas that informed the development of the institute. We next present the case and the model. Lastly, we situate the development of the model in the context of literature on interdisciplinary pedagogy.

2.0 The Institutional and Intellectual Context

The University of Toronto's Knowledge Media Design Institute (KMDI) was established in 1995, to foster tri-campus[1], cross-divisional research and teaching in the emerging field of knowledge media[2] design (Moore & Baecker, 2003). Faculty and graduate students from 25 academic departments and faculties today engage in the scientific study of the ways in which media shape and are shaped by human activities and values; the design, development and evaluation of media applications and systems, and critical reflection on the implications of these developments in the broader social and cultural context.

This bold agenda challenged traditional university structures and existing practices as it required a broad base of collaboration across the disciplines. The University of Toronto, founded in 1827, is one of Canada's largest and most prestigious universities. It has a traditional organisation structure in which disciplinary and departmental boundaries tend to coincide, and departments and faculties are the site of scholarly legitimation, evaluation and reward for faculty and students. The ability to work across disciplinary boundaries is not readily accommodated, and it is especially difficult for untenured faculty and graduate students to engage in these practices. Second, knowledge media design is an emergent field and the potentially transformative nature of the internet and the associated cluster of technologies and applications emerging, was generally not appreciated in the mid 1990s. With limited funds, the institute was established as a virtual institute, a novel networked organisational form. Thus, despite the fact that interdisciplinary practices are not new, and had become re-invigorated in the 1960s (Klein, 1990,1996), the institutionalisation of these practices in universities can continue to be a challenge.

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[1] The University of Toronto is comprised of three campus; the St. George campus in the City of Toronto and two satellite campuses located 25 km to the east and west.
[2] KMDI defines knowledge media (KM) as a specific class of media and media technologies designed to enhance human thinking, creativity, learning, communication, and collaboration.

In 2002, KMDI's Collaborative Masters and Doctoral Program in Knowledge Media Design proposal was approved by the Ontario Council on Graduate Studies thereby providing a specialisation for graduate students from a variety of academic backgrounds to engage in this emerging field. The Collaborative Program model[3] administered by the School of Graduate Studies at the University of Toronto was one institutional process that supported the ambitions of KMDI to offer graduate education in which students from more than one discipline could participate. Today there are ten academic units[4] participating in the program, and 57 masters' students and 30 doctoral students have been enrolled. Four specialised courses have been offered in addition to two core courses that provide the fundamentals of knowledge media design. On average two courses are offered per term. The potential for disciplinary mixing of students, already the norm for faculty participating in the institute, was thereby established.

2.1 The Role of Design in KMDI

Questions about how to engage with design and design practice have been a central concern in KMDI from the outset. The focus was a specific form of design; one that came primarily from the field of human computer interaction (HCI). This orientation reflected the origins of the institute in research on collaboration technologies as well as the physical location of a number of the faculty and the institute administrator in the department of computer science – also the home department of the first Director. KMDI's orientation to human-centred design (Moore &Timmerman, 1996), however, differentiated it from other North American computer science departments, in which the notion of user-centred design proposed by Norman & Draper (1983) was the norm at that time. As well, a number of the faculty founding KMDI had been associated with the Ontario Telepresence Project and worked with researchers from Xerox PARC and EuroPARC on media space. Many had been active in the field of CSCW: Computer Supported Cooperative Work, and associated with the Scandinavian model of participatory design (PD) since the 1990s. Thus, from the outset, a wide range of theoretical and methodological approaches informed the research carried out in the Institute. A diverse array of epistemological foundations do not necessarily co-exist comfortably and part of the research of the institute has been to explore this issue (Moore, 2003; Lottridge and Moore, 2009), and to develop strategies to negotiate these differences in ways that are both productive and creative.

Collectively, the faculty were less aware of the research in design that came from the design disciplines; architecture, industrial design, graphic design. However, with the emergence of the field of interaction design in the late 1990s with roots in both communities, this began to change (*Being Human*, 2008; Fallman, 2003; Leblanc, 2009). The question that began to emerge for us was how, and in what ways, might this scholarship inform our design practice? Would viewing knowledge media design through the lens of scholarship on design research be a source of new insights?

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[3] The University of Toronto through its graduate departments, centres, and institutes offers unique, non-degree granting, collaborative programs. These emerge from cooperation between two or more graduate units, providing students with a broader base from which to explore a novel interdisciplinary area or a special development in a particular discipline, to complement their degree studies. Source: http://www.gradschool.utoronto.ca/programs/collaborative.htm

[4] These include Computer Science, Sociology, Information Studies, Mechanical and Industrial Engineering, Architecture & Landscape Architecture, Medical Science, Urban Design, Visual Studies and two departments in the Ontario Institute for Studies in Education, Curriculum Studies and Teacher Development and History and Philosophy of Education.

Following Cross, we understand design "as a coherent discipline of study in its own right, based on the view that design has its own things to know and its own ways of knowing them" (2007, p. 4-5). It was our goal to explore how this way of knowing with its focus on 'making' as well as thinking, on the elaboration of the relationship between practice and research, and on the need for collaboration and integrative thinking could help advance design research in the emergent field of knowledge media design. Buchanan has written: "Some see no need for design research, and some see in the problems of design the need for research that is modeled on the natural sciences or the behavioural and social sciences as we have known them in the past ... others see in the problems of design the need for new kinds of research for which there may not be entirely useful models in the past – the possibility of a new kind of knowledge, design knowledge, for which we have no immediate precedents" (2001, p. 6-7). To achieve the objectives to which KMDI aspires, a deeper understanding of design research and the epistemic communities involved in the production of design knowledge appeared to offer promise.

We were also aware that not all aspects of design research theory, methodology and practice would be relevant to the evolution of knowledge media design. We asked: how does one explore an unfamiliar field with a group of people from different disciplines, none of whom are experts in the field? How should we learn, and how might what is learned be mobilised going forward? And finally, how does one actually do the work of exploring the relevance of a field of scholarship to an emerging area such as KMD from several perspectives while simultaneously accommodating the formal requirements of students for academic credit?

Our approach was pragmatic and initially informal. We simply started to meet and a process began to evolve. Methodologically, this approach is closest to Schon's idea of 'reflection in action' which is in a complex relationship with 'knowing in practice'. As Schon notes: "A practitioners' reflection can serve as a corrective to over-learning. Through reflection, he can surface and criticize the tacit understandings that have grown up around the repetitive experiences of specialized practice, and can make new sense of the situations of uncertainty or uniqueness which he may allow himself to experience" (Schon, 1983, p. 61). Reflecting on the outcomes months later we began to formalise this as a model of pedagogy; a model to which we will return after describing the case.

3.0 The Case Study

3.1 From reading group to reading course

In the fall of 2007 an informal reading group was organised to explore the literature on design research. This began a process that would unfold over the next four months in a 'designerly' way – open, engaged, and iterative. The inspiration for the reading group can be traced to growing awareness of the potential that traditional design theories and practices might offer. A visit to a studio in landscape architecture was part of a KMDI core course, and a seminar on *Research design: Design research,* in the other core course led a number of doctoral students to take up the instructor's invitation to engage in further explorations of the field of design research. In the summer of 2007, the faculty member sent out a brief prospectus that included an excerpt from an earlier design project which she had led, and a number of questions that might be explored. Students were asked to contribute their expectations in terms of content and focus and to commit to attending a reading group in the fall if interested.

The challenges were two-fold. First, to look deeply into the scholarly literature on design research to consider what of this corpus might be relevant to a graduate research program in knowledge media design, and second, to consider how this might be taken up in the context of the institute and the university. The four doctoral students who participated were members of the KMDI Collaborative Program, and enrolled in faculties of engineering, education research and information, and had backgrounds in computer science, engineering, and media and communications. The faculty member was a sociologist.

The group shared common ground in that all were familiar to some degree with the design literature in the fields of HCI and human factors. Each was interested in reading more broadly to explore how, and in what ways, other disciplines contributed to the literature of design research. The group met regularly, more or less biweekly, and agreed upon a set of readings co-identified by the group members. At times these seemed random and almost disconnected, but in the process of sorting, sharing and reflecting, certain patterns began to emerge. We looked across the fields of engineering, architecture and industrial design, and saw how these fields mapped to the dominant intellectual history of each period. Not surprisingly, points of tension and transition generally aligned – for example, the challenge to the rationalist perspective and the impulse to participatory practices. Yet, despite similarities in periodisation there appeared to be little cross-fertilization across the fields with the exception of the classics such as Simon's *The Sciences of the Artificial* (1970). The field of interaction design[5] that began to emerge over a decade ago is now one bridge linking traditional design disciplines and HCI.

With the richness of the material uncovered and the quality of the conversations, the group decided to continue into the second term. However, the instructor felt these efforts should be formally acknowledged. The only formal university course structure that could accommodate this style of work was a reading course. Traditionally, reading courses involve a single professor and a student, and there is no procedure for a group to work in this way. The solution was that each student had a separate reading course, a specific research paper they negotiated with the faculty member, and they continued to meet as a group.[6] (See Figure 1.)

The group met more or less weekly through the 2008 winter term, and, a seminar series was developed to complement the course. (See Figure 2.)

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[5] While there is still "no commonly agreed definition of interaction design, its core can be found in an orientation toward shaping digital artifacts – products, services, and spaces – with particular attention paid to the qualities of the user experience" (Fallman, 2003, p. 4).

[6] This constraint is a barrier to collaborative practice, as is the fact that reading courses don't 'count' toward faculty course load requirements.

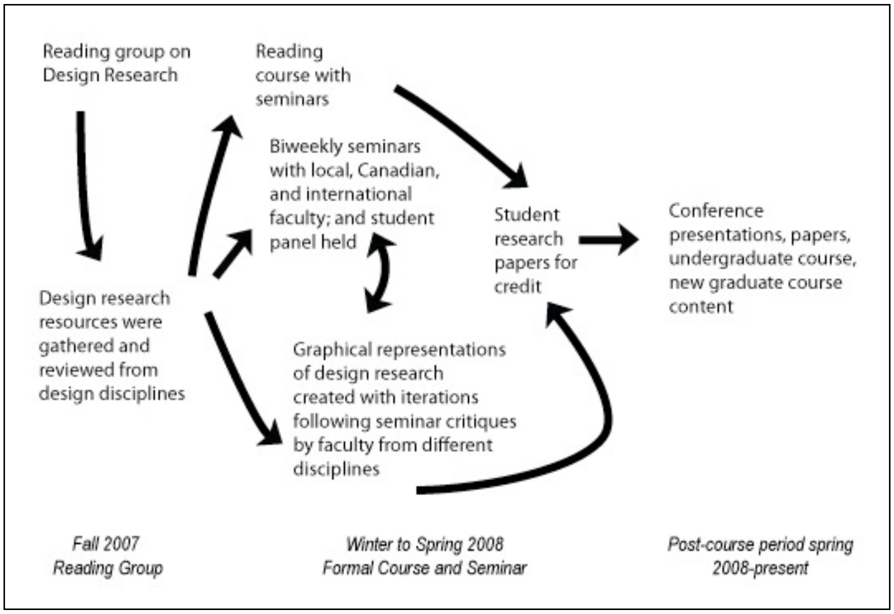

Figure 1 Design Research Reading Group, Course and Outcomes

The first seminars were given by local faculty from different departments teaching design, followed by Canadian experts with design expertise not available at the university. The students presented their research in one session and the series closed with two international scholars who participated in the seminar series and in addition gave a public lecture. These lectures were widely advertised in the university community and webcast. Overall, the series brought together design researchers from industrial design, information visualization, architecture, biomimetics, and critical design, and explored theories ranging from actor-network theory to critical design, and practices that included sketching and the use of design probes.

Figure 2 Design Research Series Poster[7]

[7] This poster includes an image from flickr.com under Creative Commons license by viagallery.com

To foster discussion regarding epistemology and Cross' concept of 'designerly ways of knowing', a number of steps were taken. First, each of the presenters was asked to provide a reading or two that was illustrative of their research perspective. This was distributed to the local community one week in advance as part of the seminar promotion with the request that anyone attending the seminar have read it. Second, the seminar series was not advertised outside the KMDI community, nor with the exception of the final public lectures were they webcast as is customary. The goal was to keep the seminars small enough for active engagement. Third, each presenter was asked to engage and reflect upon a graphical representation of design research that was being created in the course, and iteratively modified in response to the seminar discussions. The graphical representations became a set of shared artifacts around which the attendees, course participants, and presenters could orient, allowing us to consider what aspects of their epistemology, methods and practice might be relevant to the field of knowledge media design. These creative activities were one way in which our growing understanding and appreciation of design thinking could be put into practice.

3.2 Outcomes

The outcomes of the Design Research seminar surpassed expectation.

The curriculum and readings were co-constructed by the students and faculty. Each student worked throughout the term on a paper inspired by the course readings, bringing literature from their home discipline into the discussion as part of an exploration of disciplinary assumptions and perspectives. This led to deep enquiry that was reflected in the writing. Two term papers were expanded; one was published in a high-ranked peer-reviewed journal (Lottridge & Moore, 2009) and the other was presented at peer-reviewed technical conference (Smith, 2009). The ideas are being taken up in doctoral theses, and mobilising awareness of design research in the students' home departments.

The director of an undergraduate program in new media approached one of the doctoral students from engineering to develop a design-oriented course. In collaboration with a social science doctoral candidate they revised and updated an undergraduate course that drew on their experiences in the reading course. This course has been run twice and is being considered for addition to the core requirements for the undergraduate program. The students in the course have also brought this material into other undergraduate and graduate courses in which they participate. For example, in 2009, the course project in the core KMDI course *Fundamentals of KMD* was changed from a traditionally HCI three-step process of user-centred design (user requirements, prototyping, evaluation) to a four-step process that introduced the concept of ideation and included a sketching requirement.

Another significant outcome was the adoption of this approach for the newly established KMDI annual pro-seminar. Two doctoral students, inspired by their participation in the Design Research Seminar Series and the level of engagement and interaction, proposed a course and complementary seminar on the topic of Visual Thinking to the Collaborative Program director. This was taken up as the pro-seminar, and a faculty member who had contributed to the design research seminar agreed to serve as the course instructor. The students and faculty met to create a curriculum and to design a seminar series. While this course was inspired by the earlier model, the approach was modified to fit the specific needs and constraints of the group and the subject. For example, the major assignment was more visual and focused on the creation of an artifact, while continuing to integrate literature from the students' disciplinary backgrounds. This course and series was a success, and KMDI is now encouraging another group of students to articulate their choice for an emerging topic for the next pro-seminar. In the summer of 2009 the authors approached the 2009 course leaders to present a poster on the model and its evolution for the KMDI@13 Research Showcase (Lessard et al, 2009).

4.0 The Emergence of a Model of Pedagogy

A key observation from the case was that students were learning to think across disciplinary boundaries and to understand the ways in which epistemology, methodologies and values shape disciplinary knowledge and knowing. As well they were developing ways to negotiate cultures constructively even where epistemological differences were irreconcilable. This went beyond the disciplinary crossings normative in KMDI's research and collaborative program that have been primarily multi-disciplinary. The generative nature of these interactions is characteristic of transdisciplinarity.

Interdisciplinarity as a field of scholarly enquiry has long been part of KMDI's agenda (Moore & Timmerman, 1996; Moore, 2003, 2009). In transdisciplinarity the primary focus is not on the discipline per se but on the transformative potential of the interaction of individuals from different disciplines working together in a context of application. The process is dynamic, flexible, and generative. Figure 3 illustrates the various forms. It is the transdisciplinary form that we feel holds the greatest promise for addressing complex problems.

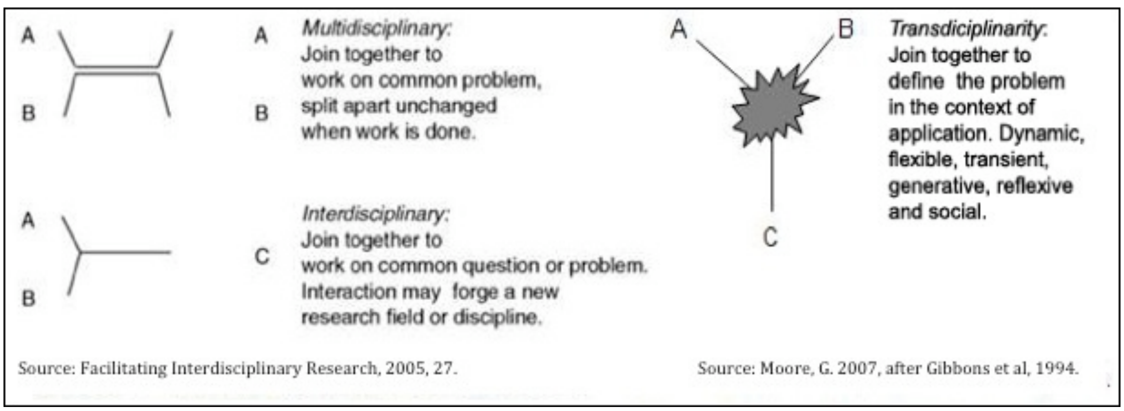

Figure 3 Inter-, Multi- and Trans-disciplinarity

Our model is summarized in Figure 4 below. Reflecting on the success of our case, we discuss three contributions beyond the activities that took place: the 'designerly' progression; the disciplined transdisciplinary nature of the engagement; and knowledge mobilisation. The model is then reviewed in terms of the literature on innovations in interdisciplinary pedagogy.

First, we position the visual model of design research by Sanders and Stappers (2008) at the base of our model to indicate the 'designerly' way the process unfolded. This references the transition from the 'messy' and informal practices at the origin to the more refined and formal outcomes at the end.

Second, by initially moving outside the boundaries of formal course requirements, we experienced the generative potential of the interaction of individuals from different disciplines working together in the context of a specific application, or what Michael

Gibbons (1994) refers to as transdisciplinarity. However, we continue to value the expertise gained through disciplinary training, and success in our case was in enabling a specific form of transdisciplinarity that we call *disciplined transdisciplinarity.* The notion is that by making disciplinary assumptions and values explicit, it is possible to co-create the bridges required to negotiate disciplinary divides and to appreciate the different epistemologies and perspectives revealed. KMDI students are frequently engaged in the design of digital media projects and have their own experiences to draw upon. The introduction of design thinking and ideas from the design disciplines engages them intellectually with how this is similar and different from design coming from a computer science or human factors perspective, The understanding and knowledge that results from this process can then be taken back to the disciplinary home unit.

Knowledge mobilisation is the third element in the model. Over the period of the course there was movement across what we are calling the *continuum of access* as the ideas moved outward from the students in the course, to the open seminar, and to their home departments and faculties. Finally these are disseminated in the university through public lectures, and via webcasting and publications, to the world.

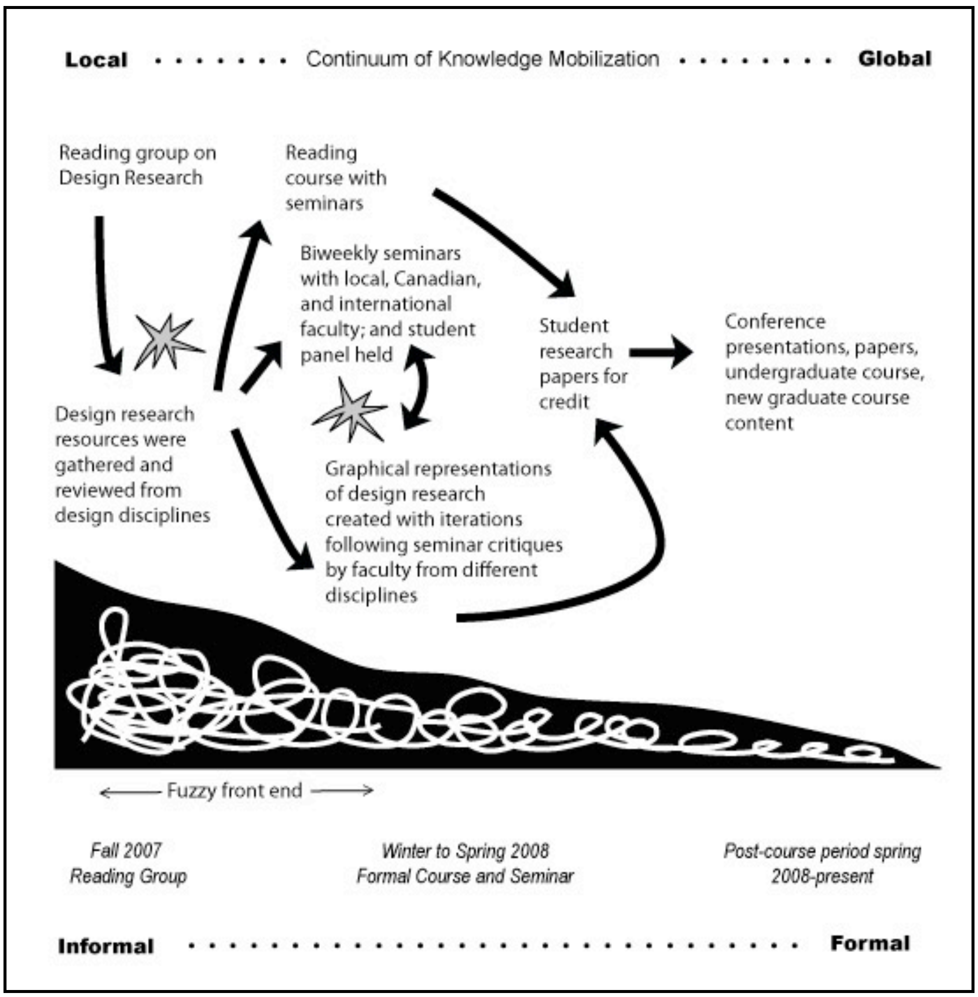

Figure 4 Pedagogical Model

5.0 Discussion and related work

A review of the literature illustrates the timeliness of this topic as educators from many disciplines consider how to prepare students for the challenges and complexity of the 21st century. In situating our work in relation to this corpus we focus specifically on pedagogy for interdisciplinary graduate education. We draw in particular on the work of Gerhard Fischer (2008) and Simon Penny (2009). Fischer's focus is on education for IT; and Penny's is on interdisciplinary education in the emergent field of media-arts and digital cultural practices, both highly relevant to knowledge media design. As one of our goals in reviewing the literature of design research was to identify the ways in which this field could be taken up and become part of graduate education in our field, we were encouraged to find scholars engaged in questions of pedagogy.

Fischer, a member of the Center for LifeLong Learning & Design, the Institute of Cognitive Science and the Dept. of Computer Science at the University of Colorado, Boulder, argues that there is a need to develop transdisciplinarity competencies which "refer to knowledge and skills required to identify, frame and address important scientific and practical problems that cut across disciplinary boundaries" (2008, p.3). The conceptual framework required to deliver these competencies, he suggests are derived from the learning sciences, Human-Computer Interaction (HCI) and Computer Support for Collaborative Learning (CSCL). Fischer's framing of transdisciplinarity is similar to ours in that it recognises the innovative and creative potential inherent in this form while also recognising the possibility of failure if there is an inability to find common ground (2008, p. 8).

The educational model of 'courses-as-seeds' (dePaula, Fischer, Ostwald, 2001) "explores meta-design and social creativity in the context of fundamentally changing the nature of courses taught in universities. Its goal is to create a culture of informed participation" (cited in Fischer, 2008, p. 5). Instructors provide the initial seed, rather than a final product and students actively co-create the course. While unaware of this research during the course, it describes our process well. However, while Fischer's approach to transdisciplinary education highlights the advantages of diversity and is awareness of the complexity of achieving it, we suggest that an important aspect of transdisciplinarity – discipline – remains masked. We argue that it is critical to foreground discipline and the significance of disciplinary differences in norms, values and ways of knowing in order to fully release the innovative and creative potential of transdisciplinary interaction. For this reason we prefer the term *disciplined transdisciplinarity*.

Penny addresses the question of the development of effective interdisciplinary pedagogy for the ACE project at University of California, Irvine; a project in the emergent field of media-arts and digital cultural practices. "The key components of such a project are: deep technical training and understanding; deep training in artmaking and cultural practice; deep theoretical and historical contextualization, and an open and rigorous interdisciplinary context which maximally facilitates the negotiation of these often divergent ways of thinking and making." (2009, p. 31). The disciplinary crossings are generally broader than in knowledge media design as ACE includes the experimental and conceptual plastic arts. While our goal is disciplined transdisciplinarity, Penny is reaching for interdisciplinarity and the creation of a new discipline. The goal of ACE is the "formation of practitioners who are neither artists nor engineers, or who are equal parts both" (2009, p. 31). And, he suggests that "there is a fair argument that, as of around 2005, the descriptor 'new media' has become an anachronism, and the 'field' has moved into a post-interdisciplinary transition phase; it is actively undergoing the transition to disciplinary status…" (2009, p. 37). Both agendas require extensive work in negotiating disciplinary or epistemic cultures, and the awareness that the exploration of the epistemological foundations of individual disciplines may prove uncomfortable (Lottridge & Moore, 2009). The ACE project, however, goes further as their slogan – "danger of permanent damage to axiomatic assumptions" (2009, p. 37) makes explicit.

While ACE and KMDI differ in their goals in terms of the desired outcomes of disciplinary border crossings, there are interests in common and two of these are questions asked in the discipline of design. First, what is the relationship between theory and practice and second, what is the relationship between problem setting and problem solving? The work of Rittel & Webber (1973) on problem setting is framed by Penny as "asking the right question" (2009, p. 46). He contrasts this with the analytical intelligence required for problem solving, and we are sympathetic to this view. We also agree with Penny's observation that "such broad integrative inquiry often demands the negotiation of world views and epistemologies that may appear quite immiscible" (2009, p. 46). However, from the perspective of knowledge media design it is important to continue to problematise the theory/practice space, as efforts toward developing a model that represents this field continue to benefit from exploring this tension. For Penny, "the reconciliation of theory and practice is a central dimension of the interdisciplinarity of ACE" (2009, p. 34). From our perspective, transdisciplinarity rather than interdisciplinarity, continues to be preferred for reasons that are critical. It keeps the future open, and does not risk falling into the trap of disciplinary rigidity and institutionalisation, precisely what a project of interdisciplinarity risks if it succeeds. Furthermore, there is value in disciplinary depth; a goal with which our notion of disciplined transdisciplinary is not incompatible. The challenge is to find those disciplinary experts willing to engage in intellectual conversations of this nature. We concur with Penny that this requires humility, courage and intellectual rigour (2009, p. 39-40).

6.0 Conclusion

"Interdisciplinary thinking is becoming an integral feature of research as a result of four powerful 'drivers': the inherent complexity of nature and society, the desire to explore problems and questions that are not confined to a single discipline, the need to solve societal problems, and the power of new technologies" (*Facilitating interdisciplinary research*, 2005,p.40). Support for this kind of thinking requires innovative approaches to education and training, and nowhere is this more important than in our universities where future researchers and scholars are trained. We will continue to require the specialised knowledge and expertise that disciplinary training produces. But while this is still necessary, it is no longer sufficient. To succeed in the 21st century graduates will need to have learned how to be self-directed learners, how to negotiate across cultures, including disciplinary ones, and how to work collaboratively in environments from the material to the virtual. Innovations in pedagogy and in our universities are required, and much we have argued can be learned from the discipline of design. This paper represents our first steps in an ongoing process of exploration to understand how best to prepare students to take a human-centred approach to the design of knowledge media as well as to be able to engage in constructive criticism of these media, technologies and related policies. A model of pedagogy grounded in disciplined transdisciplinarity we propose is one approach to preparing students for the uncertainties of a complex world.

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Set in Concrete? Crafting Innovation

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Abstract
This paper draws on the experience of practice-led research based in academia, which investigates the possibility of making hard surfaces soft.

So far the project, in its fifth year of development, has led to three patents being filed on technology allowing manufacturers to embed textile technologies onto the surface of precast concrete surfaces resulting in hybrid but integral finishes.

The work was initially understood as decorative but as the project has moved into testing and analysis phases a better understanding of the resultant altered characteristics of precast concrete surfaces has emerged – ie the resultant hybrid concrete surfaces overcome some of the negative characteristics of concrete to become colourful, warm, acoustically soft, thermally less variable and people friendly. In short, this design-led research process has extended the characteristics and hence potential of a global material.

Following on from a brief outline of the project and evidence of its innovation, the paper will be structured around two central sections examining some of the strategies that have evolved in this hybrid process and examining potential tactics that have led to innovative outcomes. The first section will examine how conceptual and theoretical thinking, generated out of a user-centred critique of the built environment and an understanding of the relationship between architecture and textiles, can demonstrably lead to pragmatic, innovative and marketable solutions. The second section will look at the interrelationships between creativity, innovation and collaboration and address some potentials and challenges.

The paper represents an early attempt to make sense of this design–led project. It aims to capture and contextualize some possible transferable tactics that might lead to more conscious and explicit processes for crafting innovation.

Keywords:
architecture; textiles; concrete; collaboration; design-led research; research-led design; craft; innovation

1.0 Introduction
This paper is based on an ongoing collaborative project called 'Tactility Factory' between a textile designer and an architect. Other than the first few years of the project, the primary author of the paper (the architect) had been principally involved in design pedagogy, helping to establish new design studios and undergraduate architecture courses in the UK. Much of that pedagogy was informed by an interest in what at times felt like two diametrically opposed areas ie how to teach design to first year students;

and, how to address critical theories that surround architectural education and practice, namely, inclusive and feminist theories. Between these two areas sits a seldom-voiced and rather rudimentary question; do design practices that seek people-sensitive outcomes result in *ugly* outcomes? (An Architektur and Heyden, 2010)
The project offered a place to explore this tension and an opportunity to practice and test what the architect had previously taught. It has therefore become a place to theorize socio-politically whilst making innovative and aesthetic products, and reflecting on the efficacy of previous pedagogical practices.

The project however was not initiated within the format of a traditional research project ie to test a research question. Rather it began with the design intentions of *making hard things soft,* in order *to mainstream tactility in the built environment.* The means by which this was to be achieved was through the application of textile approaches and techniques to the design and manufacture of built environment materials (see section 3.1.1 for the theoretical justification of this 'methodology'). The results of this design-led approach are regarded as highly innovative and much external attention has fallen on the project (see section 2.0 for indicators of innovation).

Within the context of this research paper, we will examine and question: *what tactics within the project led to an innovative outcome*? The hope is that by doing so we might identify transferable practices to other situations, leading to a conscious and explicit process for crafting innovation.

The possible tactics that craft innovation will be examined under the following areas:

- Cultivating a Distinct Context
- Creativity, Innovation and Collaboration

The paper will examine each of these in turn, acknowledging the overlaps and challenges. Firstly, there is a necessity to scope out the nature of the project and its outcomes in the following section, allowing the reader to get a sense of the nature of the project.

2.0 Project Outline

The Tactility Factory project combines the hard properties of concrete with the softness of textiles by designing innovative processes that deliver beautiful and sensorial engaging surfaces. The approach of applying 'textile thinking' to hard materials used in the built environment, is one that is not necessarily concrete-specific and could, we believe, be eventually applied across a range of materials. However for the moment we have focused on combining concrete and textiles.

It has taken four years of testing and development to identify the appropriate materials and resolve the technologies that can be used to combine textile and concrete manufacturing processes to create pre-cast concrete surfaces with an integrated and permanent textile surface. The textiles are designed and manufactured to incorporate voids, meaning that surface patterning is created as much by the concrete as by the textiles. The resultant surfaces convey an antique feel, despite being principally created using the latest digital technologies and processes. The end result is described conceptually as the 'fossilisation of textiles'.
Three technologies have been perfected to date

1. ‘linen concrete’: Varieties of linen weights and colours are used. Voids are created through which seeps the concrete, leaving an integrated and robust surface of concrete and linen. Linen is chosen since it survives in alkaline environments
2. ‘stitched concrete’: A variety of technologies is used to allow the stitched surfaces to remain on the surface. Yarns in a range of colours, weights etc can be used to create endless variations in pattern and design.
3. ‘flocked concrete’: short flocking fibres are integrated onto the surface of the concrete resulting a highly tactile and ‘stroke-able’ finish.

Fig1: ‘linen concrete’- linen textile allows concrete mix to flow through to surface creating visual and tactile patterns

Fig2: ‘stitched concrete’- textile, digitally stitched and imbedded into concrete surface gives an appearance of an embroidered surfaces

Fig3: ‘linen concrete’ panels used in private commission

The level of innovation residing in the processes and products is indicated by the external interest the project has drawn. This includes a number of awards for innovation, invitations to exhibit nationally and internationally and features in international design journals and magazines. The work is also cited in publications on trend forecasting and innovative products and forms of practice (see www.tactilityfactory.com/publicity.html) Recently Tactility Factory has been successful in winning two major competitions related to the next ‘Big Idea’ and the project is now in the early stages of forming a spin-out company.

So the question is what has caused these innovative outcomes to emerge. The next section will consider some of the possible conditions or tactics to craft innovation.

3.0 Possible Tactics that Craft innovation

3.1. Cultivating a Distinct Approach

The question: *why do this*? has echoed throughout the lifetime of the project. More particularly, *why place delicate, beautiful fabrics into harsh alkaline environments?* The most direct answer is – *why not?*. But more profoundly, because the project is a response to observations and critiques that have occurred throughout the careers of the collaborators and increasingly throughout the progress of the project. The process therefore is far from the usual process of product development that addresses an identified customer need or a specific gap in the market. Instead the Tactility Factory process begins from a conceptual range of critiques and seeks to exemplify, through a product development, an approach, indeed an ethos, that addresses wider critiques.

These critiques act as sources of motivation or investigation and are:

3.1.1 A sensory approach to technology (textile context)
The textile designer's skill in creating rich tactile surfaces through the application of appropriate technologies has led to an examination of how effectively this is achieved within the discipline of architecture.

Tactility is certainly referenced in wider critiques (Levin, 1993 and Pallasmaa, 1996) of modernism in architecture that challenge the dominance of the visual and call for the corporal and psychological experience of space to be better understood and elevated in significance. In addition, many phenomenologists that influence and practice architecture (Maurice Merleau-Ponty, Christian Norberg-Schulz, Steen Eiler Rasmussen, Juhani Pallasmaa, Steven Holl, Peter Zumthor) also position tactility and sense of touch within their wider concerns for the 'experience of architecture' and its material manifestations.

Juhani Pallasmaa whose own relationship to the senses and architecture are well documented across a range of publications (Pallasmaa,1994 and 2005), states in his most recent publication: *The Thinking Hand*, that:

> The boundary line between the self and the world is identified by our senses. Our contact with the world takes place through the skin of the self by mean of specialized art of our enveloping membrane. All the sense, including vision, are extensions of the tactile sense; the senses are specialisations of skin tissue, and all sensory experiences are modes of touching and thus related to tactility'
> (Pallasmaa, 2009 p….)

Pallasmaa understands the centrality of touch within the body's sense of itself and the world around it, but also accepts that architecture falls short of delivering a full response; *"Our architecture may entice and amuse the eye, but it does not provide a domicile for the touch of our bodies, memories and dreams'*

He does cite some examples where architectural detail offers tactile sensations. However such work represents only the elite output of the profession and in general whilst architects may want and believe architecture to deliver a full mind/body/ soul experience, in the practice of everyday architecture, it all too rarely does.

On the other hand, technology does occupy a central position in architectural practice. Many conceptual and stylistic shifts in architecture have been interdependent on technological advancements. There exists a long tradition and strong culture of architecture that pushes the development and celebrates the use of technology. However, whilst such architecture often has strong visual impact, the experience of occupying, using or passing through such spaces can be cold and alienating. As Perez Gomez fears "Technology substitutes a 'picture' for the world of our primary experience." (Perez Gomez, 1994, p5)

In contrast, interacting with a textile is personal and unique; a *cosy*, *cuddly*, *slippy*, *scratchy*, *warm* encounter. Simultaneously, one experiences an intimate physical and aesthetic reaction. Behind this emotive experience of textiles lies as much technical expertise as is required in the making of space. It is therefore the remarkable achievement of textile designers to use 'hard-core', chemical and mechanical processes (abrasive/ corrosive technologies) to transform and combine yarns into an artifact that evokes strong emotional responses. In other words, technology may be core at the textile designer's process but it is rarely present in the user's interface with the product.

The Tactility Factory project draws on such reflections and seeks to apply a textile approach to the technological development of building products in ways that respond to these concerns. In addition, the project seeks to echo Peter Rice's ethos of *Trace de la Maine, to*, "..make real the presence of the material in use in the building, so that people warm to them, want to touch them, feel a sense of the material itself and of the people who made and designed it." (Rice, 1994)

3.1.2 politics of inclusion. (Inclusive context)
The architect in Tactility Factory has been involved in inclusive design (evolving from disability studies) over a longer time span. As such, concerns for a people centred design approach are also reflected in the processes and products of Tactility Factory.

Products and components used in constructing the Built Environment are designed, almost exclusively, to meet technical specifications only. It requires the skill of the architect to use these building products in such ways as to create environments suitable for people. Tactility Factory brings a 'human' specification to the development of its surfaces, considering it to have equal importance as the technical performance. Indeed the profoundest challenges do not lie with meeting technical specifications (since much of that work has been done by technologists before us), but rather to apply technological understanding in such a way as to make artifacts and surfaces that people wish to interact with. In the shadow of this apparently pragmatic statement sits a real concern for multi-sensory experience, design quality and beauty.

The process of Tactility Factory is built on a belief in transparency and sharing. This frequently challenges the cultures of intellectual property protection and in-house academic politics, however we understand it as an instinctive and core politic to the work processes of Tactility Factory and feel compelled, as pedagogues and members of wider design professions, to demystify processes and products through active dissemination. We use traditional and electronic media (blogs/ websites) to make links, reveal our inspirations and chart tactics. Naturally, dissemination invites response and Tactility Factory has benefited by the links, suggestions and collaborative relationships that have evolved because of these disclosures.

3.1.3 A context of historical and contemporary precedents and theory
As we work practically on the project we are at the same time party to wider academic discourses. Defining and researching contexts for the work helps contextualize Tactility Factory within a range of theoretical contexts and architectural legacies.

In particular, we have become interested in the enduring and ever-evolving relationship between architecture and textiles and adjacent relationships such as fashion and surface. Starting with Gottfrield Semper's (1803-1879) theories on the interconnection between textiles and the origins of architecture itself and his development of the

'Principle of Dressing' in relation to architecture, through to the work of architects such as Hoffman and Van de Velde's who simultaneously designed clothing and architecture at the end of the 19th Century. Followed by modernism's rejection of all things decorative, influenced by Loos's 1913 text 'Ornament is Crime' (Kinney, 1999) and onward to those architects whose work has engaged creatively with surface, for example Rudolf's seminal surface treatments in the Art and Architecture Building at Yale (Rohan, 2000) and the work of the Spanish architect Miguel Fisac in 1970's and 1980's [i]. More recently the developments in nano and smart textiles covered in the work 'Architextiles' by Mark Garcia (2006) also informs the work of Tactility Factory.

We have found through this process of contextualization and analysis, examples of architecture where textiles are used either literally or conceptually. When used literally, textiles are typically used within framed and strictly regulated structures; taut, stretched and controlled; they are the 'smart' petrochemical constituents of space-age lightweight structures, seen but not touched. Where there are used conceptually, it is their characteristics of *'lightness, surface, complexity and movement'* that mirrors *'architecture's shifts towards a more fluid state'* (Garcia, 2006). Overall the result is architecture that may **look like** and indeed may even appropriate textile technologies, but rarely **feels like** textiles. (Authors, 2008). (There are of course some interesting exceptions to this rule that serve as guide points for the project.)

An awareness of existing precedents has helped Tactility Factory advance through a critically aware process. By creating a clear and distinct line of theoretical intent, which alongside logistics helps to define and order the pragmatic investigation, Tactility Factory hopes that this reduces the changes of replication and builds what Yair, Tomes, and Press (1999) call 'immunity to imitation'.

There are in the end many ways to tackle any problem, but we endeavor to choose a route forward through an informed 'creative opportunism' (Cross, 2007) rather than a random one. Our aims therefore remain focused on **mainstreaming tactility in the built environment** and whilst that may be perceived as utopian it helps guide and formulate the project, even within the scope of a business plan or the text of a patent.

Interestingly while we argue that the development of the hybrid surfaces is not a direct consequence of responding to a market need, the utopian goal closely reflects what Kim and Mauborgne (1999) in the *Harvard Business Review on Breakthrough Thinking* identify as one of the strategies of 'value innovation' ie 'the ability to pursue a quantum leap in value'. It could be argued that *value innovation* naturally arises because at the centre of Tactility Factory is the *value-laden* methodology of design.

3.2. Creativity, Innovation and Collaboration

In its early stages, Tactility Factory was driven by a singular collaboration between a textile designer and an architect. This remains at the core of its development but as it has progressed the project has drawn on and been tangibly informed by collaborations with pre-cast concrete specialists, mould makers, digital textile designers, weavers, embroiderers, graphic designers, marketing consultants, business advisors and patent attorneys.

Whilst many of those who contribute to the project do not come from a creative profession per sec they all contribute to *the application of creative ideas*; and since this is regarded as one definition of innovation (McKeown 2008), we acknowledge the contribution of all those involved in driving forward innovation in Tactility Factory.

Within Tactility Factory therefore we work hard to recognise and give space to the personal motivations of all involved. Motivations range from wishing to experiment with a familiar technology, to holding true to a certain ethic or work process. The importance and relevance of these motivations are discussed and where possible time is set aside for them to occur. However we also recognise that what motivates most creative practitioners is time for play, creative experimentation or risk-taking. Whilst this can be personally fulfilling and result in highly creative outcomes (a Tactility Factory strap line is "creativity is our currency") it can sometimes cause us to avoid the obvious, more direct routes and choose instead to explore new territories at the cost of moving the programme forward in an efficient and effective manner. This applies not only to the material manipulation of the surfaces but also the strategic direction of the project as a whole.

It is also important within such a context to value the strengths that each person brings to the process. So for example it's understood that the textile designer brings a wealth of knowledge and experience from the textile design industry. She therefore offers

- Profound technical skills, a natural curiosity and a confidence to experiment within new and unfamiliar technologies.
- An acute sensibility in creating rich tactile surfaces through the application of appropriate technologies.
- A fastidiousness about *the fabrication of the aesthetic*; trialing, testing and ultimately crafting and controlling each technical move to ensure quality outcomes.
- A pragmatic approach to product development and a track record in delivering.
- An ability to lead in trend sensitive markets

By comparison, the architect / academic brings

- A strategic clarity to the process
- A strong belief in the 'concept' / design intention mapping to the detailed level
- A confidence that large problems can be broken down into logical steps and managed.
- Skills in communicating across 'languages' and cultures ie from visual to verbal, from conceptual to operational, from creative to pragmatic

The intensity of learning around collaboration has been due in no small part to the hybrid nature of the project. Bringing concrete and textile cultures together in one project has been a challenge. Of course much has been written about the strength of working collaboratively across cultures or professional disciplines (Paulus and Arian, 2003), less is said about how to cope where cultures appear to be antithetical to one another, such as concrete and textiles.

"Where attempts are made to create diversity, the effort is often incomplete because people with varied backgrounds and thinking styles tend to have difficulty understanding one another. In practice, their differing viewpoints tend to lead to personal disputes and the creative process breaks down."

Karlyn Adams, 2005

Given that this is a multi-layered project, the chance of experimentation across the material technology of concrete moulds, concrete mix, multiple textile techniques and also across a strategic direction means that the potential for diversion, confusion and ultimately error is multiplied many times over. Communication and documentation is therefore key. We aim where possible to build diaries, schedules of materials and recipes, tables of trials and critiques collectively and over time we have renamed processes and products in a third language, specific to Tactility Factory and non-discipline centred. The creation of this 'third' nomenclature is a symptom of collaboration across a wide stretch of cultures and is a necessary outcome of a hybrid collaborative practice.
Naming is also part of the categorization and critique of design trials. We aim for bi-weekly round-table discussion about the artifacts produced. All collaborators in Tactility factory regardless of their background or role take part in these sessions, and it is at these moments that we witness what Cross describes as the 'co-evolution of problem and solution', where 'Designing appears to be an 'appositional' search for a matching problem-solution pair, rather than a propositional argument form problem to solution'. Given that this project has not sought to address a defined need in the market place but rather to respond to a conceptual gap, this act of 'crafting' the problem, categorizing and re-categorizing the potential solutions relates not just to making a product but also defining an as-yet unrealized market-scape. As we categorize and name we also ask: why would anyone need this product? what purposes could it serve? what other problems does it relate to? The design process therefore appears to be in flux, almost uncertain of its own rationale. To some extent this also echoes Lawson's study of the architectural design process where, after observing the processes of many architects, he argues that the only thing one can be certain of is that ".. designers have to gather information about a problem, study it, devise a solution and draw it, though not necessarily in that order." (Lawson, 2006). The one chief difference here is that architects traditionally accept that however convoluted the design process, the solution to the problem will ultimately be a building. For Tactility Factory, however, there is no foregone conclusion.

4.0 Conclusion

The Tactility Factory project has opened up many lines of enquiry. The work of making sense of its processes and outcomes is ongoing and this paper is an initial attempt to capture and contextualize some of the tactics used during its development that seem to have resulted in, or crafted, innovative outcomes.
In terms of Cultivating a Distinct Approach, there is little doubt that the project has benefited from having a clear intellectual context to respond to (3.1.3 historical and contemporary precedents and theory); a justifiable and defined methodology (3.1.1 a sensory approach to technology); and perhaps less obviously, an alignment to a set of values that help to sustain and focus ongoing development (3.1.2 politics of inclusion)

Even before the technology to produce the surfaces had been fully resolved this Distinct Approach had given the project a unique identity and had drawn sympathetic collaborators and interested parties to it. It would seem therefore that innovation can be supported not only through a crafting of the process but also a crafting of the intention, approach and context.

In terms of Creativity, Innovation and Collaboration it is clear that understanding the different approaches and modes of creativity that each contributor brings to the process is crucial. Tactility Factory's regular round table discussions are convened in front of the surfaces produced. The very tactility of the surfaces causes the meetings to take on a less conventional format and contributors interact directly with the surfaces and each other; humanity in combination with creativity, are part of the discussion. This interaction is further underpinned by the ongoing development of a hybrid language used in the naming, categorizing and re-categorizing of design and surface outcomes. This third nomenclature becomes another form of representation, opening up new perspectives on processes, possible markets and new relationships. It helps define actions, present and future.

Finally, understanding the context, the extant skills and motivations of the team, the nature of materials, process of fabrication and the extent of resources; combined with a critical confidence in the design process, may not only allow for the evolution of new products but also unexpected results.

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Sketching in Hardware and Building Interaction Design: tools, toolkits and an attitude for Interaction Designers

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Abstract

In this paper, we present a *Sketching in Hardware* perspective to Interaction Design (IxD) education and practice. We start our discussion by highlighting the differences between *Prototypes* and *Sketches*, and explaining why we believe the term *Sketching in Hardware* is suitable and appropriate to the IxD practice. We introduce a short history of the term and its origins before relating it to Experience Prototyping activities and other related design processes/methodologies.

Our main discourse consists of observations and a critical analysis of academic activities and professional work suggesting that *Sketching in Hardware* remains quite challenging despite the recent progress in the development of new tools and toolkits. The low barrier to entry and the explosion of tools and toolkits are very welcome, but this democratization can also be misleading. The learning curve is still steep in many ways. The current sketching tools seem to have leapfrogged our design skills and our ability to deal with that avalanche of technical capabilities. Designers regularly loose a critical perspective on their sketching and prototyping activities. We noted that students and designers alike spend a lot of time mastering intricate tools and debugging technical issues when they should be developing, evolving and fine-tuning interesting experiences or sketches informing their design process.

We close our discussion with a review of various toolkits and building blocks currently available to interaction designers for designing new technology and future concepts. We ultimately suggest five guiding principles to be taken into account in the design of new toolkits or upgrading of existing ones. These same principles and qualities not only can, but should also radiate in the experiential qualities, well beyond the built material artifacts. *Sketching in Hardware* is not just playing with electronics; it has serious implications and repercussions in the way we design stuff.

Keywords

Interaction Design, Prototypes, Prototyping, Sketches, Sketching in Hardware, Toolkits, Experience, Design Tools.

Prototyping is a core aspect of design activities. As a loose definition, prototypes are manifestations of a design made before the final artefacts exist. Many authors have written about the various forms and variations of prototyping activities (Buchenau & Suri, 2000; Buxton, 2007; Houde & Hill, 1997; Lim, Stolterman & Tenenberg, 2008; Shön, 1982). They often diverge in the specifics but globally, they describe the same design activities used to filter a design-space and build corresponding representations. In the field of Interaction Design (IxD), such design activities are often encompassed in terms like Experience Prototyping, Hardware

Prototyping and Physical Computing. Our main objective with this paper is to present a new perspective on sketching in Interaction Design and describe our view of how students and designers go about it.

Sketches are not Prototypes

A few authors like McCullough (1996) and Buxton (2007) point out the importance of the mediums and that prototypes are different from sketches. Sketches, in any mediums, have different qualities and purposes. Without simplifying too much, sketches are generally used and valued earlier in the design process, while prototypes are more beneficial towards the later stages of the process. These two representations have their own specific role, intent, qualities and purposes in a designer's toolbox. Buxton (2007) proposes this comparison or continuum (Fig. 1). In our view, while this polarization can be useful to discuss and understand the differences, most design manifestations sit somewhere in the middle, depending on the context and situation they originated from.

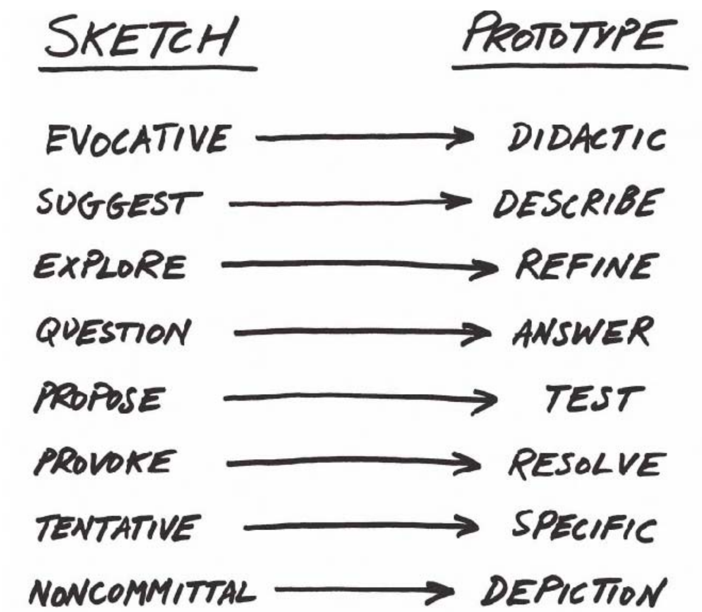

Figure 1. The Sketch to Prototype Continuum (Buxton 2007)

Prototyping is a term widely used in many domains outside design. In software development, a prototype is generally understood as a working proof of concept, a partial instantiation of the final application where some aspects are usable for testing or internal reviews with client, users and contractors (Floyd, 1984; Wikipedia, 2010). The focus is clearly towards showcasing solutions, evaluating options and agreeing on specifications, all of which are situated in the later stages of development. Although newer approaches and methods are breaking this tradition (agile method), prototyping in software development involves very little ideation and explorative and noncommittal activities.

In Industrial Design and Product Engineering, a prototype corresponds often to the latest instantiation before going to final production (Feirer, 2002). All problems are solved at this stage and the prototype is (ideally) an one-off copy of the upcoming production item. What comes before the prototype adopts a variety of names depending on the use and purpose: exploration models, volumetric or form study models, visual models, functional models, proof-of-principle models, engineering models, throwaway prototypes, concept prototypes, etc. Sketches are also well understood and highly valued in Industrial Design. They are fast, explorative and tentative representations to exteriorize and communicate ideas. Additionally, the self-reflective qualities of sketching are often more important than the resulting sketches themselves (Hanks & Belliston, 1990). Numerous authors have highlighted the crucial underlying processes of sketching that support creative thinking (Schön & Wiggins, 1992).

From our perspective, we believe ‘*sketching*’ is an important term that designers and design students should be using more when referring to design activities that relate to evolving and building interaction ideas creatively. Although not perfect, the term ‘*Sketching in Hardware*’ reflects well the action of sketching in any mediums (with or without computing capabilities) well beyond pen and paper. Compared to ‘*prototyping*’, ‘*sketching*’ feels definitely more appropriate for evolving ideas and developing design concepts. To our knowledge of educational curriculums and today’s practice in design consultancies, very few designers work in the later phases of the design process: close to mass manufacturing and production, where ‘real’ prototypes are commonly found. These activities tend to be very technical and are naturally best handled by competent engineers and professional builders.

History of Sketching in Hardware

The term *Sketching in Hardware* is not exactly new. Researchers like Holmquist (2006) have introduced the term some years ago, and it is somewhat present in today’s IxD teaching curriculum and professional practice.

It is important to note that although the term is relatively new, the activities and motivations have been around for decades. Companies, design consultancies and research groups have been developing interactive physical products or projects with a strong focus on early electronic sketches or half-faked interactive demos (Fitzmaurice, 1993). Almost a decade ago, Greenberg & Fitchett (2001) introduced Phidgets as a toolkit to support, build and test physical interfaces quickly. During the following years, the ideas and tools evolved rapidly, left the research labs and gained widespread adoption in design school and consultancies. The term ‘*Experience Prototyping*’ is well recognized today in the design community and has strong roots with the user-centered design movement (Buchenau & Suri, 2000). We agree that both *Experience Prototyping* and *Sketching in Hardware* have a lot in common and are almost interchangeable. Our intention with this paper is not to argue over exact definitions, but more trying to describe, understand and enhance the design activities taking place. Let us just finish by mentioning that both terms complement each other very well, *Sketching in Hardware,* due to it’s strong sketchy, almost messy and more designerly connotations, has the benefit of emphasizing the material and experimental qualities, whereas Experience Prototyping highlights that the goal is to design and support the experience and not the prototype (or the built artefact).

Sketching and building Interaction Design differently

Technical know-how can be a blessing or a curse

From our teaching and tutoring experience (as well as being students ourselves), we observed that students are often mesmerized by the new technological and technical possibilities. Discovering new technology and being able to appropriate it to build something that works (partially at least) is usually very satisfying and gratifying. It is somewhat natural to be in that 'wow phase'.

But designers have to move on and make good and meaningful use of those tools. As good craftsmen, designers should avoid pursuing a project (or prototyping) relentlessly to a point where it becomes self-conscious demonstration and point-less perfectionism (Sennett, 2008). Great and seductive demos and prototypes surely have their value in the design process, "but they are only one part of a means to an end, and certainly not the end in itself" (Buxton, 2007, p. 412)

However, the skills and knowledge required to build hardware sketches are difficult to outline, mostly because the nature of the work spans many disciplines and domains. Technical know-how in electronics, mechanical systems, programming, sensors and the like are absolutely helpful, but so is knowledge in improvisation, performance arts, storytelling, communication, movie making and psychology. In our opinion, it is not necessarily the sketch you make that counts, it is how you use it to inform your design activity.

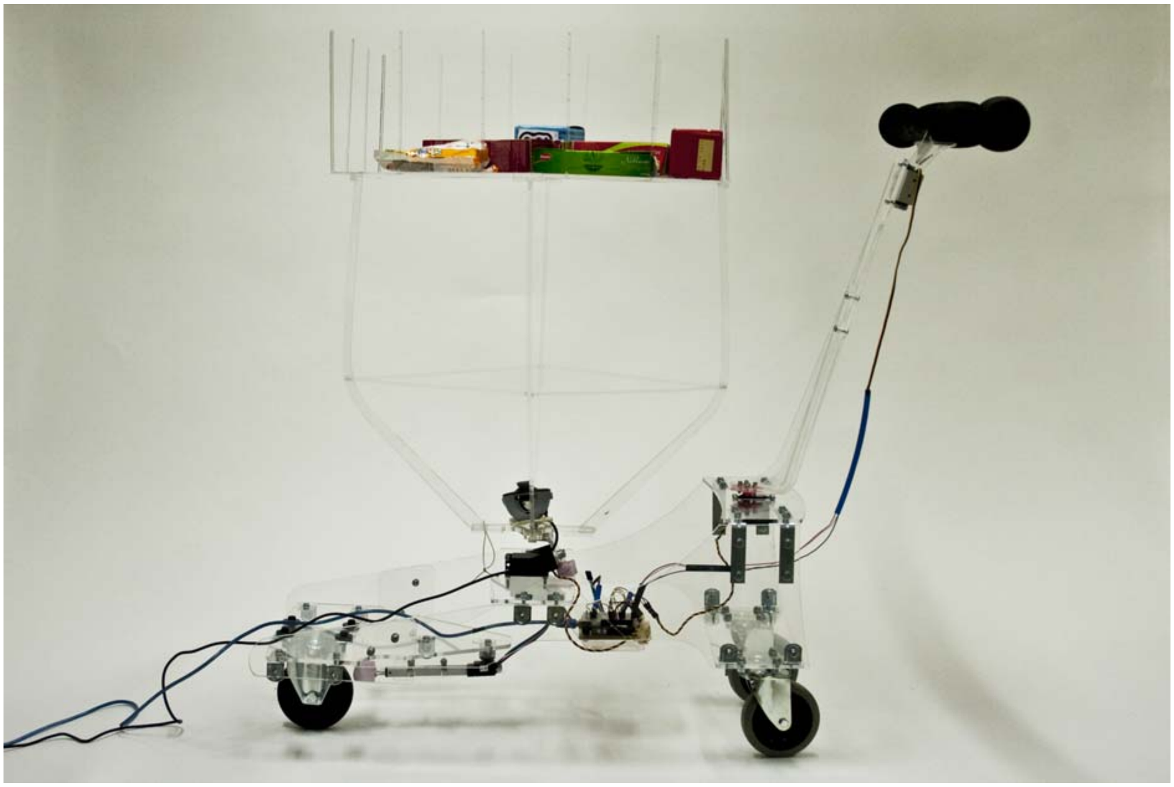

Figure 2 Shopping Cart prototype, an example of over-prototyping (image credit: George Paravantes and Amid Moradganjeh)

Throughout the courses we teach in Experience Prototyping and Sketching in Hardware, we repeatedly have technically-inclined students who have difficulties balancing technical prowess and the actual design outcomes they get from building hardware sketches. They build technically impressive stuff "because they can". Despite clear learning benefits, we feel these projects are missing core characteristics of *Sketching in Hardware*, namely the noncommittal, rapid and disposal aspects. Whatever comes out of these sketches has usually very little to do with the actual design project they are associated with. Impressive: sometimes; informative to the design project: often no. Figure 2 shows an example of an ‘over-prototyped’ project realized by two interaction students at the Umeå Institute of Design. The realization of the hardware sketch of a shopping cart represents a substantial amount of work. It never worked properly and was never presented to users or other participants. The remaining of their project was terribly well executed and coherent. In short, it didn’t help or support their design project significantly. We can see in it a perfect example of a prototype realized just for the sake of prototyping.

At the other end of the spectrum, designers and students with no programming or electronics knowledge have also their share of challenges. Although quite approachable, most tools or toolkits still require some understanding of programming, code and electronics. Without these skills, it is very difficult to evolve beyond ready-made examples and pre-caned configurations. Students often feel frustrated when they cannot get anything interactive working on their own. We understand their frustration but encourage them to try different routes or attack smaller and more manageable problems. What these students are generally very good at is finding alternatives and detours around problems, to eventually reach their intended goal (or a different one).

We see this ‘problem-solving with detours’ as a highly valuable skill in Sketching in Hardware because it is humanely impossible to know everything. Everyone has his/her limits. How one manages to keep moving forward despite these hurdles and constraints is in our opinion admirable. We could call this cleverness or pragmatic sketching.

In an ideal world, students and designers should have the perfect mix of technical skills and creative approaches to evolved complex but useful and informative hardware sketches. There are no magic recipes or prescriptive notions that dictate how one should go about building hardware sketches and using them in a particular project. It is a life-long (or career-long) learning experience.

Bringing back the Experience

Prioritizing design outcomes over technical know-how

The current prototyping toolkits use technology about 10 to 20 years old, if not more. Compared to what can be found in the latest electronic devices today, they are dinosaurs. From an engineering perspective they are almost laughable. Therefore, having something that works using those toolkits might be personally gratifying, but from a technical standpoint it is not exactly groundbreaking. The real value for designers and other collaborators in toolkits comes from leveraging their simplicity, mixing and remixing technology with creative processes, and most importantly aiming on the experiential outcomes and not so much on the process of ‘making it work’.

We have seen that in other disciplines like Industrial Design (ID), doodles or volumetric models fulfill different functions during the design process. The vocabulary in ID is not extremely sharp, but decades of activities have laid considerable foundations to describe processes and methodologies that are commonly agreed upon. The Interaction Design discipline is in its infancy. Our current shared vocabulary, mostly adopted from other disciplines, often falls short to properly describe the dynamic nature of our sketches and interactive prototypes. We usually try to minimize this gap the best we can by using a variety of mediums and interactive depictions (like hardware sketches). Without a clear vocabulary and understanding that intuitively connects intent and outcomes, designers can sometimes find themselves focusing on building something that works and not explicitly identifying why they are sketching for.

In our view it is important to consider that hardware sketches can also work as tangible and intellectual springboards towards other disciplines. They help the designer play in other disciplines' sandboxes, and learn how to better communicate their design ideas in different technical jargons. Finally, hardware sketches and experience prototypes are key components in establishing shared reference points with colleagues, users and other collaborators. They naturally invite others to relate and build on something (half) real, tangible and concrete.

Toolkits: technology building blocks for Interaction Designers

A toolkit has to be useful and helpful to its users: that is easier said than done. What is useful to reach these *sketching in hardware* objectives? The big answer is: it depends! As we highlighted above, each project is unique and the designer's skills and understanding of hardware sketches are constantly changing. Toolkits need to balance flexibility and simplicity. What is useful for a first-time user can be very different for an advanced user. An advanced user might enjoy very basic features if pressed by time or under certain condition/mindset. So it is never black or white. It's all grey!

In our quest towards a better education curriculum and a more enjoyable IxD practice, we decided to reflect on what would be, in our view, the ideal toolkit for interaction designers. We quickly came to the conclusion that it is futile to think that such unique magic-bullet toolkit exists. If we look back at history, we notice that a multiplicity of tools and toolkits will always prevail, some very highly specialized ones, others more multipurpose and aimed for general use.

Despite this failed intellectual attempt, we believe that current toolkits are not always well suited for Sketching in Hardware activities. In regards to the current status of the design practice, we think there is definitely room for improvement in many areas. Students and designers are often struggling on the same issues over and over again. We think new or improved tools and toolkits could be developed to better match today's needs in sketching in hardware activities. These beliefs come from our experience in teaching and using such tools ourselves, but they are also inline with similar discourses from numerous researchers and teachers in the field of Interaction Design (Buxton, 2007; Moussette 2007; Saffer, 2009)

We identified five high level characteristics or qualities that should be supported or at least considered when developing new toolkits for interaction designers. They are presented in no particular order of importance. We try to support each point with concrete propositions, examples or critique found in today's toolset.

Openness and level of visibility/accessibility

Just like Nature, complex and elaborate systems are made of simple underlying parts or processes. Accessing and peeking at how things work or are composed can be very beneficial to develop a good understanding.

The goal is not to expose and decompose all processes, but allow for different levels of visibility/accessibility. Complex processes can be encapsulated in simple representations/actions to ease introduction and support high-level perspective/work. The inner working processes should be accessible if one is interested to dig in. Some complexity can be exposed to invite or tease the user to explore more. The level of details cannot be infinite, but documentation should be as good as possible. Knowing that one can further explore references, sources, libraries and other internal details is very reassuring, even though very few are actually doing it. Open-source software and hardware like Processing and Arduino exist and are successful because of the all-embracing commitment to this openness principle.

On a more graphical level, applications like LabVIEW, VVVV, MaxMSP and Pure Data offer simplified graphical dataflow programming environments where encapsulation is obvious. Advanced and curious users can access the functional code behind each individual graphical node. Expert users can often build new functionalities into the tool if the underlying processes are exposed properly.

Each design problem can be said to be unique. Manufacturers and toolmakers cannot realistically envision every possible use or situation for their tools. With open tools, designers and users can fully embrace the system, and effectively help the producers to refine or enhance their offerings. Note that simplicity or reduction in complexity doesn't translate to simple or trivial work. Some level of abstraction is necessary for humans to cope with complex task or endeavors.

Hackability

By hackability, we mean that parts, modules, or the whole toolkit should be open for unintended and unplanned uses. While manufacturers cannot obviously support these activities, the design or functions should not thwart those who feel adventurous. For example, parts from one toolkit should be usable with other toolkits without major difficulties.

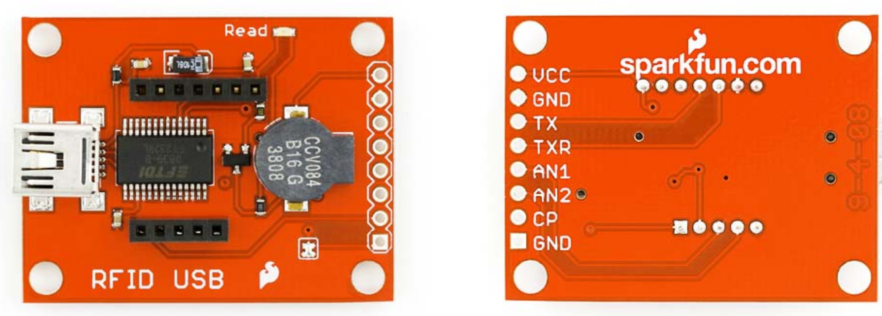

Figure 3 Sparkfun's RFID module, with numerous exposed connectors. Ready for repurposing or hacking (image credit: Sparkfun.com)

Sparfun's model (Fig 3) provides breakout pins for wiring extra parts or using the module with other than the default USB port. By exposing the already-available functions, one can repurpose it more easily. The module from Sparkfun uses a very ubiquitous technology (RS232 serial communication) to transmit its data. The design is intentionally simple. This simplicity has a cost. The module is quite dumb and only send data values. Once attached to a computer, it cannot announce its functionalities and share other secondary status or auto-configuration data.

Figure 4 Phidgets RFID module. Friendly but a closed platform, on the hardware side at least. (image credit: Phidgets.com)

The Phidgets module (Fig. 4) works with a special set of hardware and software combination and offers advanced software functionalities (notification when the RFID tag is removed). This tighter integration can be a double edge sword: it is simple and works very well as long as you work within the limits offered by the manufacturer. Outside this area, it is very difficult if not impossible to reuse the module and combine it in your own ways. For example, it is impossible to use with a dedicated microcontroller due to the USB connectivity. By design, it has to be plug into a computer to work, despite the low computation power required to send and receive RFID tag values.

Added value when time is limited

The ability to get going quickly and get results fast, within minutes if often crucial in the design practice. In educational settings the time constraints are not so present and crucial. Nevertheless, the focus or the work should be elaborating on variations of the experiences, not on debugging technical issues.

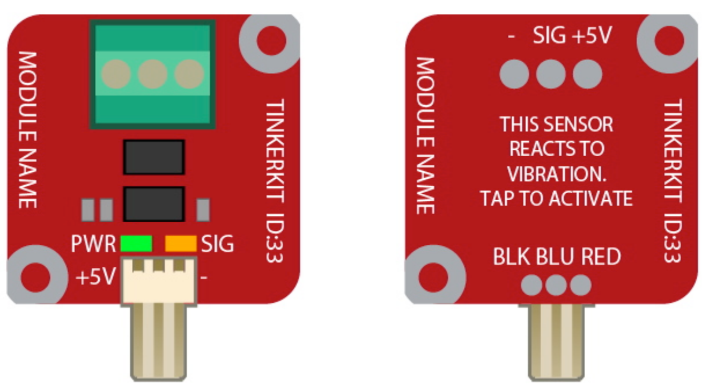

Figure 5 A proposal for new TinkerKit modules, with emphasis on labels and at glance information.

Labels, diagrams, numbering and details on the device are crucial for novice users, or users under stress or pressure. These details usually incur no additional hardware costs, but they do require extra care and attention by the people who develop the tools. What can be evident to an electronic engineer (designer/builder of such modules) might not be obvious to an interaction designer. Having to download and look up a PDF document just to find how much voltage is needed to power a device is frustrating and not efficient.

At IDEO and presumably in many other design consultancies, the most challenging sketching/prototyping issues lay beyond the technical skills of its designers. The difficulties reside in how to balance *build-to-learn* – from the medium or experimentation – and *build-to-gather* rich user feedback within a constrained timeframe. Projects last on average 12 to 16 weeks. The team needs to define the problem, come up with innovative concepts and provide deliverables that have the potential to outlive inside the clients' organizations and ultimately impact their product portfolio and business.

Spending anything more than a few days building something is a luxury and need to be well justified even within a company with a strong culture of prototyping like IDEO (Buchenau & Suri, 2000). Prioritization is key and there isn't much time available for experimentation. Low-fidelity prototypes are still useful to gather initial feedback but once we move towards designing the user experience, the fidelity needs to be tuned up immediately for two reasons. First, because the user experience usually means 'behaviors, transitions or gestures' that might have never been done before; second, because users are increasingly technology and user-experience savvy. Obtaining a 'suspension of disbelief' when presenting pen and paper concepts for electronics devices is becoming harder and harder.

From our experience in practice, only a few (2-3) serious prototypes/hardware sketches are realized for a particular project. Their aim is to have the most impact in the overall design, or present extreme concepts that occupy opposite places on a scale (e.g. knobs and levers vs touch screen and voice commands) and that can be used to align the designers' intents with real user expectations.

No matter how diverse the project challenge is, three points or needs consistently show up when developing hardware sketches under stringent time constraints. For us, the ideal tools or toolkits would:

- allow the designers to experiment different versions of the 'experience',
- build something convincing to be presented in user feedback sessions and
- allow for improvements and modifications at a later point in time.

Versatility or 5 ways of doing the same thing

Design is all about exploring options and possibilities. The toolkits shouldn't force the users into a monolithic approach and impose an unique way to solve a particular problem.

We find value in approaching a problem from many angles and perspectives. Building or sketching interaction can take so many forms. The continuum from a highly specialized tool to a totally generic device is vast.

If we take the case of Phidgets, designers have a large choice of programming languages and platforms to develop and build their ideas. An expert user can use C++ to configure and interact with the devices, while a novice designer might use Actionscript or Java instead. The manufacturer of the system supports both equally.

On the hardware side, electronics modules can "speak" many protocols and adapt to various host systems. For example, a particular distance sensor can work in analog mode for simplicity and out-of-the-box use without reading much documentation. The same sensor can also be connected using a serial protocol in order to reconfigure it or send more complex commands/queries. This versatility comes with some drawbacks (the device in inherently more complex), but does offer flexibility and some form adaptability.

Generally, exploring options and possibilities will involve more than one system or toolkit. Mixing and matching different components in new and creative ways help designers the space of possibilities. We appreciate tools and systems where designers can come in and apply knowledge they already acquired previously. Each tool has its limitation and requirements, but often a knowledgeable user will be able to quickly get up to speed if the tool follows best practices and general conventions. Having to learn new ways of working can be frustrating and time consuming.

Human friendly

Technology should speaks for itself, ‘transpires’ its status or ways of working. Power lights, communication status, functions broadcast, non-symmetrical connections are small details that make the life of designers so much more enjoyable (or less painful).

One recent example that our students have been struggling with is the new ActionScript 3.0 language from Adobe. When writing code in the Flash application, one has to include and specify various libraries to add functionalities to the interactive application. The application requires you to “include” and type the exact name of the libraries you want and need to use. For an experienced programmer, this might be standard or obvious procedure, but for a designer this is quite tricky. How one should know which libraries to include and what is the exact name for it, even if it was never encountered before? No default choice, pre-made lists or options are offered to the user. You have to look deep down in the documentation to find that information, and manually type the information in your document. It is not very straightforward and satisfying indeed. You inevitably learn the most common ones quickly.

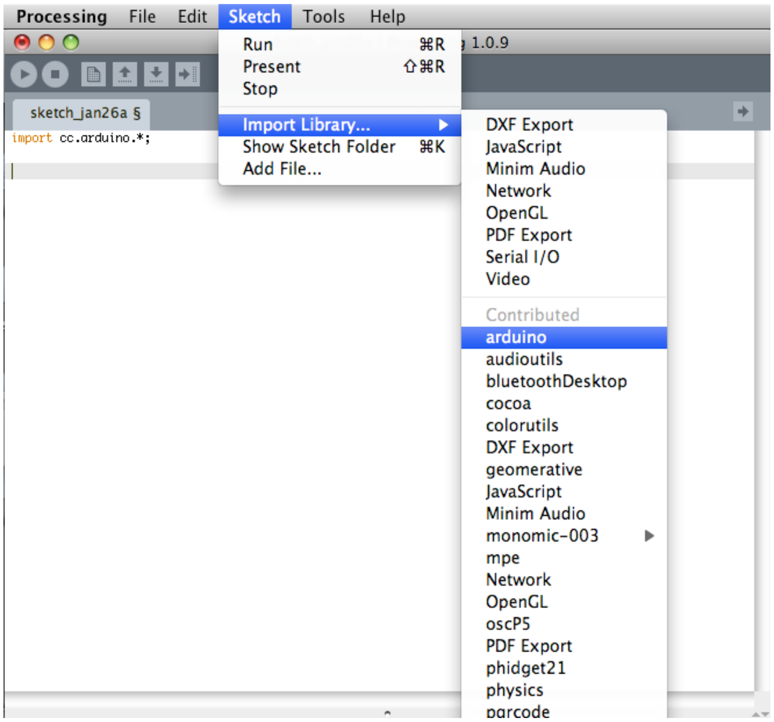

Figure 6 Processing application and the available libraries selection.

If we compare this experience to developing software sketches in the Processing application, the task is almost the same, but the application in this case provides various cues and selections to choose from. First the application has default libraries covering the core functionalities, so you do not have to write anything for the standard libraries. Second, if you need to use a specialized library or set of functions, a menu entry lists all the installed and available additional libraries. In one or two clicks, one can choose, include and readily use new functionalities in your sketch (Fig 6). We find this procedure definitely more humane, at least for novice and casual programmers like us.

On the hardware side, we strongly encourage the widespread use of status lights to communicate power status and activity right at the hardware layer. It is much easier to track down problems with blinking LED (or absence of it) instead of writing custom debugging code in software. A quick glance at a power status light will let you know if the device is properly powered. Physical affordance can definitely help too. Non-symmetrical connectors enforce the right polarity when connecting devices and cables. They often incur no or ridiculously low additional costs (fraction of a cent) in parts. Small details like this make huge difference in the long run. All humans make errors, even the highly trained ones.

Discussion

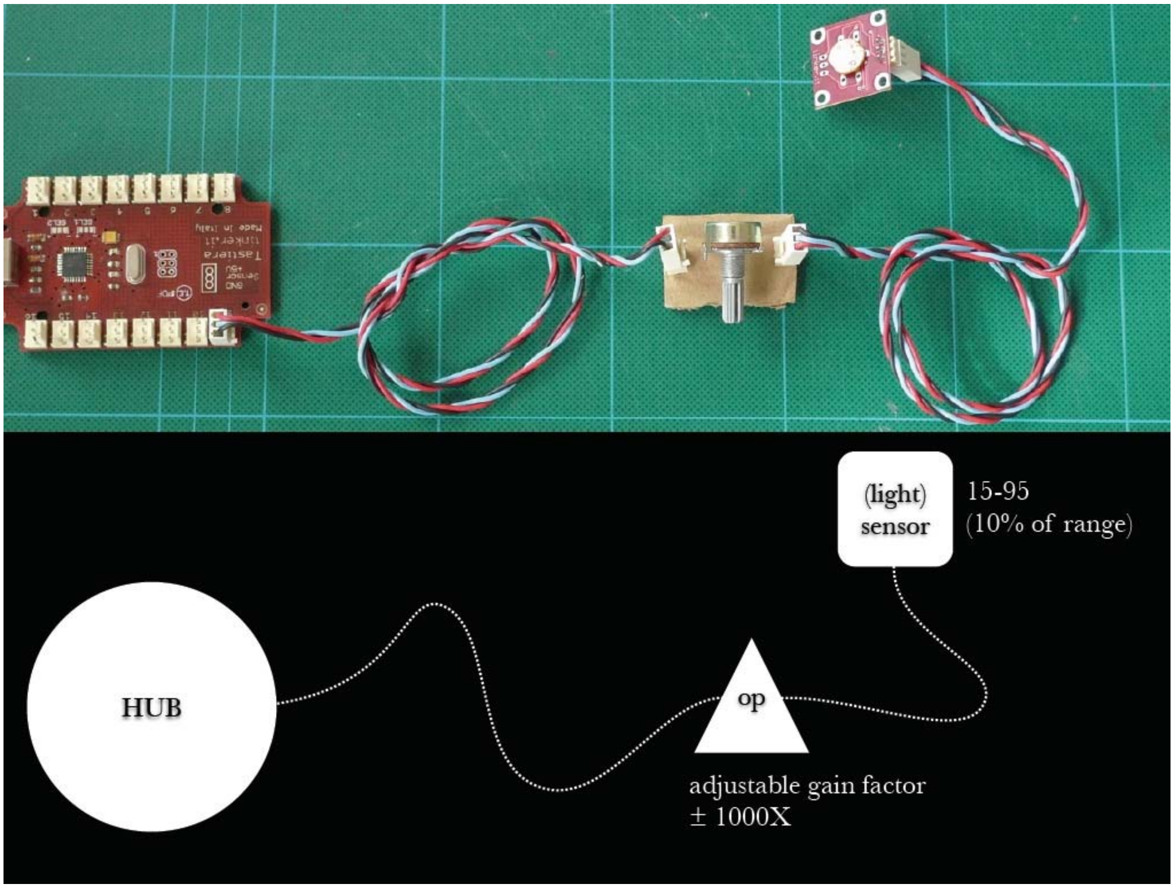

Figure 7 A non-working depiction of inline operator module.

Our work is currently ongoing but we are actively developing instances of tools where these values or qualities are put forward. We are building on previous tools and toolkits, leveraging previous successes and de facto best practices and standards. Figure 7 shows an early sketch of inline operators that provide a tangible control over sensors and various modules. The operator allows one to explore and adapt to a much wider spectrum of values, without changing code or sensor module. It supports expanded design explorations in a simple tangible way.

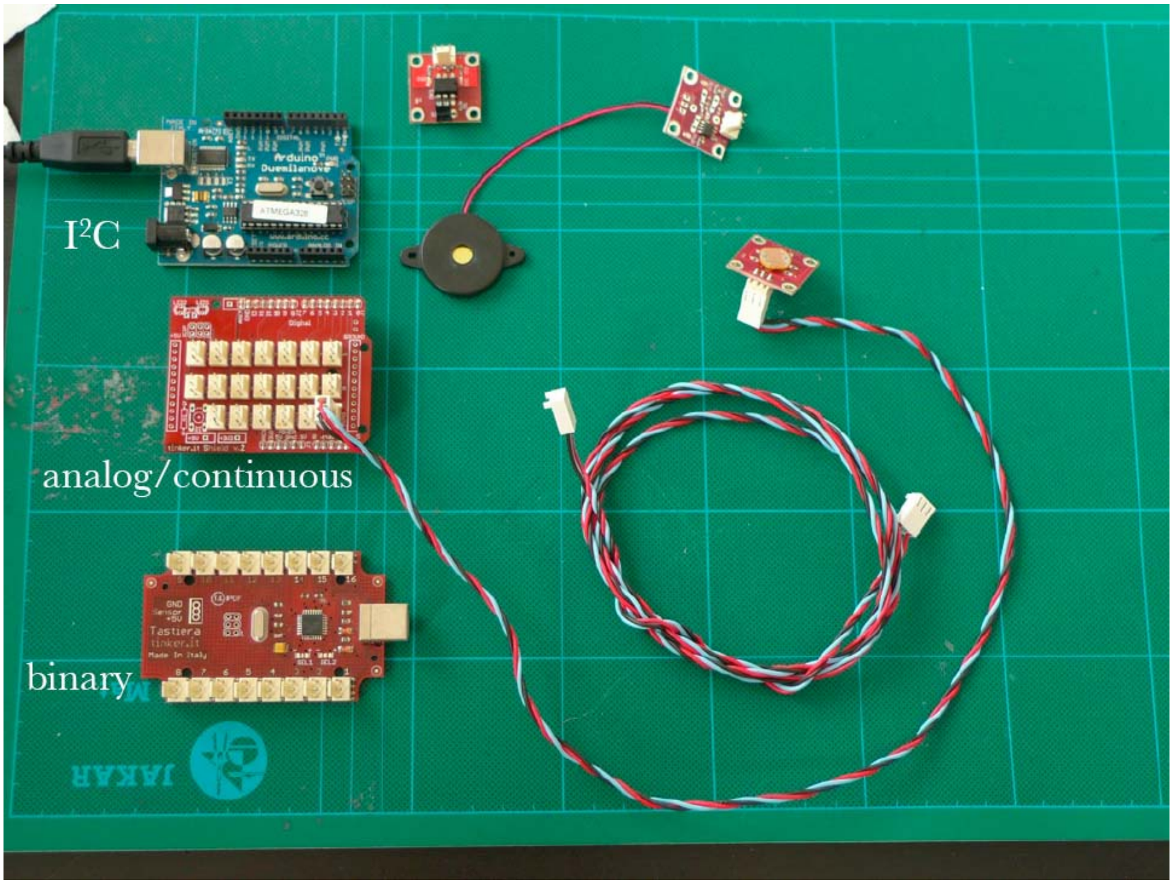

Figure 8 Smart sensors/modules can be used with different host systems

The availability of faster and more powerful microcontrollers means we can build “smart” toolkits and sensors more easily. When connected, modules broadcast their functionalities and requirements, and then establish the most desirable protocol of connection or communication. Simple analog parts can be mixed and combined with fancier or more complex ones. Older parts and items can be used without worrying about compatibility and interoperability. Designers can focus more on the outcomes of their sketching, and less on the technical side of things. Figure 8 shows how a particular smart light sensor would work depending on the capability of the host system. It would transmit configuration and status data only if the host module can receive and understand it. Otherwise, the smart light sensor would revert to a simpler analog mode, or even to a binary mode (on/off) if necessary.

This is work in very early stages. We hope to refine our ideas and sketches further, and evaluate them with design students and practicing professionals in design consultancies.

Conclusion

With this paper, our main objective was to present the *Sketching in Hardware* perspective in the field of Interaction Design, and explain our view and experience around those somehow new ways of building or sketching ideas. We observed and noted numerous challenges, but also very rich and stimulating design activities. Despite our criticisms, we strongly believe in this new perspective and its potential for establishing a strong understanding of interaction concepts, solidifying prototyping knowledge and taking sketching activities to a new level. Designers have to know their limits and when it is advisable to ask other professionals. *Sketching in Hardware* is not just playing with electronics; it has serious implications and repercussions.

Ultimately there is an open discussion that pervades the professional practice of (interaction) design about whether designers should focus on being excellent craftsmen of human-to-human and human-to-device interactions, or should designers excel as good design generalists ready to take on challenges a few levels up in abstraction (the big picture). It is our belief that one cannot live without the other. Some designers will go deep into the technical side and into the art of crafting intricate interactions, while others will focus on high-level themes and global agendas. We hope those sketchers and visionary designers can together build a better and more enjoyable world.

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Designing for Cultural Diversity: Participatory Design, Immigrant Women and Shared Creativity

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Abstract

Immigration and multiculturalism are realities of the globalized world that has given rise to subcultures, which possess specialized knowledge and language that is not shared by the main culture. This increasing interaction among people from diverse cultures has produced a complex ethno-cultural mosaic that presents formidable challenges for visual communication designers' as well to other designers. Complexity has always been part of human environments that comprises of mutually dependent social relations. Cultural diversity of designers and audience of messages in a design scenario brings complexity in the design research process.

This research study explores an effective visual communication language, through the medium of the poster, for culturally diverse audience of immigrant women in Edmonton, Canada. The decision, to investigate the effectiveness of a visual message through the medium of the poster was informed by triangulated results from a pre-workshop survey, interviews with the staff and discussions with the immigrant women who are either interested or in need of services of the centre, *Changing Together*. While designing messages for a culturally diverse audience, participatory design exploration approach assisted in developing a framework for research methodology. A participatory design workshop was planned, for the Centre for Immigrant Women in Edmonton, to investigate possible visual vocabulary for an ethnically diverse group. The workshop results were synthesized in the form of three poster prototypes, which represented the needs and realities of those immigrant women. Prototype poster designs were tested to examine the results of the mutually identified visual concepts. Based on the observations and synthesis of research findings, it is concluded that user-centered participatory approaches of design can work effectively for developing a visual vocabulary for an audience of culturally diverse women.

The research direction of this project is based on the concept of shared creativity of ethnically diverse immigrant women, through collaborative design exploration workshops. The concept of shared creativity is also harmonious with the spirit of multicultural pluralism, which forms the basis of the Canadian culture. This role of a designer to identify problem-oriented activity, and to develop participatory strategies to address those real issues provided a chance to contribute to the social process concerning cultural diversity in a constructive and sustainable manner.

Key Words

Participatory design approaches, Collaboration, Design process, Rhetoric, Interdisciplinary, Design and society, Human / user-centered design, Learning, Social and cultural studies,

Cultural Diversity

The United Nations World Commission on Culture and Development Report titled 'Our Creative Diversity' defines "culture" as the whole complex of distinctive spiritual, material, intellectual and emotional features that characterize a society or a group. It includes creative expressions, community practices and material or built forms

Multicultural ethnic diversity in first world cities has created subcultures. Micro-communities fed by these sub-cultures possess specialized knowledge and language that is not shared by the main culture. World development organizations around the globe are developing culturally sensitive approaches to strengthen community projects' planning and programming effectiveness and create conditions for ownership and sustainability. United Nation Population Fund's (UNFPA) 'Cultural Lens' is an example of one such promoted approach, which recognizes the importance of the socio-cultural capital of various micro-communities and emphasizes community participation and people centered approaches in community project design and development. This approach recognizes that acknowledging, appreciating and working with the social capital in these communities can create conditions of ownership and sustainability, which can lead to strength the main culture.

Immigration and Immigrant Women in Edmonton, Alberta, Canada

> People of different religions and cultures live side by side in almost every part of the world, and most of us have overlapping identities, which unite us with very different groups.
>
> — *Kofi Annan, Former Secretary-General of the United Nations*

According to the Oxford Dictionary, Encarta and Wikipedia, immigration in general, refers to the movement of people among countries, or it is the act of entering a country with the intention of remaining there permanently.

The Report of Auditor General of Canada (Fall 2009), states that immigration plays an important role in the economic, social and cultural development of Canada. Statistics Canada indicates that immigration accounted for two thirds of Canada population in 2006. Alberta reports the highest percentage of immigrants/visible minorities of the three Prairie Provinces.

The 2006 Census enumerated 527,030 immigrants in Alberta representing 16.3% of the total population. Between 2001 and 2006, Alberta's immigrant population increased by 20.2%. This was more than two times higher than the non-immigrant population, which grew by 8.7% during the same period.

There were slightly more females than males in the immigrant population of Alberta. In 2006, out of 100 immigrants residing in the province, 52 were women. About 31,930 immigrants in Alberta were children under age 15. This represented 6.1% of the immigrant population.

As of 2006, 143,335 immigrants call Edmonton home and 52% of these immigrants are women. In late 1990's Statistics Canada reported that nearly 20% of women living in Canada were newcomers to the country and on average these immigrant women were more highly educated as compared to their Canadian counterparts but they usually survive on low income. This is due to various reasons, the discussion of which is beyond the scope of this paper, but it clearly suggest there are barriers that prevent the successful participation of immigrant women in the mainstream culture.

It has repeatedly been declared in a variety of Government of Canada's Statistical reports that diversity is one of the defining characteristics of Canadian society. Over the last two centuries, the linguistic, cultural and religious make-up of the country has significantly changed in the wake of various waves of immigrants, first, mostly from Europe; and more recently from a wider range of societies including many non-European countries.

The diversity that marks Canadian society has had a positive effect on the country as new skills and ways of looking at the world have been adapted from succeeding waves of newcomers. The diverse nature of the country, however, can also introduce tensions into the social fabric as different groups struggle to adjust to their new social milieu while at the same time trying to maintain their cultural identity in a rapidly changing environment.

In 2006 UNFPA-IOM (United Nations Fund for Population and International Organization of Migration) jointly organized an expert group meeting to formulate a set of recommendations for action by governments, international organizations and civil society, as a contribution to the high-level dialogue on international migration and development to mainstream female migrants' needs and rights into the agenda. All participants agreed that women's migration or immigration had received too little attention rather it stated:

> Insufficient attention to female migration in its different aspects violates the human rights of the people concerned, holds back development and reduces the possibilities for achieving the Millennium Development Goals.
> — UNFPA-IOM (2006)

Visual Communication Design for Social Change

Victor Papaneck (1974) in the opening remarks of his book *Design for the real world* states that design is basic to all human activity. Niesuma (2004) argues for alternative design scholarship, which offers designers an opportunity to think about how their work might be directed at social change and well being of marginalized social groups. Sifting through the discourse about design, Fuad-Luke (2009) admittedly says design plays a comprehensive role in suggesting or setting new values and inculcating a societal change. Communication design research is defined by it's interdisciplinary complexity as the problem content always comes from another disciplines as emphasized by Strickler & Neafsey (2002), Frascara (2002) and Fuad-Luke (2009). Poggenpohl (2002) goes further by saying that 'Design envisions the future' by taking a felt need or problem or for what is often an abstract idea and making it tangible so that the various stake holders in the idea can imagine together, socially, creatively and interactively to give the abstract some shape.

Frascara (2002) argues that social relations are complex and the introduction of people in a design equation introduces further complexity. According to Patton & Woodhouse (2004) the inherent nature of design as a human activity is that it is generally, deeply socially oriented. It encourages human participation at various stages of design process from contextualization of problem, ideation, and conceptualization, making, use and reuse. Participation in design, as mentioned by Stairs (2005) meets the human ideal of mutual support or altruism. Which is agreement with Buchanan (2001) when he says that the implications of the idea that design is grounded in human dignity and human rights are enormous and they deserve careful exploration.

Centered on the Users

As in today's globalised world there is a highlighted trend toward specialized audiences, McCoy(1995) pointed earlier, that focused messages and eccentric design languages tailored to each audiences unique characteristics and culture, need to develop. Buchanan (2001) adds that the quality of communications, artifacts and interactions and environments within which all of these occur is the vivid expression of the cultural values.

While addressing cultural plurality and related issues by the development of visual vocabulary for a diverse cultural audience for communication of a social message has diminished the focus on homogenized audiences that used to be the focus of the designers in the recent past. Elizabeth Sanders (2001) very rightly predicted about the evolution and emergence of new design spaces in response to user's needs for everyday creativity, which requires the designer to understand the experience domains of people. Sanders predicted that in future as designers involve the everyday user in the design process, tools, rules and methods for research and design would begin to blur. This will result in research becoming more creative; and design becoming more rigorous and complex.

> Participatory design is a high-level feature of design methods that can be implemented in a myriad of ways. It is not a single and integral design method. I consider the following dimensions: domains of human activity, roles of stakeholders in a design; types of shared design representations, the scope and duration of participatory interactions and the relationship of users to the design activity with respect to changes in heir knowledge and skill. I believe these dimensions have important implications for some of the fundamental issues that have been raised regarding the effectiveness of participatory design methods. (Carroll 2006, p 3)

Effective communication can contribute in strengthening the communicational power of the messages being developed for the female immigrants globally and specifically in Edmonton for the proposed research project. According to Bonnie Sadler Takach (2003), effective communication results from meaningful interpretation of well-designed artifacts and that context, purpose, and individual experiences affect that interpretation. She maintains that to produce effective results, we must work continually with members of the public to assess and calibrate our actions. And as established by Fuad-Luke (2009, p 347) one of the fundamental premise of co-design is that it offers an opportunity for multi-stakeholders and actors to collectively define the context and problem and in doing so improve the chances of a design outcome being effective.

Designing Posters for Immigrant Women

A publication by Statistics Canada about 'Women in Canada: A Gender Based Statistical Report published in March 2009, states that these immigrant women may also have to overcome many of the gender-related inequalities, which women in Canada have traditionally experienced. In this scenario, it is very likely that foreign-born women face a particularly more complex set of hurdles in their attempt to adapt to Canadian society. On the one hand, they have to cope with all the problems associated with adjusting to, what for many, may be a completely new lifestyle. Language has been identified as one of the main barriers for many immigrant women, by various surveys conducted by the Alberta Government and Non-Governmental Organizations that are offering services to immigrant women. Lack of ability to speak any of the two official languages i.e. English or French; compounds the social navigational problems of these women.

A year ago while volunteering for Community Service Learning at University of Alberta, I was introduced to “Changing Together – A Centre for Immigrant Women”, which is the only organization in Edmonton that focuses exclusively on the needs of immigrant women of all ethnic backgrounds. The Centre has grown significantly in the last 23 years and is ready to expand its outreach by employing culturally appropriate mediums and messages to serve the community of immigrant women in Edmonton.
The decision, to investigate the cultural sensitivity of a visual message through the medium of the poster, was informed by a short survey form filled by the staff and some of the immigrant women clients of the centre. Thus starting the cooperative design or participatory design journey of user inclusion within the development team, as J.M Carroll discussed in his paper *Dimensions of Participation in Simons Design.*

> In an age of transmission and computerized technology, it is surprising that the poster continues to flourish as a significant form and primary means of communication (Timmers, 2003).

Timmers articulates that an effective poster is a dynamic force of change, in the social context. She continues by stressing that the means by which a poster’s messages are conveyed are crucial to its effectiveness, as they are intended for varied segments of the society. The accessibility and adaptability of the poster communication through its graphic vocabulary makes it a popular medium for social messages. She makes a strong argument for the poster, as a communication medium, which can by changing its tone and vocabulary, reflect shifting cultural values and codes of behavior.

Interviews with the professionals of the Centre for Immigrant women also supported the idea that the initial communicational material of the facility should be supplemented with a poster to get a better outreach response from the culturally diverse audience of immigrant women. From the initial seminal research a number of questions emerged, for example; is there a real need for clear visual communication message for this culturally diverse audience? Why does this need exist and who identifies this need? How can the issue of uniformity within diversity be addressed in the design of these visual communication messages for the medium of a poster? Some of these questions helped in refining the following final research question of this exploratory research project, which sets the direction for future design explorations for this important community of immigrants in Edmonton, Canada.

How to Explore an Effective Visual Communication Vocabulary for a Culturally Diverse Audience of Immigrant Women?

Due to an earlier volunteer interaction with a few social organizations, nationally and internationally, there was personal awareness of certain visual communicational challenges that need to be addressed while designing messages for culturally diverse audiences. I agree with McCoy when she says that while dealing with this kind of an audience, the entire equation of sender-message-receiver needs to be reconsidered. Frascara further stresses it by highlighting the importance of the inclusion of receiver component in the design equation. In his following statement, while addressing the designers particularly those who are working in the social domain, he drew attention to an important aspect of listening to those for whom we design.

> One of the valuable resources of creativity and skill is our ability to listen and learn from those for whom we design. (Frascara, 2000)

Krippendorff (2006) further elaborates that for designers, listening may take several routes from engaging in ethnographic research to inviting those interested to participate in a development team. He professes that participatory design starts with overcoming the voiceless user.

Susann Vihma in her essay about design semiotics compares design, which is a sort of symbolic system, with verbal narrative and storytelling. She explores the reason for associating [visual] forms with speech and verbal communication. She suggests that form in material and visual presence always expresses something to somebody. As Krippendorff mentions three concepts that are central to the semantic turn; the concept of human beings in human-centered design, the concept of knowledge and the concept of culture that nourishes design. The project research premise here is that:

- there is a need for a culturally effective and appropriate visual vocabulary for immigrant women of ethnically diverse backgrounds
- and that immigrant women themselves (for whom the poster is being designed) can contribute positively in developing an effective visual vocabulary

Research Methodology

The aim of this participatory and collaborative design research project was to explore an effective visual vocabulary for posters, being designed for an ethnically diverse audience of immigrant women in Edmonton, Canada. This research study was planned in collaboration with a community service provider, a Centre for Immigrant Women. An attempt was made to understand the wisdom embedded in respective cultural discourses, which could inform the overall learning outcomes of the project.

The project follows the basic design research process model, which involves the steps of problem identification, investigation, analysis, planning, synthesis and evaluation. However the research study employs different methods of design research techniques including observational research, a short visual analysis and a participatory design research workshop.

The research methodology combines visual ethnographic methods, observation techniques, and participatory design workshop approach into visual symbol development for the poster, which supports and utilizes the diverse cultural context of the users. (Fig.1)

The research in this situation is not market research or an audience study but rather practitioner-based participatory design research in which the engagement actually enables insights that contribute to the ongoing development of visual communication elements and the practice of collaborative design techniques. The initial focus is not the provision of data or information. Rather it is an attempt to work with the stakeholders to create an opportunity for a longitudinal study not only of the practice and reflection on the practice, but in order to build iterative cycles in information and communication design processes that, over time, will support the accounts of phenomena in the field and also provide a deeper understanding of the complexities of communication design for multicultural communities, in this case the one in Edmonton, Canada.

Project Participants

Immigrant Women

Immigrant women, who come from all over the world and represent diversity in cultural and linguistic backgrounds and form more than 50% of the immigrant population in Canada. Immigrant women from the centre 'Changing Together' were identified as a group for the participatory design workshop. Women in this study were females from 25 to 65 years of age. The focus on this group was not intended to generalize this wide age group, but rather to allow for opportunities to work with authentic groups that may include individuals between those ages faced with the challenges of immigration and language barriers.

Criteria for selecting the group

After discussing with the 'Changing Together' professionals, it was suggested that selecting a mix of new and experienced immigrant women from different groups of classes being offered at the centre might lead to more authentic outcomes. Collaboration with these identified student and teacher groups from ESL (English as Second Language) Basic Computer Literacy and Seniors Social class were sought.

Informed consent

Consent forms were administered to each participant. For those who not very comfortable with English language, the forms were translated to their own spoken language where necessary, with help of a fellow colleague translator.

Defining

Formative stage of my exploratory research defines my research and the design problem. The significance of research problem was established, based on the information gathered from the brainstorming, reframing, visual analysis, and observational research. The basic challenge was to handle the multicultural aspect of the visual communication vocabulary for the ethnically diverse target audience with varied literacy levels. Approaches based on different cognitive devices were employed to develop an understanding of the social design problem to define the design exploration**.**

Diverging

Divergent research approaches were applied to help develop an understanding of the problem, basic quantitative and qualitative data about the immigrant women was gathered and then strategy was devised to explore a commonly understandable vocabulary of images and symbols. Different methods for inquiring into the stakeholders' concepts and motivations were employed, these included unstructured interviews, observational methods like photographing different activities at the centre, visual ethnography by converting photographic data into digital stories and stakeholder participation in the design process through participatory design exploration workshop. As Krippendorff (2006) articulates that human-centered design methods, therefore weave available knowledge of how meanings arise within relevant stakeholder communities into the design process in order to assure that a design encourages the meanings that lead to reliable interfaces.

During this participartory design process, the focus was on generating words and images which were understood across various cultures, for the poster. It helped the image bank development and the ideation for the final inerpretation of the poster. It also helped in creating an emotional resonance in the prototype designs, which were later taken back to the group for testing and evaluation.

Visual symbols and Images were explored and developed through the technique of adjective attribution to concepts of *immigration* and *Changing Together* during the participatory design exploration workshop. All the adjectives and synonyms contributed by participants, who came from varied cultural backgrounds, were written on flip charts for recall during the later visual concept sketching exercise. The group was also encouraged to explore the agreed upon adjectives in the form of *an act*, for example how can we all together show *Changing Together*. And the group of participants responded by first holding hands and then they tied their colorful scarves to make a circle of different colors while holding them together (Fig 2). An image bank emerged from which symbols and images could be applied in the prototype posters. (Fig 3)

The above discussed, diverse steps helped to clarify, root and expand the range of options for designer's imagination but these were guided by how the stakeholders conceptualize the effective visuals for the poster. The next stage was about what designers traditionally do to synthesize apparently disparate elements into a new unity. So accordingly based on the identified visuals from the participatory workshop, three poster prototypes were designed. (Fig 4 a, b and c)

Earlier, a visual survey of the public spaces, which are frequently shared by the identified audience, was also conducted and shared with the group. This helped in identifying and agreeing on the channels of distribution for the poster. According to Timmers research (2003) one important factor in understanding the continued power and appeal of the poster is the accessibility of its physical deployment.

Transforming

Once a substantial amount of information, from the above-discussed modes of research, was collected it was synthesized into rough prototype designs for three posters. A testing session with the same audience of stakeholders was conducted where the poster designs for their visual vocabulary were tested in the form of a written evaluation of individual poster symbols and their comparative visual analysis was also made (Fig 5). This step in the research brought the stakeholders back into the process to test the extent to which the design and visual vocabulary was effective. While the posters were being tested, participants were encouraged to think aloud and their responses and observations were noted down for further analysis. As noted by Krippendorff (2006) data obtained through the method of Protocol analysis (Newell and Simon 1972) provides the design analyst with records of correlation between verbal accounts of what users see and think about their interactions. Which leads to adding valuable specificity to the otherwise 'meaning-dry' observational record on the one hand and abstract verbal accounts obtained during interview on the other

These initial findings will be used for the design of further poster iterations and to achieve a set of culturally agreed upon visual images, which have effective messages for a diverse audience, through the resultant poster design.

Triangulation of methods like protocol analysis with visual ethnography and observational methods offered an opportunity to overcome uncertainties afforded by the use of a single method. Based on the observation of research findings it is concluded that user-centered approaches to design can work effectively for developing a visual vocabulary for a culturally diverse audience.

Observations about prototype poster designs

Prototype posters served as carriers, and realizing these shared experiences facilitated communication in the evaluation and testing phase. Stappers (2007) in his essay on *Doing Design as a part of Research* maintains that Prototypes speak the language of experience, which unites us in this world. The method of knowledge generation through the design of working prototypes based on participatory design exploration session, helped in gaining fundamental understanding of a multicultural group. (Fig 4 a, Fig 4 b, Fig 4 c)

All together, the exploration in the formative and summative stages was successful and confirmed some of the assumptions that were made at the beginning. Most of the testing session participants responded positively toward the proposed prototypes and contributed in generating a succulent discussion on the merits and demerits of the chosen visuals. Interesting patterns were observed in the choice of prototype design.

- Mostly participants who were the staff members (of diverse cultures) had a preference for the Poster C and agreed that a knot of different colors is a symbol which accurately represents the concept of engage, encourage, empower which in turn symbolizes immigrant women's lives.
- Staff participants also identified with a circle of hope in the Poster B, but the black color was strongly disagreed upon by most of the participants.
- Images of Poster A, were found highly representative of the concept and almost 90% of those who represented the audience /users found this option the most convincing.
- Regarding the Centre's identity, mostly commented that the overall Poster Design was the centre's identity, and they don't see the logo a separate element.

Discussion of the Findings

Based on the observations and synthesis of research findings, it was concluded that user-centered participatory approaches of design could work effectively for developing a visual vocabulary for an audience of culturally diverse women. The user participation in the generative research stage definitely provided invaluable information in understanding the users perceptions, dreams and needs. This helped in creating a basic image bank, which was mutually agreed upon and was well accepted by a large representation of various cultures.

Some contradictions surfaced to the earlier assumptions from before this research exploration activity. The main assumption that displaced women would have a preference for nostalgic images and colors were proven completely wrong.

The majority of people in a group had preference for a certain visual, thus creating patterns of behavior. As in the case of Poster A, most of the participants who were ESL (English as Second Language) or basic computer literacy students, could relate to the symbol of butterflies and threads more than any other visual. Clearly the visual preference had two highlighted poles. i.e. Poster A and C. However a complete consensus in cultural sensitivity towards colors and symbols was found.

Concluding Reflections

The nature of this study was exploratory from the beginning. It also demonstrated the effectiveness of using generative, participatory methods in design research that helped in creating a sense of ownership and responsibility in the end users by making them stakeholders and design participants. Additionally it gave the design researcher, the opportunity to initiate a capacity- building process in a social services scenario, which can offer sustainable solutions for collaboration in the design-for-social-change process. The project outcomes reinforced Manzini's (2004) concept of "designing to enable people" rather than "designing to solve problems."

The method of knowledge generation while developing community collaborations, through the design of working prototypes based on participatory user-centered exploration session, assisted in gaining a fundamental understanding of the audiences' responses and needs.

This study also established that communication design could play an essential role in motivating and facilitating the social development and integration process of immigrant women in Edmonton, Canada. The research direction in this project until now has been based on the idea of shared creativity. This implies a deep transformation in the user's role as well as the designer's role of taking social responsibility. UNFAP-IOM jointly acknowledged, that Women's immigration has received very little attention, which apart from having other social consequences also holds back development. So the process of design where a subject facing a problem is not only 'the part of the problem' but 'also a part of the solution' contributes in building confidence of the participant stakeholder. One positive occurrence that was witnessed was significant increase in vocal skills and confidence level of the stakeholders. Many women from *participatory design workshop* and the *testing session* shared that they felt more important and respected when they were asked for an opinion or independently entrusted with a 'responsible' task such as that of visualizing a poster the centre.

The participatory design research methods can be seen as concrete steps towards the participation of these immigrant women in the local social development process while simplifying the cultural complexes.

A more immersive and reflexive role for the designer was explored – that of participating in a social process to facilitate in the emergence of effective communicable visual ideas for a local multicultural micro-community of immigrant women in Edmonton, Canada. This concurs with Poggenpohl (2002) when she says that it leads to the development of knowledge gained through pragmatic observation that is actionable. The role of a communication designer to identify problem-oriented activity, and to develop participatory strategies to address the real issues will provide a chance for them to contribute to the social process concerning cultural diversity in a constructive and sustainable manner.

The research project also helped in developing insight firstly, about of the role of multicultural user participation in the design process, in addition to identifying visual representations that communicate to a culturally diverse audience. And secondly it demonstrated that embracing diversity of human experiences facilitates in the emergence of focused visual messages for multicultural immigrant community. The project promoted awareness of contemporary social issues of immigrant women from the perspective of a design research student, in today's global village scenario, where we are striving to understand the wisdom embedded in respective cultural discourses. Future investigations can lead to design communication projects, which can improve various services for these social groups of culturally diverse communities of immigrants in Edmonton. It has to be seen whether such graphic communication design projects can change patterns of behaviors, acquire knowledge and empower these diverse communities while fostering their creative expressions, in the long run. If yes, then can the above discussed project methodology serve as a model in that scenario?

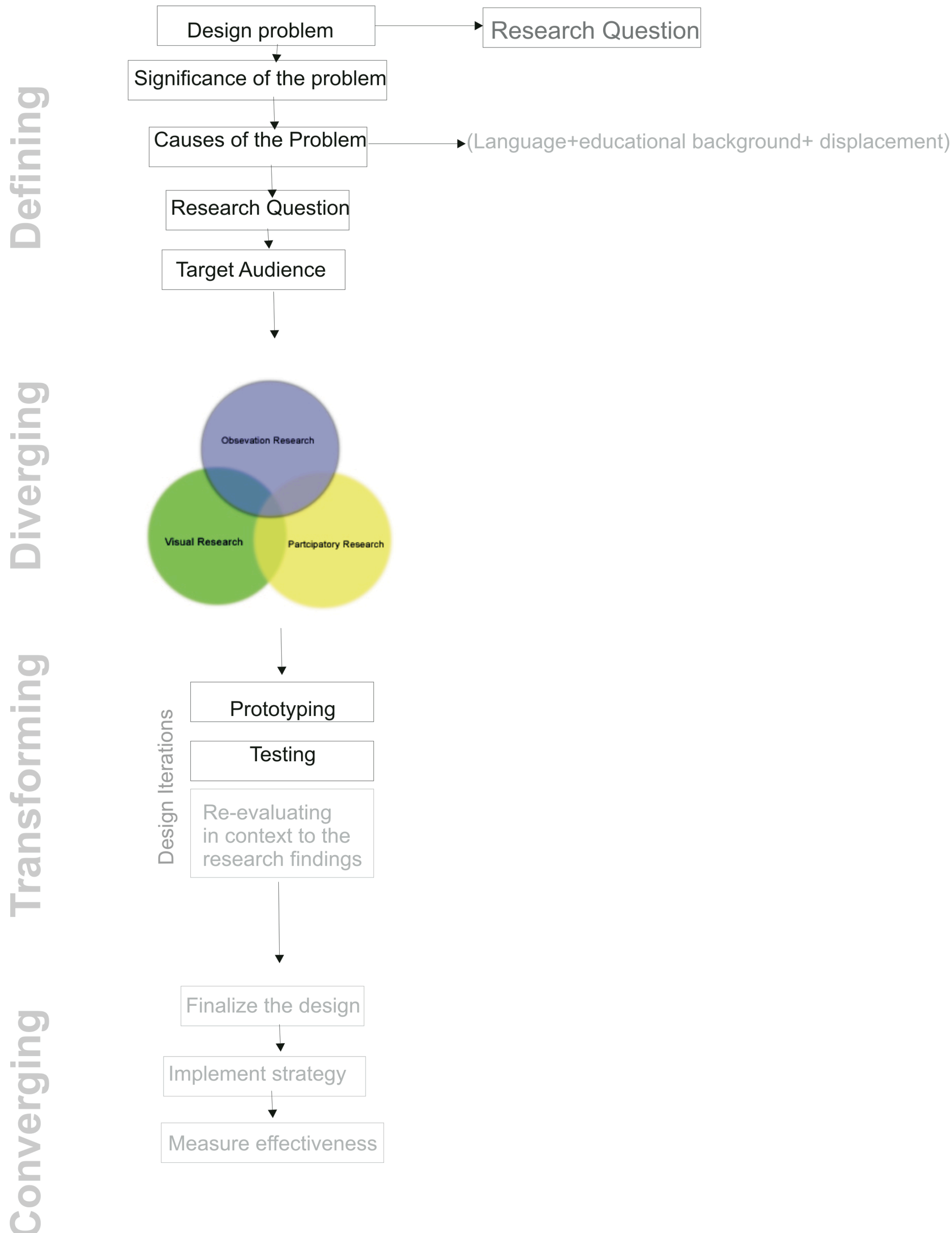

Fig 1: Research Methodology

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She is a Graduate candidate in Visual Communication Design at University of Alberta, Edmonton, Canada. Being a visual communication designer/instructor, community volunteer and an active citizen, her teaching, practice and research interests are grounded in the notion that design can influence social transformation. She intends to explore sustainable collaborative design methods and generate new knowledge to discover and harness the power of design within the field of 'design for community development' in a diverse cultural context. Her work considers endless possibilities of affecting change through the focused use of design and powerful conceptualization, which she also experimented-with during her teaching 'Visual Communication Design' at a Women University in Pakistan.

In her ongoing graduate research project she is focusing on collaborative/participatory design methods through digital story telling process with an aim to contribute and nurture creative expression while accessing critical knowledge and perspectives in relation to immigrant communities' identified socio-cultural health services access problems.

Transitions Heuristics in the Pursuit of Well-being: Situating Interactive Products and Services in Transitions

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Abstract
Transitions in people's lives take shape in the roles they enact, and the environments they inhabit. In these transitions, people encounter the paradox of changing and unchanging happenings, occurring simultaneously at multiple channels with differing magnitudes, and through immediate and long-term interactions. In this multiplicity of dimensions, transitions bring complexity while they emerge, throughout their occurrence, and while they resolve. Dealing with this complexity oftentimes results in stress, decline in emotional and social qualities of experiences. Interactive products and service systems play an important role in transitional experiences, by providing support for people to hold on to during the transitions. However, they are not explicitly designed with transitions and their complexity in mind. In this paper, I introduced *transitions heuristics* stemming from the *modes of transitions framework*, to understand and act on the complexity behind transitions. Transition heuristics leads the inquiry to discover principles at work in the existing interactive products and services and unveils the functioning principles that transforms these products into transitional experiences. The discovery unveils four threads of transitional products: routine, performance, ritual and narrative, which encompass a hierarchical and concentric relation with each other.

Keywords
Interactive products and service systems; heuristics; experience design; routine; performance; narrative; ritual; case study; analysis; principles; methods

People live with transitions both rooted in human nature and in culture. These transitions affect people's lives in two dimensions; roles people enact and environments people inhabit. As an example, take a dual-income family who has just moved to a new city due to a job change, right after they had a new baby. This couple is dealing with the transitions both between their work and parental roles and in becoming a new parent: environmental transitions both in switching between work and home and in inhabiting a new city. Looking at their experience across immediate and long-term interactions, one can identify transitions phenomena oscillating between changing and unchanging traits, fluctuating in implicit as well as explicit processes; and happening at micro and macro levels. Transitions such as marriage or parenthood are intentional, however, loss of a loved one or an unexpected illness is an accidental transition. Moving from one city to another can be initiated directly by the person; however, it might also be indirectly related to a job change triggered by an employer.

Transitions can resolve as growth, continuity or decline. In the case of decline, transitions affect people's well being in at least three ways: an increase in stress (George, 1993), a decrease in felt-life qualities (Mccarthy & Wright, 2005) and establishment of a social order (Goffman, 1967). Oftentimes these transitions do not emerge consecutively but happen simultaneously at multiple-channels, and they affect people in similar ways but at different magnitudes. There are four kinds of transitional experiences that can be defined on top of four types of transitions, affecting people's lives. Mobility is the self-changing locations; adaptation is the self's quest for familiarity in unfamiliar roles; habituation (socialization) is the self's development of new patterns of interactions in a new individual or social setting; and adoption is the transformation of the self into a new environment. Immediate interactions arising from mobility and adaptation shape our daily transitions. There are *spatial* transitions, such as commuting between work and home, and *social-role* transitions, such as switching between parent and employee roles. Long-term interactions, characterizing habituation (socialization) and adoption, shape both life-stage transitions such as retirement, and environmental transitions, such as *migration*. These transitions in return shape our experiences through their qualities. Simply put, transitions bring complexity while they emerge, throughout their occurrence, and while they resolve.

Interactive products and services play an important role in these transitions. They provide people with tangible means to hold onto during periods of transition (Belk, 1988). Communication services are good examples as being support for transitions. Think of a mobile phone service that our imaginary family begins to use in their transition. With its phone capability, it supports families in mobility in between locations. With its GPS application, it serves as a resource for adaptation in the city. However, transition as an experience has not been considered explicitly among the experience design community. Moreover, the fact that people have changing and unchanging character traits is underestimated. Ironically, interactive products, which are dynamic by nature, have been designed according to the static character traits of people or the environment. There is a need both to reconsider experiences from the perspective of transitions, and to harmonize changing and unchanging character traits. In this article, I develop a transition heuristics based on the modes of transitions perspective (Ozenc, 2009) and heuristic approach (Young, Pecker & Pike, 1970) used in rhetoric, then I apply the heuristics on the interactive products and service systems (IP&SS) in transitional contexts. The inquiry concluded with the new kinds of transitional IP&SS, their principles, and insights, which can be used as a ground for developing products and service systems for transitions.

Modes of Transitions

Issues around transitions relate both to the changing and unchanging traits of people as well as the variations of changing and unchanging, including the new and old, strange and familiar, unconventional and conventional. These traits reveal a paradox: How can people possess both changing and unchanging traits? To overcome this contradiction, people make transitions with 'character,' or actions rooted in moral and intellectual virtues that harmonize the changing and unchanging dimensions in one's life (Goffman, 1967). Prior work on transitions has identified distinct perspectives on how people encounter the challenges of transitions, including *coping stress mechanisms* (Folkman & Lazarus, 1994), *adaptation processes* (Ashford & Taylor, 1990), *role-boundary models* (Ashforth, Kreine & Fugate, 2000, Clark 2000), and *moderation of transition stages* (Allen, 1984). Each perspective can be situated into a certain understanding of the concept of character, and its unique set of principles can be applied to people's understanding and deliberative action.

With ‘character’ one can deal with transitions. It allows a person to pursue continuity and stability during and after transitions, and through the means and ends of transitions. Means can be the logistics in a spatial transition, such as commute choice of a daily worker, whereas, ends can be the purpose in an adaptation, becoming a public transportation user. The means is the determination of character with actions, and also the determination of actions with character (Mckeon, 1968). Mckeon clarifies what is meant by actions in the determination of character:

> An action is right if it is well adapted to the circumstances, resources, needs, and purposes of the agent, that is, if it is well done; an action is right if it improves the circumstances, realizes the potentialities of available materials, orders needs, and develops the abilities and interests of the agent, that is, if the end achieved is good. All actions, even erratic and neurotic actions, are reasonable, since they have discoverable causes of which the agent is frequently explicitly conscious. An action is rational when it is well adjusted to the character of a person and his purposes under the circumstances; an action is rational when the reasons for the action and the values achieved by it have been examined and judged (Mckeon, 1968, p.113).

There are several different ways to approach the determination of character and of actions in transitions, each of which spotlights different aspects of the process. A focus on human nature emphasizes the unchanging qualities of temper and coping traits in transitions; the dramatic approach emphasizes the changing qualities of the persona and its adaptation and moderation processes; the ethical approach prioritizes the merging of changing and unchanging qualities of habits; and the social approach highlights the turn (tropes) of character traits in a social environment. Approaches that focus on habits and social turns are more holistic, encompassing aspects of coping, adaptation, and moderation processes.

The hypothesis that character helps people facilitate their transitions is followed by a second hypothesis. Products with character can support people in transitions, as their relationship is a reflexive one (Buchanan, 1995). In rhetoric, one can talk about character in the voice of the designer, the product, and the audience (Buchanan, 2001). However, regarding technology’s intervention, obvious manifestations of such reflexive relations in social media products (i.e., Flickr, Youtube, Facebook, etc.) hint at a radical emerging quality. In these examples, the character of the product is defined by the mergence of the designer, product, and the people using the product. With such a move in the emergence of character within interactive products and services, we can discover an insight that merging the characteristics of people and products composes character elements in interactive products and service systems, defining an experience. Evoking an Aristotelian tradition of poetics, Moholy Nagy unfolds the material, formal, efficient and end causes as the ‘character elements’ of products. In this way, he explains the dynamics of a maturing industrial design field and how such a relationship results in a unified whole (Nagy, 1944). In a parallel mindset of poetics, McKeon explains the character elements of people with ‘temper’, ‘persona’, ‘habits’, and ‘social turn’. Thinking of an experience as a means of the formal, material, efficient and end causes can help us to ground the character elements in an experience. In the discovery of these character elements, merging the character elements of people (McKeon, 1968) and products (Nagy, 1944) leads the inquiry to discover the character elements of experiences: routine, performance, narrative, and ritual. These are the frames that constitute the modes of transitions (Ozenc, 2009), which compose experiences (Fig.1).

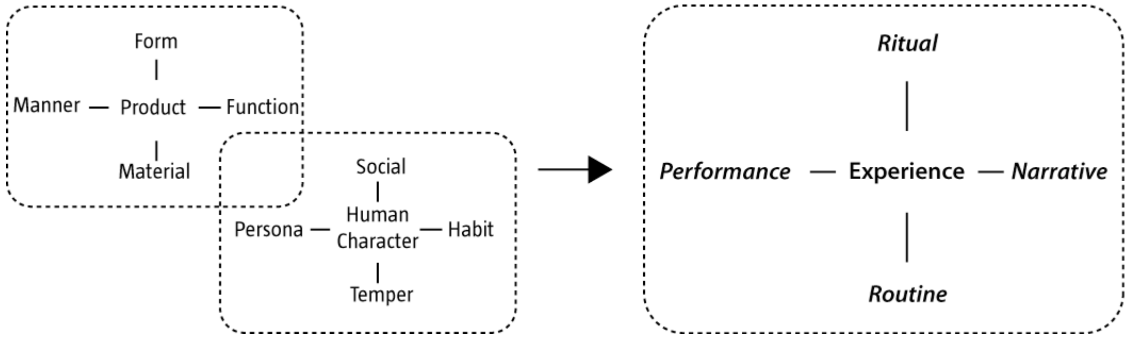

Figure 1: Modes of Transitions

Having identified the modes that define character elements in an experience taking shape through IP&SS, the next questions would be what kinds of products are particularly relevant, how these products support people in transitions, why they are relevant to the transitions, and what kinds of principles are guiding them? To inquire into these questions, developing a heuristics is useful to make a systematic inquiry that provides the necessary tools to ask questions using principles and methods (Young, Pecker & Pike, 1970). In describing a heuristic mindset, they made the following statement:

> A unit of experience can be viewed as particle, or as a wave, or as a field. That is, the writer can choose to view any element of his experience as if it were static, or as if it were dynamic, or as if it were a network of relationships or a part of a larger network. Note carefully that unit is not either a particle or a wave or a field, but can rather be viewed as all the three (Young, Pecker & Pike, 1970, p.).

In approaching an experience, one can approach the experience as part of bigger whole, as dynamic relationships between parts, or as a unified and integrated whole encompassing the parts and their relationships. These are conceptually hierarchical and one does not necessarily prevent other perspectives but might dominate them. In order to make experience approachable, one needs to segment the experience into units. And to understand a particular unit adequately, the heuristic approach suggests looking at that unit's contrastive features, variant forms, and distributions. Contrastive features can be summarized as the features that distinguish the unit and reveal distinct qualities of the unit from the other units. For instance, a wireless router can be distinguished from other routers with its cable-free quality. Variations are the changing qualities that are built on top of the contrastive features. They create diversity by suggesting different versions. Returning to our example, it might be the range, modem connection, or multiple-entry-allowance qualities of a wireless router. Distribution defines how the unit is situated in a bigger context. In the example of the wireless router, distribution would entail the Internet provider service in a home or office context.

Elaborating on the possibility of a transitions heuristics, one can easily find the correlation between the heuristic elements of parts, wholes and relationships and the transition phenomena. Transitions happen in parts (self) and wholes (environment), and in the relationship defined between them, regarding people's emotions and social qualities. Products are introduced into these transitions at all levels, in the immediate term (like with mobile phones), and in the long-term (as with health-care services). Since they mostly exist in-between contexts, and experiencing a transition by themselves due to the immaterial materiality (Ozenc, Kim, Zimmerman, Oney & Myers, 2010) of interactive products and service systems, defining archetypes for transition products to build a transition heuristics is challenging. However, we can attempt a typology of products based on the type of transitions mentioned earlier. The typology is malleable and one product can fall into multiple categories. I map the space of transitional products in Figure 2.

Spatial Transition	Social-Role Transition	Life-stage Transition	Environmental Transition
Transportation and Communication products, (i.e. Ubicycle, Merian, Telenav, Zimride, Nuride, Goosenetworks)	Communication and Personal care products (i.e. Helicor Stress Eraser, Emwave, Zipcar)	Health-care and other Care services, Collectives (i.e. Nala Patient Chair, Direct-life, Keas, Good Grief Center, I –am-too-young-for this! Cancer foundation)	Community services, Collectives (i.e. Activmob, Open door, Patients like me, Cure Together, Community-revolution health, Lotsa helping hands, I –am-too-young-for this! Cancer foundation)

Figure 2: A typology based on the types of transitions.

Inquiring into these products for emerging patterns, IP&SS situated in transitions can be viewed as units of experiences, which are open to be viewed as particle, wave and field. Thinking through the lens of heuristics, there emerge three product families, which provide a means to make a systemic inquiry using principles of transitions. These product families are the mobility, care, and community products. Mobility products are examples of the part, care products are the wave, and community products are the field. These are however the existing state of products that have been used in the context of transitions, which haven't been yet explored through the lens of modes of transitions.

To inquire into the particle, wave and field means, in other words, the parts, relationships, and the wholes in transitional products, there is a need for discovering the guiding principles in transitions. Principle is defined as "a comprehensive and fundamental law, doctrine, or assumption" (Webster, n.d.), which defines the beginnings and ends of phenomena. Watson makes a distinction between the first principles and secondary principles in his inquiry (Watson, 1970). First principles are principles that cause the beginnings, and secondary principles are functioning principles that are caused by first principles. He then identified four kinds of principles: elemental, reflexive, comprehensive, and creative principles. Elemental principles are analytical composed of functioning parts. If these parts are functioning for the sake of functioning, they become reflexive principles. Comprehensive principle states functioning principles are inherently part of a designed bigger whole. Creative principles are arbitrary in its relating to functioning principles (Watson, 1970). In approaching the transitions, I followed a similar approach to the guiding principles and discovered that each frame embodies one kind of principle characterized by Watson, and each kind consists of first and functioning principles. Each mode the frame itself is the first principle, followed by its functioning principles.

Looking at the core of transitions, there are embodiments of several functioning principles. At the center of a transition, there is an experiencing *self* in a dialogical relationship with the *environment.* Transitions occur in the swing of *changing* and *unchanging perceptions* and *interactions* of the *self* with the *environment*, defined with *emotions* and *reason* at *immediate* or *long- term time intervals*. This twisted swing affects the logistic, emotional, and social qualities of people's lives at differing magnitudes. To address these challenges, the habitual (narrative) and social (ritual) modes of transitions bring a holistic grasp on the rational, emotional and social dynamics in transitions.

Principles derived from the framework illustrate a diversity based on the character frames of routine, performance, narrative and ritual. Routine is the elemental first principle: Its functioning principle involves changing versus unchanging, role versus environment, immediate versus long-term, emotion versus reason, perception versus interaction, individual versus social, and reflection versus participation. Performance embodies the reflexive principle: its functioning principles are the integrity and finding harmony. Narrative embodies the comprehensive principle; its functioning principles involve *quality of life and well being*, and ritual embodies the creative principle, its functioning principle involves the *participation*. There is also a stratum, with layers of comprehension from routine to the ritual. While routine covers the natural tendencies and performance the nurturing, the narrative and the ritual cover both the nature and nurture aspects of transitional experiences. In these layered compositions of character elements of experience, routine and performance provide the means of immediate interactions, whereas the narrative and ritual provide the means for long-term interactions (Figure 3).

	Contrast	Variation	Distribution
Part	Routine	Procedure, Repetition	Order in Changing versus unchanging, role versus environment, immediate versus long-term, emotion versus reason, perception versus interaction, individual versus social, and reflection versus participation
	Performance	Enactment	Integrity and harmony
Wave	Ritual	Reflection, Interaction	Participation
Field	Narrative	Expression, Emplotment	Well-being, Quality-of-life

Figure 3: Transition Experience Heuristics schema

In exploring the transition heuristics through product examples, I describe the type of transitions and its characteristics; highlight the type of products people use in that transition; continue with the experience frame people prioritize during their use; and finally give specific product examples followed by the variations and distributions. In exploring the different kinds of transition products, from part to whole, I use the hierarchical relationship between the products to tie the argument to the principles, which suggests that one kind of product can fall into other characterizations, and that they have an intertwining and concentric relationship.

Routine and Performance products

The spatial transition means the changing environments, whereas the social-role transition means the changing of roles in relation or independent from environment. In the past decades, these transitions went through revolutionary changes, especially with the advances in the transportation and communication domains, which provide physical and performative mobility for people to navigate in their everyday lives. With the help of the technological advances, both transportation and communication domains now define product ecologies that involve not only products both also services and systems. Transportation ecology spans from bikes to cars; from ridesharing services to public transportation systems. Communication ecology spans from mobile phones to the Internet, personal wake-up services to the SMS systems for public awareness and collective action. In the richness of these ecologies, there also exist intersections combining both transportation and communication domains. This mergence between domains results in services that help people *plan, coordinate* and *use* the transportation services with the support of communication products. In some of these services, the focus is on the logistics of the transportation, i.e., helping people find matches regarding where, when, and with whom to go, and in some other situations, creating behavioral change for healthy life styles.

Mobility products include transportation and communication uses, routine materiality, and performative manners to frame experiences. Routine materiality of an experience is built through the planning, coordinating and repetitive use of a product (Wakkary & Maestri, 2007). This helps the transitioning person to build order in everyday life. The performative manner of an experience is a mechanism that enables a person to enact different roles and scripts in order to form consistency among routine materiality and ritual forms. People use routine and performance constructs in a dialogical relationship and in experimental ways. For instance, once the person finds resources for routine materiality, she can practice this materiality with small performances. If the performances fit to the context of the transition, the person gradually works through the routine materiality with repetition to form experiences.

Transition products in this type of situation illustrate richness with the ride and car sharing products. They are composed of both communication and transportation aspects of mobility. The idea behind ridesharing is to match people who are travelling to identical or near-by destinations. And the idea behind car sharing is to optimize the car use through offering membership-based car sharing. The higher goal for this type of product is to create more sustainable communities through leveraging spatial transition into a lifestyle transition. The challenges of such motives are several; they include planning, coordination and use. The use of such products seems to be the most critical challenge, as it needs habitual change. For instance, once people have built their routines using solo driving or owning a car, it is hard to change those routines unless there is a substantial intervention into their routines. To address these challenges, designers deploy strategies and interventions through online and physical media.

Goose-networks (n.d.) help people to find rideshares and alternative ways of commuting, thereby is providing a commute trip planner tool. The tool is flexible enough to provide not only rideshares but also public transportation and shuttle services. Goose-networks works with the routine frames. By situating the product in an office setting, Goose-networks increase the logistic reasoning while decreasing the emotional and social barriers. The variations of this type of service include Zim-ride (n.d.), a ridesharing service that supports people finding rideshares in campus environments; Nuride (n.d.), an incentive based rideshare program giving rewards whenever people use alternative ways of commuting. Goloco (n.d.), a rideshare service providing rideshare groups based on different roles, like attending church or concert. Among these variations, the possibility of leveraging the spatial transition into a lifestyle transition depends on how effective the product can use routine and performance frames as principles and strategies.

Zipcar (n.d.) is a membership-based car-sharing service providing hourly or daily car rental in designated locations of a city, whenever people need to become mobile. The Zipcar merges an interactive product and a service system to allow a person access to a car whenever she needs it, instead of owning and maintaining a car. From the perspective of transitions, Zipcar is a good example of a product that uses the performance frames. The service positions itself through the role performances rather than the routine frames such as commuting. To actualize the performance frames, they build personas around the vehicles that they provide for car share. Having segmented the cars by following trends, they present unique car personas as a person's neighbors. Mini Convertible Mollie organizes an annual block party, whereas Honda Civic Carlos teaches yoga, and loves to kayak, Prius Ping jogs in the morning and doesn't say much; Toyota Tacoma Tony is good with power tools but single. Each car represents a certain kind of prop that will facilitate different kinds of lifestyles, helping a person to adapt to the environment.

Products that use routine and performance frames as their principles for strategy and intervention functions at immediate-interactions level. However, once they are thought as part of a bigger context, they point out the long-term life-style and life-stage transitions, to be considered (later in the paper, or later in some other context?

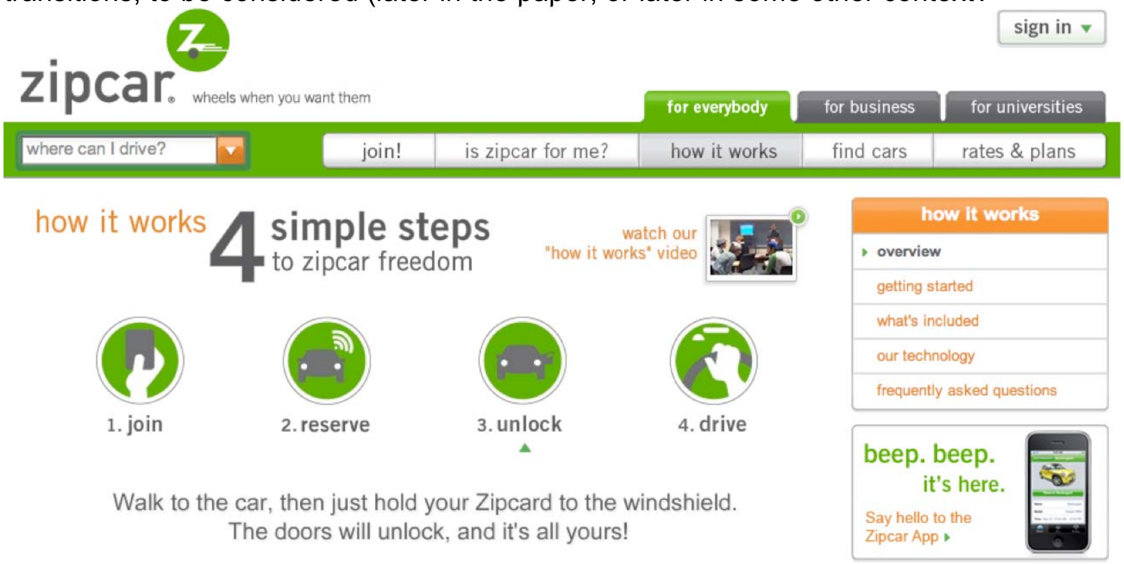

Figure 4: Zipcar, helping people to enact different roles through performance frames

Ritual Products

People experience intentional changes, such as acquiring a new habit for a healthy life style, or unintentional dramatic changes in their lives, such as loss of a loved one, serious illness, or losing a job. These transitions affect people's lifestyles and life-stages, requiring them to reconsider their roles and/or their environments. People need to perceive and act on the situation appropriately in order to continue their lives. Care products intervene in people's lives in these kinds of transitions. They can be personal or social, depending on the nature of the transition. When it is a personal one, care products help a person to reflect and act on the situation. Reflection provides the awareness, and awareness in turn triggers emotions to become actions, helping the person to overcome the turmoil. In case of social ones, they work through engagement and participation.

Care products use ritual frame constructs to form an experience. For ritual form, there needs to be a focus of attention, presence, and engagement in the activity (Collins, 2005). Once the ritual form is built, there emerges an emotional energy that provides the social turn for the person to transform according to the new situation. In a social setting, such ritual form needs to have a mutual focus of attention, co-presence, and participation, to create an emotional energy. Such ritual frames need performative constructs to provide focus of attention, and to build the stability that has been threatened by the changing roles and environments, and routine constructs to sustain this stability. For performances to create mutual focus of attention, ritual frames need symbolic props to enact, such as a university banner pole for a graduation ceremony. Ritual frames can function both as reflexive and also participatory constructs, based on whether it is an individual or social one.

As an example to a lifestyle transition, *Direct-life (n.d.)* is a personal care service that can track people's health and exercise records for a healthier life style. This service works over long-term use, and with reflexive principles. Compared to Direct-life, Emwave (n.d.) and Helicor Stress Eraser (n.d.) provide an immediate feedback for breathing patterns, and they aim to decrease stress by reflecting on the breathing. These products deploy ritual frames, in the sense that they aim to create awareness. They provide an emotional turn to transform the person into a new being who can adapt to the circumstances of the new situation.

Figure 5: Good-Grief center helping people in grief through ritual frames

There are also services of care that focus on unintentional changes, such as loss of a loved one. *Good Grief Center* (n.d.) is a bereavement service located in Pittsburgh (USA), which gives personal and social support for people who have lost their loved ones. For personal care, Good Grief Center provides care packages that include a handcrafted journal, a music and meditation CD and good grief cards that supply reflection pieces. For social care, they provide social support groups and organize workshops and meditation sessions for people who are in transition. There are variations to the Good Grief Center, such as Center for Loss and Life Style Transitions (n.d.), The Compassionate Friends (n.d.), Healing Hearts for Bereaved Parents (n.d.), etc. In these services, care comes after a dramatic unfolding, in which an overload of emotions has arisen.

The challenge in these kinds of transitional services is to address the emotional turmoil, which can easily turn into depression. The ritual frame construct can push the passive emotions to transform into active emotional energy. They can achieve this only if the person in loss can engage and participate in the service. There are many ways of participation, including a reflexive one, or a social one that happens through expression. Expression to another kind of product, namely narrative ones, which help people participate in the change through expression.

Narrative Products

Some transitions require a social turn that intervenes in the long-term and that helps people to adopt themselves to the new situation. Community domain does this by leveraging care products into another level, helping people not only to interact but also to participate in the services for change. They achieve this through expression, with narrated stories of each person allowing them to participate and become part of the community.

Community products function through narratives frames. Each person shares stories through the product, letting others know, be aware, and act on the situation. Through stories, a common sense is created based on participation. In a transition, the materiality of the story is out there, with the routines and performances. The transitioning person takes this temporality and performance, which emplots them in a dramatic construct, composing a unified whole that will create meaning and stability in the transition (Ricoeur, 2005).

I'm Too Young For This! Cancer Foundation (n.d.) (i[2]y) can be characterized as a community product that positions itself as an advocacy organization that serves the next generation of cancer survivors and their caregivers in their late teens, 20s, and 30s . i[(2])y sets its mission as “empowering young adults affected by cancer, by reducing late detection, ending isolation, improving quality of life, and providing meaningful survivorship. i[(2])y uses music, the arts and social media to organize, energize, mobilize and activate young adults to the cause, build community, end stigma and make it hip to talk openly about stupid cancer.” i[2]y takes the narrative medium with a broader perspective and use these media as functional frames for individuals and for the community.

Figure 6: i[2]y functions through narrative frames

Lotsa Helping Hands (n.d.) is another community product, which aims to create a platform for caregivers, volunteers, and people who are in transitions. They position themselves as a facilitator, providing communication resources that support family caregivers and volunteers by empowering their community circles who want to help those in need. *Patients Like Me* is a disease based community platform for people to congregate and share stories around diseases (n.d.). *Cure Together* (n.d.) and *Community-Revolution Health* (n.d.) also use narrative frame constructs to engage people in conversations. The medium of the narrative frame is diverse among the community products. Revolution-Health Service, for instance, provides blogging resources for people to express themselves and share their stories. In the bigger context, there are several motives behind these narratives: for inspiration, for learning, for creating social change through participation.

Considering the range of transition products and how they intervene in transitions at different levels, there emerge three high-level insights:

1. People compose their experiences with products using principles as strategies. These principles are the modes of transitions and their variations. For instance, Zip Car uses a performance frame as a strategy to facilitate the principle of finding harmony and

integrity among many different roles, whereas Goose-networks uses a routine frame as a strategy to build the principles of order and stability.

2. In deploying strategies, people are not bounded to one typical frame, they are open to maneuvers and making strategic moves to the extent of their principles. For instance, Good Grief Center provides the resources for both ritual and narrative frames. People can make strategic moves concerning how to deploy them in their transitional experience. They can either use the product as a reflexive one through cards and meditation CDs, or a participatory piece, engaging in workshops, and using not only ritual but also narrative frames.

3. The dynamic and cross-boundary uses of frames are possible with a unifying quality of character. Character helps people to prioritize the principles so that it affects the strategies at work. Character in that sense is a unifying principle for people who are in transitions. It houses order, integrity, quality-of-life, wellbeing, and participation as its principles.

Reflecting back on the inquiry, transitions heuristics begin with the typology of existing products that are in use for different types of transitions. The principles that are informed by the modes of transition reveal the future qualities and dimensions of new kinds of transitional products and services. These are the *routine*, *performance, ritual* and *narrative* products, embodying first and functioning principles that are hierarchically nested with each other. The transitions heuristics contributes to the design and research practice in several ways. First of all, it gives the competency to develop a systematic inquiry identifying issues for the complexity of transitions; then it provides efficiency in defining sweet spots with the frames in the process for actionable findings; and finally as being a design driven heuristics, it bridges the analysis and synthesis phases in the designing of strategies, products and services for transitions.

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Involvement in the design student approach

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Abstract

This paper is about the methodology used in the first six months of the Design course at my university in Brazil. This was inspired by the so called Social Design methodology developed in another Design course where I previously worked as a lecture and researcher.

Educating designers is a complex subject because it is a matter which integrates techniques to help the students to develop their observational skills, creativity, social awareness and individual talents.

A student who arrives at the university has already skills, knowledge, and the capacity to project their life according to his/her education. Including this fact in the class's approach is the first step of this methodology.

The students are told to look for a group outside the university with an interlocutor, where they will develop a real design project. The purpose here is to guide the student, not to propose a problem or even resolve it, but he or she will be able to develop the capacity to identify fertile areas for action. Thus a constructive atmosphere will develop with the aim of bringing new benefit for the group, rather than the more negative mindset concerned with fixing a perceived problem. The student designs an object and tests it in order to get feedback from his adopted group. The student is encouraged to get as much feedback as possible in order to challenge his preconceived ideas and promote double-loop learning.

This paper shows the techniques used by the students related to data collection as an attempt to generate a "model 2" operating system as advocated by Schön and Argyris (Smith, 2001), and some of the projects developed during 10 years of the university design course.

Keywords

participatory approaches, design methods, design and society

Since 1997 I have worked at the Univeridade Federal do Espírito Santo - Ufes, in Brazil, with the students who are starting their first term, or semester. During the first four months the students develop a design project, construct and test it. This is a complex subject because it is a matter which integrates techniques to help the students to develop their observational skills, creativity, social awareness and individual talents. The objective is to give the student an experience of how designers act in a project, to what should attention be paid, how the data can be collected, and in which areas a designer can be useful. This shows the student part of the world he or she will be involved in for, at least, their next 4 years.

This paper will show the methodology used during 10 years of activity using examples of the projects developed by students over these years individually or in groups of 2 or 3 students.

The approach

The student arriving at university for the first time already has a skill set, and knowledge from their experience thus far. We recognize this, and it is the starting point of our methodology.

Here we believe education can enhance the existing capacity of students to allow them to become more aware of how an individual's personal experiences are connected to larger societal circumstances, according to the approach of Paulo Freire, the well known Brazilian educator (Nogueira & Freire, 1966).

The first step for the students is to find a group with whom they will develop a real design project. This group can be a school, a company or any organisation, but it must be outside the university system, and there must be an interlocutor to provide a link between the student and the group. People share and integrate knowledge best in social environments (Nonaka and Takeuchi, 1995) and a good interlocutor is essential for the project. As recommended by C. Alexander (1975), the involvement of the users, the interlocutor, and the student all together will be necessary for a successful experience.

The lack of a formal previous study in this area is substituted for by intuition, involvement with this group (at least 2 times a week) and curiosity. The real life situation instigates in the student the development of his/her capacity to look at the surrounding world when taking decisions. The format is to go to a place with plenty of activity in which the subject is new for the student, because previous knowledge could interfere in their observations.

The interlocutor is a person who is already involved in a project, in a work, in some movement towards getting a result. It is never a person who is waiting for something to happen, or somebody who has a complaint, but is not doing anything to resolve the situation. Engagement with an action is the basic requirement for the profile of the interlocutor. We used to say that the student has to find a person who has “shining eyes”. Shining eyes produced by enthusiasm and engagement. The reason is that we believe that it is important that the student, at this initial point, learns to identify fertile fields within a project, identify situations that work and people that will be working WITH them and not people that the student will be working FOR (Pacheco,1996:23).

The steps for the student making the project are:

1) Find a locale with an interlocutor, collect the data, and visit the place at least twice a week over the four months period of the project.

2) Define the general objective of the project

3) Research the subject

4) Elaborate the hypotheses, classify them in groups and test them.

5) Define the specific objective of the project

6) Generate alternatives and test them

7) Define the final alternative

8) Construct it

9) Experiment it

10) Form a conclusion

To find the locale is a very important step, because without a good environment it is very difficult to work well. It is preferable to delay finding a suitable locale and find it, than to work in the first place found just to start the project early. There is an example of a student who was part of a group of the university that started to work in a locale where people were involved in a campaign “if you drink, do not drive”. This student was not satisfied with the locale because she could not identify the objective of the interlocutor's actions, since these actions were not very clear to her. Instead of insisting more and trying to identify his objectives later, she resolved to change to another place and there, unfortunately, the interlocutor did not have “shining eyes”. This was a physical education class and it seems that the teacher (the interlocutor) was doing a work almost mechanically and her eyes were not “shining” because of this. Then she changed again to another place where the interlocutor had “shining eyes”. However, the student could see, in time, that this was because the interlocutor saw in the student somebody to work for him. His eyes were shining not because he was involved and happy with his job, but because he had seen in the student somebody who would follow his orders. By this point the student had concrete experiences of this abstract condition: “to find shining eyes”. She had a conception about what this was and she was following her intuition. The result so far was that she had had a number of unpleasant places to work. Despite this, she did not give up and later she found a very interesting interlocutor, a teacher who worked in the interval between formal classes, called “recreação” (this word comes from a two word junction: recreate and action). This interlocutor was somebody very creative and involved with her work, she had a clear objective and accepted the design student to her classes in order to develop a project. It was not easy for the student to find a nice place, but the guidance she received and her own understanding, and fidelity with her understanding, were responsible for the success of this first step of the project.

Once the locale and the interlocutor are found, data must be collected. Beyond natural observation, and records made with pictures and/or drawings, some other techniques are used.

Techniques related to data collection

There are basically 3 techniques used by the students to collect data about the interlocutor and his or her work. The point here is to collect valid data, which is connected to the real world, not to the student’s preconceived ideas. So, the strategy is to encourage feedback and outside input. This is an attempt to generate a “model 2” operating system as advocated by Schön and Argyris (Smith, 2001). In other words, to encourage open communication and minimize the influence of predetermined mindsets from either the student or the interlocutor.

The first is called “Listing beliefs and actions”. Along side observations of what is happening in the locale, the student starts to make a list of what the interlocutor says about his or her work and what the student can see about his or her actions, comparing one to the other. At one level this is important because, as Bregman and Haythornthwaite (2001) point out, conversations are ephemeral. However, more importantly, this is an attempt to determine the position of the interlocutor. It is common for people to have a mental map on how to deal with situations (Argyris and Schon 1974). However, frequently people’s perception of how they deal with situations is different to how they act in reality - espoused theory and theory in use (Smith, 2001).

Making this list is a useful tool for determining the position of the interlocutor at the start of the project.

Example of a classroom teacher as interlocutor is shown in table 1.

Table 1: List of beliefs and actions

Beliefs	**Actions**
I am very organized.	The interlocutor uses a class plan in which the periods of activities are distinct and she follows what is written in the order it was written.
It is important to stimulate creativity.	The interlocutor holds the hands of the students and shows how to paint a picture.
I prepare each class the night before.	--------------------------
	(The cell above is blank because this action was not seen by the student.)

What this example shows is that the first statement was observed by the student, and the interlocutor's action was related to the statement. Reading the report, anybody would agree with the statement that the teacher is organized.

On the other hand, the action related to the other statement is not an action which illustrates the stimulus of creativity. The result is that the action is not related to what the interlocutor said about her work.

The third statement has an action which happens at a time to which the student has not access and because of this, cannot be considered in the final analysis.

This technique is very important to 2 goals. The first one is to be conscious of to what extent the interlocutor is aware of his/her actions, to be able to select a subject to work with which would be possible in the local universe. The second is to identify which subjects would be under the student's observation. What is done in another locale, or another time, can be interesting, but without the direct observation of the student, cannot be used in this context.

The second technique is another list. A "List of good things at the locale". This list is about everything good that had drawn the attention of the student, about the work being done and the environment around. It is important here to select only examples that are effective. Students always seem to have the habit of observing what is going wrong in a place. They arrive at the locale with the idea that they will resolve a problem and consequently the problem has to be found. The exercise here is different. We stimulate the students to, first of all, pay attention in everything that shows that actions have worked.

Example from a project made with a teacher of Capoeira *(an Afro-Brazilian art form that combines elements of martial arts, music and dance):*

. teacher uses discipline successfully.

. joy in the faces of everybody.

. practice using repetition.

. students respect the teacher.

. students smile when face difficulties.

. abundance of wishes to learn and to teach.

Example from a project made with a teacher who works in the interval between formal classes, called "recreação"

. the teacher explores creativity modifying the use of traditional tools to other functions.

. the teacher talks to the students to reflect about what they are doing.

. the children have a lot of fun in the class.

. the students are stimulated to socialise.

Here we diverge from the intervention strategy of Schön and Argyris (Smith, 2001). Instead of aiming to identify problems in communication within the organistion and intervene to correct them (Argyris and Schon 1978), the case here is to teach students who will in the future have a positive approach to helping the client with design. Thus, we argue that in this context it is more important to identify when and how something goes right, or in other words, produces what is being expected, than to look for negatives.

This list gives the student a lot of inspiration when he or she develops their project because both the list and the final product of this design exercise are linked to the success of the project. We used to say that we work with joy, not with problems. With movement, not with stagnation. We also used to say that we work with what is in abundance, not what is missing. In all of the examples above, the resulting products were linked in some way to each environment as will be seen at the end of this paper.

It is at this point that we differ from traditional approaches in design, because at the same time as the word "problem" means opportunity, it also carries a meaning linked to stagnation and missed opportunity. On the other hand, the word "joy" is suggestive of something going well, movement being made.

So, the "fertile field" can be identified by the student and there is the "gold". There is the solution. The student is stimulated to start seeing the solution, not the problem.

In any given moment a "problem" will not be sought. Instead, only opportunities will be considered according to the behaviour and actions of the interlocutor. The idea is: if the interlocutor is already involved in some project, action, or objective with enthusiasm, and the student works with him or her, this situation will not be called a "problem". It will be called a "project situation".

Still with the aim of developing a model 2 situation, with a maximum amount of feedback, the third technique is the "Word game". This is a visual conversation between the student and the interlocutor. It also derives from another list. In this case, a list of key words related to the universe of that locale. There is no limit to the number of words, but it has to be done after a period observing the place to be as complete as possible. Ideally, someone who knows the locale should be able to say where, when and with whom the student is working by only looking at the list. Verbs and nouns can be used.

After this list is made, the student prepares each word individually on a separate piece of paper, each piece having the same size and typeface in order not to produce any impression of hierarchy. This collection of papers is then given to the interlocutor and he or she is asked to organise them according to his or her own criteria. The interlocutor can take out words that he or she does not believe make sense, or put new words that he or she believes are missing, in order to organise according to his or her logic.

What is the point here? The students, when organizing the list, are making visible what they have in their minds/thoughts. When the interlocutor organizes the words, he or she makes visible what is in his or her mind/ thoughts. So, this visual conversation is used to clarify a lot about the place, the work that is being done and the characteristics of these two people, the student and the interlocutor.

These examples show different kinds of organization. Sometimes the interlocutor organizes by order of importance, by groups, writes a story or uses different approaches (figure 1).

Figure 1: An interlocutor organizing the word game.

The definition of the objectives

These techniques help the student to analyse the situation, the communication codes, daily life, routine, and in general how the things happen, in order to have material to identify the objective of the project. So, the general objective of the project is only defined after about three weeks of observation. It is never decided on before this because it would be a result of conjectures not certified by the student's observations. A conclusion is only reached after a study, after an analysis, after a period of familiarity between the student and the locale and interlocutor, in order to allow him or her to make conscious choices. This objective is then defined by the students, in conjunction with their interlocutor. The objective is not given to the students as a task to be done.

The students have to put all the data to be analysed together, because they are connected. It is then easy to choose a pertinent objective when this objective is related to a lot of actions of the interlocutor, it is clear in his or her mind and so it can be seen by the student. When analysing it is important to consider the context in order to interpret well the data. Sometimes the objective is not very clear. The list of actions, for instance, is not linked to the word game and this can be result of either a poor level of observation or to an unclear situation. Normally the unclear situation happens when for some reason the real objective of an action cannot be said. For instance, in a fitness academy when the reason for some action is to get money, instead of producing healthy clients. It was common over these 10 years to see students changing the locale because, at this point of collecting data, it appears not to be a good place. It is very possible to make a mistake and what happens is that the group of students has to start a new project in another place. The good part of this is that they carry with them the learning of this experience and this new place is better chosen and the data collection is faster.

The first hypotheses

With the general objective defined, hypotheses are formed and here the student can formulate strange or impossible ideas. All that is required is that all of them must be linked, clearly, to the general objective. We believe that it is important that the student must be free of self-reprimand (a model one value in the Schön and Argyris schema -

Smith, 2001) in order to be creative. Normally the students have difficulty in doing this because they want to be "reasonable". Because of this, it is stipulated that they have to form and draw 20 hypotheses. This number has to be large enough to allow interesting ideas to appear (figure 2).

2.1 2.2

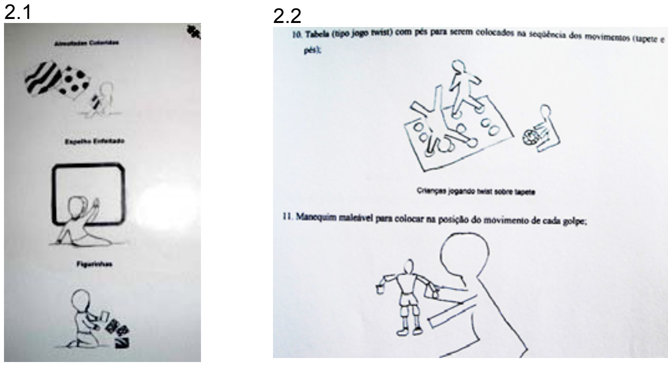


Figure 2: Examples of the first hypotheses 2.1) In a project developed with people with visual deficiency. 2.2) In a project in a class of Capoeira.

The tests

From these 20 hypotheses, the students separate the similar ideas into groups and test these groups with the real users. This test is done in order to see if the group is valid, so only a basic mock up is used.

The results of these tests will allow the student to chose the best way forward. The student and the interlocutor will analyse the results together.

In the case of the Capoeira class, the possible objectives defined were to work with either the teaching of the movements of the “dance”, the names of the movements or the music and rhythm of the dance. Three possible approaches were tested with the capoeira group based in the three situations: in the first one, the children were stopped in a place and learning, in the second, they were making movements, and in the third working specifically with rhythm.

In the first one, the students should link the name and the movement as playing cards (figure 3). The result was not satisfactory because the drawings of the movements were sometimes confused.

Figure 3: The student tries to associate the name of the movement in Capoeira with the drawing of it.

In the second one a cube/die was used. The child had to throw the cube/die and the face would show the movement to be done. Whoever knew how to do the movement presented himself and did it. This was ok, but the children were more showing what they knew rather than learning something new, and the interlocutor thought that this was outside of his present objective.

The third one was a test to help the children to drum correctly through visual hand guides on the table. This test was very well accepted by the children, and the interlocutor had identified it as the best one (figure 4).

Figure 4: The interlocutor (standing) and the children in Capoeira class.

In the case of students who worked in a school for people with visual deficiency, there was another set of circumstances. The challenge was to stimulate children to identify contrasts and some experiments were done with contrast gloves, a contrast rug and a contrast cube/die.

It was observed that the cube/die and the rug were efficient and then a rug was constructed that could be transformed into a cube/die according to the interlocutor's exercise proposal.

5.1

5.2

5.3

Figure 5. 5.1: Tests with the glove. 5.2: The rug and 5.3: the cube with the interlocutor holding the child in front of the mirror.

Defining the specific objective and generating alternatives

Once the specific objective is known, it is time for the students to generate alternatives, now with their “feet on the ground”, considering viability, price, material and dimensions of everything they are thinking of.

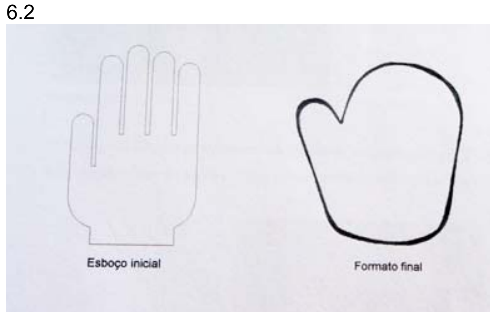
At this point, practical tests are again necessary because the next step defines the final alternative to be actually constructed and they need to know which one is the best. In all of these moments, the interlocutor is participating of the decisions and if other people are involved, they are also aware of what is happening.

The following images show the alternative tests and studies used in the Capoeira example above, until the final product was decided, including a bag to carry the “hands”. A design product made by this methodology should include the context. In this case, a complete product should have the tools to guide the children to drum (the “hands”) and a place to keep and carry these.

Tests included “hands” with numbers (figure 6.1) and later a study of possible combinations of numbers and colors. Faced with the construction, the students realized that the “hand” should be easier to cut in wood and the form of the hand was simplified (figure 6.2). After tests of the alternatives, it was resolved to use the system of colors and numbers seen in figure 6.3. It was also seen that it was necessary for a bag to be constructed to keep the material together (figure 6.4).

6.1

6.2



6.3

6.4

Figure 6: Tests and studies made until the definition of the final form of the product in Capoeira class.

In the case of a circus school, the issue was to rank the students according to their skills in order to stimulate them to learn what they didn’t yet know, or improve what they needed to.

The idea tested was to put on the wall 2 types of display. One showing, individually which type of performance each student knew (figure 7), and another showing each type of performance, with which students knew them, in order. The best student in the first place (figure 8).

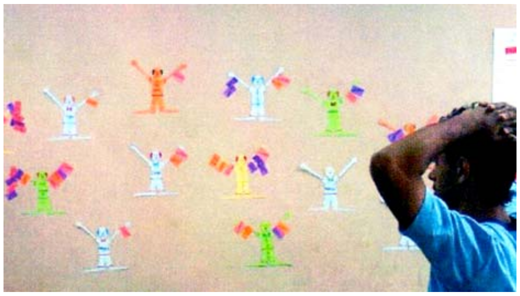


Figure 7: Test of a possible individual performance register design. This was changed to the final product after the test.

Figure 8: Test of the ranking of each exercise and the names of the students in order.

Once the definition of what actually will be constructed has been settled, the next step is the construction itself which can use a workshop at the university with the help of an instructor.

Preparing the observation of the final product in use

The experimental part is done over 3 weeks. In order to help them in the observation of what is happening and study the impact, 3 tasks have do be performed before starting the experimentation period;

i) a list of <u>which</u> points they will pay attention to,

ii) a list to <u>how</u> they will pay attention and

iii) a chronogram of <u>when</u> this will happen over the 3 weeks.

They have to include: taking pictures of the final object in use, time for any possible adjustments and time for the object to be left at the locale to be used with and without their presence, so that later questioning can determine it's usefulness. At the end, a letter from the interlocutor is required reporting on the development of the project.

The final result

The experiment is done with the final material in the real situation.

In the case of the Capoeira class, “hands” in wood were developed, marked with numbers and colors, in the size of the hands of the students, with a sand paper underneath and a special table cloth in order to not slip when beaten (figure 9). Some of these objects were developed over the experiments. Part of this development was also a bag to carry the objects.

Figure 9: The interlocutor and the children of the Project in a Capoeira class using the hands to guide then in drumming.

In the case of the circus class, the final product was a panel with two type of register. The individual performance of the students (figure 10.1) and their positions in the different categories of the course (figure 10.2). One was on the left hand side of the panel and the other on the right hand side. Over the experimental period it was possible to see students improving their performances because they would like to occupy more spaces on the panel

10.1 10.2

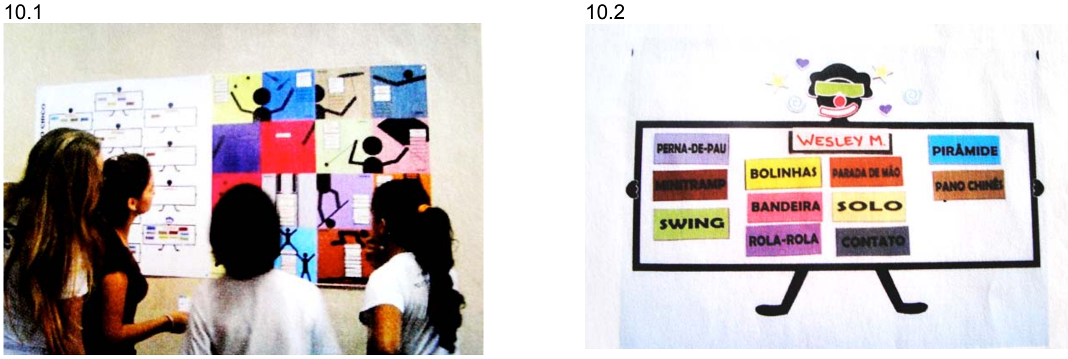


Figure 10: 10.1) The panel in which the performance of the students in the Circus class is registered in order to stimulate them to learn and exercise more. 10.2) The detail of the individual skills. The name of the child can be changed to another in order to be used over the years.

In the case of the work project made with people with visual deficiency, the product was a flexible rug that could become a cube (figure 11). The necessity for some three-dimensional stimulus was seen over the experiments.

11.1 11.2 11.3

Figure 11: The final product and its flexible format in the project with people with visual deficiency. 11.1) Rug, 11.2) Rug and “wall”, 11.3) Cube.

Conclusion

This method seems complex mostly because it is new for the students. Normally they come from a education model in which it is the teacher who brings the subject to be studied and not the student who brings the subject to be discussed in class. Our method can be applied to a lot of situations, but has fitted best mostly in situations of classes where there is a teacher as the interlocutor. The interlocutor can be another person, like a seller, a social care person, etc, but with teachers application seems to be easier in this new approach. In a situation in which the interlocutor is a teacher there is a clear objective, a predefined schedule and the student has only to find somebody who likes his job, who has "shining eyes". This makes the exercise less complex and still keeps the purpose of the discipline.

This participatory approach of the student, with an outside interlocutor and group, is an important exercise for them. Over the rest of their course they will experiment with other types of approach, but this was chosen as the first one for them to work with. Among other aims, the reason is that this approach stimulates questions, a wish to research, and produces a type of individual experience in which each student will have their own learning. Experience over 10 years has shown that this overall approach, which is similar, but not identical to the strategy of Schön and Argyris, can produce in the student a positive and productive approach to communication with the client.

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The projects mentioned in this article were developed by the following students from the Universidade Federal do Espírito Santo: Mirela Capistrano Stefonini, Carolina Paulino, Kamila Lirio Ofrante, Denise Bissa, Emanuelle Machado, Keller Coimbra Ogioni, Maxwuel Goldner, Carolina Campos D. Sessa, Viviani Gama Carnielli e Lorena Manhães Ceolin.

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Discovery and Creation: Explaining Collaboration between Designers and Scientists in Scientific Research

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Abstract

This paper examines the role of product/industrial design in scientific research. It reports the results of three case studies in which designers and scientist collaborated. The paper presents the initial findings of these cases, and reflects on the designers' contribution to research, and on those aspects that can act as a barrier or as a facilitator in designers and scientists' collaborative endeavour.

Keywords

Product design; industrial design; science; scientific research; interdisciplinary; collaboration; participatory approaches.

Design has the potential to play an important role in scientific research by linking it to people's day to day lives, but also to steer research in new and unexpected directions. Attempts have been made to discuss the commonalities and differences between design and science (Cross, 2001; Willem, 1990; Bonsiepe, 2007) and to compare design research and scientific research (Krippendorff, 2007; Glanville, 1999) and to reflect on how design can be complementary to research practices (Rust, 2004). There have also been attempts to study the impact that designers collaborating with scientists can have on public perception of science (Beaver, et al., 2009) and there is extensive literature about the interaction between art and science that occasionally mentions design[1]. However, there is little empirical evidence of product/industrial designers[2] having an active participative role in scientific research, and few studies of the role that product/industrial design could have in the practice of scientific research.

This paper illustrates the initial findings from three case studies undertaken to explore the impact that product/industrial designers might have in scientific research addressing the questions:

- Can designers meaningfully contribute to scientific research, and if so, what would be the nature of such contribution?
- What would be the main aspects that can act either as a barrier or as a facilitator for collaboration between designers and scientists, in the context of scientific research?

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[1] The cited authors seem to use the word design as an overarching concept that covers different design disciplines. In this paper, it is assumed that the discipline of product/industrial design is included in that design overarching concept.

[2] In this paper, the term Product/Industrial design refers to the Industrial design definition of the ICSID (International Council of Societies of Industrial Design): "Design concerns products, services and systems conceived with tools, organisations and logic introduced by industrialisation - not just when produced by serial processes. The adjective "industrial" put to design must be related to the term industry or in its meaning of sector of production or in its ancient meaning of "industrious activity". Thus, design is an activity involving a wide spectrum of professions in which products, services, graphics, interiors and architecture all take part. Together, these activities should further enhance - in a choral way with other related professions - the value of life. Therefore, the term designer refers to an individual who practices an intellectual profession, and not simply a trade or a service for enterprises." (ICSID, 2010)

Background

Although there are known examples of collaborative interaction between designers and scientists in commercial, academic and institutional contexts[3], access to useful information about these initiatives is limited.

Interaction between social scientists and designers in the context of product development has been well documented in Squires and Byrne, (2002). Although the book covers several aspects of collaboration between social scientists and designers, it does not focus on collaboration in the context of scientific research, remaining instead in the realm of product development.

A meaningful contribution to the subject of collaboration between designers and scientists has been made by Rust, (2004 and 2007). In the first paper, Rust claims that although scientific pursuit is different from that of design, it may be possible to initiate collaboration between both “traditions” that serves both of their aims. The author proposes that designers’ abilities to “image new scenarios”, and to create a “practical environment” and “experimental artefacts” may be of use to scientists to select or even generate routes of scientific enquiry. Rust sustains that there is a “creative dimension” in scientific research and that designers can contribute to it. Rust presents examples of collaboration between scientists and designers, and concludes that designers can contribute to scientific research.

Even though Rust offers an interesting perspective on interdisciplinary collaboration, identifying both opportunities and barriers for designers in collaborative research, he does not present firsthand empirical evidence to sustain his claims. Although some of the papers cited in support of his argument show a reflection on research outputs and research methods, they do not look at the specifics of interdisciplinary collaboration, or reflect on the experiences of the researchers in the context of interdisciplinary work. This opens up opportunities for further empirical exploration of collaborative work between designers and scientists.

In his 2007 paper Rust reflects on how creative disciplines (art and design) can contribute to scientific research. He argues that designers may be better suited to undertaking research activates than artists. Rust points out that participant in design and science research projects may experience difficulties because of the absence of a “shared formal language”. Rust also formulates “tentative principles” for interdisciplinary research between creative people and scientists.

Although Rust develops interesting ideas, most of the evidence that supports his claims (personal conversations with artist and designers), is not presented or accessible. It is apparent that further study on collaboration between designers and scientists that presents “first hand” evidence may help to find new insight on the subject.

Approach

In order to fill the existing literature gap in collaboration between product/industrial designers and scientists, and with the purpose of obtaining empirical evidence to support claims on this theme, initial case studies, involving designers collaborating with scientists on their research work, were carried out, observed and analysed. Three case studies were selected from a range offered by a university technology transfer office. These studio cases were selected so that a) the design team (composed of the two main project researchers) could provide a meaningful design intervention, and b) the nature of the research needs, and subsequently of the design intervention, would be different in each case.

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[3] *A few good examples of commercial and academic design and science collaboration that can be found on the web are: Simbiotica (University of Western Australia http://www.symbiotica.uwa.edu.au/welcome), Material Belief (Goldsmith Univ. http://www.materialbeliefs.com/), Biomimicry Guild (http://www.biomimicryguild.com/)*

Case 1 (Mask project) entailed the development of a device for the testing of a medical scientific hypothesis; *case 2* (Immuno project) included the design of systems and devices to reduce the time taken to perform a laboratory analysis technique. *Case 3* (Multistable project) involved developing a new technique of forming multistable structures from a variety of materials.

Different activities were carried out in each case study, and the project stakeholders' participation changed for each activity. Stakeholders can be divided in two different groups: Project Team (Scientist(s) + University technology transfer officer(s) + design team) and Design team (2 main project researchers + project director).

In each of the three case studies, the main activities were:

- *Preliminary meeting:* to understand the nature of the scientific project, to understand the perceived design need and to determine whether the project matches the research team expectations. (Project team)
- *Briefing meetings:* To discuss and agree on the design brief for the project (Project team)
- *Visits to labs/field:* To understand scientist/user requirements (Project team, or Design team + scientist(s))
- *Desk work:* To prepare presentations, reports, papers, briefs, computer drawings/plans, etc. (Design team)
- *Brainstorm/design focus sessions:* To generate/discuss ideas (Design team, or Project team, or design team + invited designers)
- *Workshop/lab work:* To make sketch models, to produce prototypes and to test ideas. (Design team, or Project team, or Design team + Scientist(s))
- *Interim meetings:* To report, discuss project developments. (Project team or scientist + Design team)
- *Presentations:* Formal communication of design work/ideas (Project team)

Notes, tape and video recordings were taken during meetings and work sessions. Initial and follow up semi structured interviews with the participant scientists were recorded and physical collection of cognitive artefacts and design outputs was undertaken. Design team follow up discussions were systematically carried out immediately after each meeting, presentation and work session. Written case reports were produced and the project team was invited to comment, and check for any errors in perception or interpretation.

The mixed data sources were analysed by the research team, to determine patterns, common issues and differences among the case studies. Analysis was carried out mainly through the narrative reconstruction of the study cases, using recordings, documents and design outputs as to trigger memories and reflections.

Case 1 Mask Project

Project Background

The scientist was conducting research in gas delivery for patients with respiratory problems. In order to perform experiments with patients, a mask was needed that would provide a perfect seal against the patient's face. However, the scientist found that the masks available on the market do not provide effective sealing or are not sufficiently comfortable for the patients over lengthy periods of study.

To address this problem, the scientist, using materials readily available at home, created a first prototype to solve the problem.

However, the mask was manufactured with materials not suitable for a clinical environment and medical trials, was not designed in a way that production of a standardized small batch (for clinical trials) was possible, and it was not comfortable enough to try on patients.

Scientist Requirements

The scientist required his concept be developed into a mask that could be tested on users. He was interested in finding materials that would make the mask comfortable to wear, and that allowed the manufacture of a batch of 30 masks for use in:

- Clinical trials and experimentation leading to the development and improvement of oxygen therapy techniques

- Accurate gas measurement for early detection of respiratory problems.

He was also seeking to use them as the basis for the development of a mass produced mask, to target the medical research market in the first instance, and then the clinical and therapeutic market.

The Design Team Approach

In a preliminary meeting, the design team agreed on producing a working design brief so all project stakeholders could discuss and agree on the project programme, its tasks, objectives and deliverables. The brief also helped to ensure that the designers had a clear understanding of the project design parameters and the mask's potential primary and secondary users (patients and clinicians) and context (labs and hospital wards) characteristics. At this stage while a collaboration agreement was in principle tacitly accepted by all participants, internally the design team further discussed the suitability of the project as a case study, because of doubts on two aspects. Firstly, the main concept of the mask seemed to be quite developed as an idea, so the design task appeared to be limited to finding materials and ergonomic adaptation. The design team was concerned that these were minor tasks that didn't offer enough opportunities for a meaningful contribution to scientific research. Secondly the project seemed to be too similar to those that would frame a normal product design consultancy commission. Rather than being involved in the scientific research process, addressing research questions, the designers felt that they might be solving a standard product design problem in which the customer happens to be a scientist.

However on further consideration, the project appeared to provide an opportunity to understand what the impact of a "normal product design project" would have in scientific research. In addition, the project would provide a good opportunity to demonstrate to the gatekeepers (university technology transfer officers) the design team's capabilities. Finally as the design team had been recently formed, this project would be "safe" enough to allow team members to develop working and collaborative practices.

The designers felt it necessary to directly observe patients in their environment, and to be able to revisit the information received, in the field. For this reason, the design team also conducted a guided visit to the hospital in order to observe patients with different levels of respiratory problems.

The Design Process

A first draft of the brief was presented including a detailed work programme and product specification, a description of who would be using the device and the context in which the product would be used. The brief was approved and it was agreed that the design team would focus on developing a mask for clinical trials and experimentation (leaving the potential development of a mask for commercial purposes aside). The focus on trials and experimentation meant that the project was no longer primarily concerned with exploitation.

After a brainstorm session involving other design researchers, the design team decided to follow the main principles of the scientist's idea, but to explore new materials options. This resulted in a mask that looked substantially different to the one developed by the scientist, but promised to meet all the criteria of the design brief.

Although the scientist's reaction towards the new design was positive and he eventually gave his approval to proceed with the construction of a prototype, he brought up for discussion some discarded features from his original design. He seemed not completely convinced by the design team's arguments, although samples of materials and drawings were presented to him alongside the explanations of the new design.

The designers proceeded to build a prototype of the mask. Once finished, the design team presented it to the project team. The prototype was tested by the scientist during the presentation and it become evident that it met the design parameters. It was agreed that the scientist would carry out formal tests with a sample of healthy people with different face shapes. After the tests the scientist reported that the new mask satisfied his technical requirements.

Nevertheless when further testing was carried out on cadavers some minor problems of sealing were observed. On this occasion, the scientist's response was to modify the mask to overcome these newly detected problems. This new feature implied a departure from the design team's ideas. Furthermore, in a later meeting, the scientist suggested incorporating some of the features of his original prototype. At this point the design team chose to incorporate ideas from both the scientist's and the design team's prototypes.

Case 2 Immuno Project

Project Background

A team of scientists built a fluid handling device based on a commercially available plastic component. They believed that their device could form the basis for a safer, cheaper and faster method of performing an immuno assay (a common laboratory test) compared with existing techniques. However, the device was not easy to handle, it did not allow multiple tests to be performed on different samples simultaneously, and it did not fit other standard components for carrying out immuno assays (microtiter plates, multiple channel pipettors, etc). These problems made it difficult for the scientists to prove their idea by making a reliable and credible comparison with other existing immuno assay techniques.

Scientists' Requirements

The scientists were looking for the development and fabrication of an improved version of their handling device so they could:

- Develop the new Immuno Assay procedure.
- Measure its levels of safety and reliability, its cost and its speed, so a comparison could be made with other existing competing procedures.
- Have the main underlining design principles ready for the development of a commercial version in the near future and for a fully automated version in the long term.

The Design Team Approach

In the first meeting of the project team, the designers were given an explanation of the fluid handling device and were introduced to the general principles of immuno assays. However, conducting an immuno assay in practice is a lengthy process that involves several steps. Also, a number of key aspects of the process had a scientific basis and were not directly observable, requiring an explanation in scientific terms. The designers asked for an observation day so they could have a real sense of the immuno assay process, and be able to associate the theoretical aspects of the process to the actual stages of it. The observation day was carried out and helped the designers to fully understand all the steps and the main scientific principles of the process. A diagram prepared by the scientists with scientific symbols was used during the day to explain those aspects of the process that were not directly observable. Some days later, the designers created their own diagram of the process, assigning a pictogram to each stage of the immuno assay, identifying its name and its corresponding scientific symbol. This diagram was shown to the scientists and it confirmed that the designers had achieved a good understanding of the process and its associated scientific concepts. Although at the beginning of the project, the design team was not familiar with the scientific concepts and vocabulary related to immuno assays, this mix of observation, scientific explanation and visualization of the process through diagrams, helped to establish effective communication between scientists and designers.

The Design Process

The design team started their design process by borrowing some standard equipment used to carry out immuno assays. They intended to use these in combination with sketch models to test some initial design concepts. The design team soon realized that any idea they might develop should be proved beforehand as being as efficient at handling liquids as the model developed by the scientists. However, the reduced scale of the components and parts they were designing did not permit them to use the sketch modelling techniques they were used to. So the designers had to resort to computerised rapid prototyping techniques to create the models. Since these techniques are considerably more expensive than normal sketch modelling techniques, the processes of consultation with the scientists was more thorough and intensive than usual. Interestingly, the presentations of the prototypes, carried out in the scientific labs, became almost “design sessions” were the scientists and designers considered different ideas and took key design decisions. Of equal importance was that the designers developed competing ideas, and subjected them to group scrutiny.

After a few prototype iterations and a number of discussions with the project team, the design team proposed a more radical version in which a set of objects formed a fluid handling system. A prototype was made, the scientist carried out some tests and they found that the system successfully met the design parameters. The scientists decided to take this idea forward, by applying for additional funding for the further development and production of 100 test devices.

Case 3 Multistable Project

Project Background

A scientist has patented a process for producing structures that can be configured into a variety of stable shapes without plastically deforming the material (e.g. a metal sheet that can be rolled into a tube). These structures are named multistable structures. The scientist has developed a number of samples and sketch models that have been used to show the potential of multistable materials to different potential industrial partners. In particular, he has built a sketch model of an accessory using bistable hinges (Bistable is a form of multistable material that changes from one shape to other as a consequence of a mechanical effort). However the size of the hinge seems too large and not easily adaptable to the accessory body. An accessories manufacturer has taken interest in this product and the scientist and the university technology transfer officer believe that manufacturing a more sophisticated and “designed” model of the accessory will help to cement the interest of the accessories manufacturer. They also believe that this material will allow the production of low cost accessories for people with limited purchasing power.

Scientists’ Requirements

The scientist was looking for the development of a bistable hinge of an appropriate size to be used in an accessory. He also wanted to build a new model of this accessory made out of metal with an integral bistable hinge, in order to use it as an example of the potential use of multistable technology in industry. Lastly they wanted to expand the range of possible applications for multistable structures.

The Design Team Approach

In the first meeting with the project team, the scientist explained the principles of the process that he developed to bring multistable properties to metallic sheets, and he showed some samples of multistable and bistable materials. He also brought the accessory's hinge sketch model. After this first meeting, there were discussions amongst the design team about the suitability of this case, since it seemed that the scientist's need (and the university technology transfer officers' needs) for design input, was more focussed on attracting commercial interest in his patented process than progressing his research activities. However, the designers thought that during the process of developing the hinge, questions would arise that may foster new thinking and encourage new directions in the scientific research. On this ground, the designers engaged in collaboration.

The Design Process

Soon after starting the development of some initial concepts the designers realised that it was necessary to have access to the multistable materials and to learn the multistable forming process in practice. For this reason, the scientist granted the designers access to the workshop in which the multistable samples had been made, so the designers could learn and practice the multistable forming process, and use multistable material for sketch modelling.

During this period of experimentation it became clear to the designers that although the nature of multistable materials was well understood by the scientist, the process of formation of multistable material was not standardized, and the tools used for it did not allow a precise control of the process. Furthermore, knowledge about the process of achieving multistability has been developed only for one type of material, and any idea that implied the use of a new material would first require the development of a new material-specific process. The project team met to discuss these issues. Through the discussion it became evident that any development of applications for the multistable process would need further development of its theoretical base, and would need the intervention of engineers with the expertise to perfect the process and make it more precise, and to develop more adequate tools for the experimental production of multistable material.

Regarding the development of the hinge, the designers also pointed out at that the rationale of using multistable material to produce accessories for people with limited purchase power may have not been appropriate. Producing accessories with multistable material would probably be more expensive than doing it with other competing materials, for example injected moulded plastic. Furthermore, developing accessories using bistable material would not necessarily be the right strategy to raise interest from the accessories manufacturer. A working model of a bistable hinge should be enough to show the potential of the process.

At the end of this meeting, the project team realized that on one hand it was too early for the type of collaboration that has been set up, and on the other hand, the planned project outputs were not adequate for its aims. At this point it was agreed that the collaboration should be postponed.

Initial Findings

The case studies have offered insight related to the questions into the initial research questions:

- Can designers meaningfully contribute to scientific research, and if so, what would be the nature of such contribution?
- What would be the main aspects that can act either as a barrier or as a facilitator for collaboration between designers and scientists, in the context of scientific research?

1. Design Contribution

Although the designers contributed to scientific research, the nature of this contribution was different in each of the studies.

Case 1: Mask Project

By developing the mask, the design team contributed to the scientist's research by delivering a suitable design proposal for experiments to be conducted. Also, the designers contributed to the scientist's understanding of the differences between developing a mask for experimentation and a mask for commercialisation. Additionally, the design input affected the scientist's understanding of his mask original idea and opened his mind to new possible solutions.

In addition the designers enhanced the commercial potential of the research, by providing a model that can help the scientist to attract partners or investors. In this way, the designers set the foundations for a viable product, potentially useful for other researchers, and for clinical applications.

Case 2: Immuno Project

By delivering a new system for Immuno Assay tests, the design team developed a tool that will potentially make the scientist's research procedures faster, safer and less expensive. If commercially exploited, these benefits can extend to other research and clinical laboratories around the world.

The designers also helped to bring the scientists' idea to a level of development advanced enough to make it easier to apply for a grant for funding further development. Finally, the designers' intervention brought the project closer towards commercialisation.

Case 3: Multistable Project

Even though the collaboration did not have any specific design output, the designers made a contribution to the scientist understanding of his own research. By specifying to the project team what was needed before designers could make a meaningful intervention in the project, the scientist was able to reassess his research priorities in regards to the development of the multistable production process. Thus, the designer's intervention triggered the project team's reassessment of their strategy towards the commercialisation of the multistable application in the accessories industry.

2. Barriers and Facilitators

Some common issues arose from the case studies that can be identified as barriers or facilitators for collaboration between designers and scientists in scientific research.

Communication

Some issues regarding communication acted as a barrier in the projects. For example, the designers' understanding of some important aspects and features of the projects was slowed down at the beginning by the scientists' use of specialised vocabulary and acronyms. However, this was quickly solved by the designers using different resources including direct questions to the scientists, internet searches, and elaboration of written summaries and graphic diagrams. An example of this was seen in the Immuno project, in which the designers created a diagram of the immuno assay process, associating scientific nomenclature, pictograms and text. The scientist also helped to overcome this problem by making an effort to filter out some technical expressions from their vocabulary while talking to the designers, but sometimes this resulted in key pieces of information being partly communicated. These omissions were later found to be critical to the design task. But on the whole, the combination of the efforts of designers and scientists allowed the creation of a basic vocabulary kit that permitted a fluent exchange of ideas.

Standard design communication tools such as drawings, sketches and models were useful to facilitate communication during the collaboration. Also, the design brief became instrumental in ensuring that all project stakeholders had a mutual understanding of the project main features and the nature of the collaboration. It helped to make explicit any misunderstanding that problems of communication may have produced.

Roles

Understanding of roles by all members of the project team became a fundamental aspect of collaboration between designers and scientists. Lack of clarity on the roles that scientist and designers play in regards to the design activity, can become a barrier for collaboration. In the Mask Project for example, the scientist independently made design changes to prototypes that compromised some of the basic principles of the designers' concept. Although well meant, these changes sometimes created tensions between the scientist and the designers. However, they proved to be useful in the long term, since a final solution was reached by combining both the designers' and the scientist's ideas.

The Immuno Project was different in this aspect. Even though the scientists had produced some design ideas before the beginning of the collaboration, they kept them aside during the project. Interestingly, during presentations and interim meetings while testing the prototypes produced by the designers, both designers and scientists agreed on design direction by consensus. This was a form of co-design with scientist and designers sharing the design role. However, it was the design team who pushed the ideas forward and when necessary, changed the project direction.

Another issue that can become a barrier in designers and scientists collaboration was the preconception that scientists had about a designer's abilities. At the beginning of the Mask Project for example, the scientist said that he was looking for design input since he did not "know anything about materials and (he was) not good with (his) hands". This view did not change: He stated at the end of it that the designers' main contribution to the project was related to the new materials they found and to their professional standard of prototype.

On the other hand, designers failing to be explicit about their role and capabilities can also become a barrier for collaboration. In the case of the Multistable project, the scientist expected that the designers would be able to do a job that should be actually done by a manufacturing engineer (develop multistable elements from new materials). An early conversation about the designers' capabilities and limitations would have been useful and would have saved time.

Preparedness and relevance

Another aspect that potentially can hinder collaboration between designers and scientist is the project's readiness for design intervention. Design development input can be limited if certain preconditions are not met. For example in the multistable project, the requirement of developing a new product (hinge for accessories) was not timely since the process to produce multistability was not fully developed and multistable materials were not standardised. On the other hand, the immediate need of that project was related to the further development of a production process, which made the product design input irrelevant at that stage. This highlights another aspect that can become a barrier for collaboration; there may be certain stages in projects for which Product/Industrial Design input is not relevant.

Conclusions

This paper has examined three case studies of collaboration between designers and scientist in the context of scientific research. It described their background, the scientists' design requirements and the design team approach. It also offered details about their design briefs and design processes.

This document has also summarised the initial findings of the research, specifying the design contribution to research in each of the projects, and the possible barriers and facilitators in collaborative effort between designers and scientists.

This work provides an initial step towards understanding the ways in which designers might contribute to scientific research and to its related activities. By developing this understanding further, it is expected that strategies that facilitate collaboration between product/industrial designers can be developed. In the long run this might also influence the way in which scientific research proposals and funding applications are made and the way in which scientific research teams are configured. Most importantly, the results may change scientist and designers' perception of each other, potentially fostering collaboration.

While this paper has attempted to outline aspects such as communication, roles, preparedness and relevance to highlight possible barriers and facilitators in collaborative work between designers and scientists, other equally important aspects such as personal characteristics and personal attitudes have been left aside. Questions like: How do personal characteristics such as age, interests, personal views or working habits affect the success of collaboration, or what is the importance of designers' and scientists' attitudes towards other disciplines and ways of working when they engage in collaborative endeavour.

Although this paper has provided some initial examples of the potential role of designers in supporting scientific research, they are based only in a type of collaboration in which designers engage with scientist in a form similar to that of the client and the design consultant. The nature of these case studies, in which the scientists identify a design issue and seek design professional intervention, implicitly excludes the designers from a direct intervention in the core of their research.

Future case studies may team up designers and scientists to meet the needs of a mutually agreed research project based on a scientific question, so that in this way, the role of designers may switch from that of a design provider to that of a researcher with a design background. In this manner, new and unexpected ways of design contribution to scientific research may be revealed.

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Cognitive Biases and Design Research: Using insights from behavioral economics and cognitive psychology to re-evaluate design research methods

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Abstract

In light of well-established principles in behavioral economics and cognitive psychology, we consider how minor variants in the structure, framing, and phrasing of several common design research activities may unintentionally elicit more biased participant responses than currently recognized. To begin investigating the relationship between minor modifications to design research activities and changes in participant responses, we propose designs for three experiments, and then explore their weaknesses and limitations through a short-term pilot study.

In our discussion, we suggest that a better understanding of cognitive biases may be used to produce more accurate and salient participant responses – either by minimizing or by explicitly eliciting activity- and context-induced biases as appropriate to the research at hand. Additionally, we propose that recognition of context-dependent preferences could lead to more holistic models of user behavior.

This early research is a work in progress. The principle aim of this paper is to provide a conceptual foundation for additional research into how participants' cognitive biases might influence the outcome of design research activities, and related implications for research activity design.

Keywords

Design methods; Cross, trans, inter, multi-disciplinarity; Cognition; Behavioral economics; Cognitive biases

Seemingly irrational behavior is pervasive in everyday decision making. People routinely make decisions that are not in their own best interests: they fail to participate in company-matching 401(k) programs despite being essentially offered free money; they smoke despite knowing the long-term risks of lung cancer; and they volunteer to work for free.

As design researchers, we strive to develop holistic models of human behavior within specific domains. Our models, and the methods by which we seek to discover, challenge, and extend them, will be most effective if they take into account both the conscious and unconscious 'irrational' behaviors people exhibit daily.

The field of behavioral economics, which draws upon both classic and contemporary cognitive psychology, offers substantial experimental data that help explain the ways in which irrational decision making is influenced by seemingly minor and irrelevant factors (see Rabin, 1998).

Literature review

Judgmental heuristics

Psychologists Tversky and Kahneman[1] (1974) proposed that irrational decision making can be partially understood in terms of judgemental heuristics and the cognitive biases to which they lead. *Judgmental heuristics* are the mental shortcuts that help our brains process information and quickly make decisions. Without these heuristics, we would be faced with the insurmountable task of evaluating every small piece of information we encounter every second of every day.

In particular, Tversky and Kahneman (1974) identified three heuristics commonly used to estimate probabilities and values: representativeness, availability, and adjustment and anchoring. *Representativeness* is defined as assessing the likelihood that a person or item belongs to a particular group based on how closely it aligns with one's existing understanding of that group; such assessment often involves drawing upon stereotypes. *Availability* is defined as estimating the frequency or probability of an event based on how easily examples of the event come to mind. Examples that are particularly visceral or salient are more likely to stand out, thus causing people to overestimate the frequency of their occurrence. *Adjustment and anchoring* is defined as estimating a probability or amount by starting from an initial reference point and then making adjustments in the direction that seems most appropriate.

Judgemental heuristics enable us to function efficiently in the face of large amounts of information and stimuli. However, reliance on these shortcuts can lead to systematic *cognitive biases*, i.e., tendencies to evaluate information, exhibit behaviors, and make decisions in consistently biased ways.

Cognitive biases and common behavioral tendencies

Substantial work in behavioral economics and cognitive psychology has been devoted to exploring, challenging, and uncovering the scope of cognitive biases, including those that stem from judgemental heuristics (see Rabin, 1998). Many of these findings suggest that what people think they like, need, and want – topics particularly relevant to design research – is often influenced by the way their options are framed.

Previous studies, such as those discussed below, have focused on the application of this knowledge to the domains of market research, consumer decision making, and product appraisal. However, we argue that there is greater relevance to the larger domain of design research: cognitive biases not only provide insight into participants' decision-making behavior, they can inform how we attempt to elicit and understand participants' preferences.

The following overview is organized around seven behavioral tendencies, selected because they have been widely circulated in behavioral economics discussions and because they are particularly relevant to design research. These tendencies are summarized in Table 1.

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[1] Kahneman was awarded the 2002 Nobel Prize in Economics for his contributions to the field (Nobel Foundation).

Behavioral Tendency	Description	Sources
Loss Aversion	Tendency to avoid options that result in a loss relative to one's current reference point, and to perceive losses as more impactful than gains of equal value	Kahneman & Tversky (1979); Tversky & Kahneman (1991); McNeil, Pauker, Sox & Tversky (1982); Tversky & Kahneman (1986); Wertenbroch & Dhar (2000)
Endowment Effect	Tendency to attribute increased value to an owned item or entity	Thaler (1980); Kahneman, Knetsch & Thaler (1990);
Status Quo Bias	Tendency to select a default option when one is present	Samuelson & Zeckhauser (1988); Madrian & Shea (2001)
Affective Forecasting Error	Tendency to inaccurately predict future emotional states	Loewenstein & Schkade (1999); Simonson (1990); Gilbert et al. (1998); Loewenstein (1996)
Context-Dependent Preferences	Tendency to change one's preferences based on context, including how many options are being compared and the nature of their comparison (joint or separate)	Simonson & Tversky (1992); Tversky & Simonson (1993); Hsee & LeClerc (1998)
Affective-Cognitive Decision Making	Tendency to be more influenced by affective reactions than cognitive reactions when cognitive resources are limited	Shiv & Fedorikhin (1999)
Introspection and Consideration Override	Tendency to alter one's preferences when prompted to analyze them	Wilson & Schooler (1991); Amir & Ariely (2007)

Table 1 Summary of relevant behavioral tendencies

Loss Aversion: Is it a loss or a gain?

Kahneman and Tversky (1979) found that the framing of decisions, prospects, and possible outcomes influences the way people make decisions. People tend to evaluate options in terms of whether they result in a loss or a gain relative to a starting reference point. Losses are seen as being more impactful than gains of equal value, and as such people tend to avoid outcomes that involve loss. This behavioral tendency is known as *loss aversion* (Tversky & Kahneman, 1991).

Typically, people do not fully consider a given option in terms of both potential loss and potential gain; instead they generally accept the loss or gain frame in which the option is initially presented. Framing the same option in terms of a loss or a gain has been found to substantially change the perception of its desirability (McNeil, Pauker, Sox, & Tversky, 1982; Tversky & Kahneman, 1986). For example, McNeil et al. (1982) found that framing the same medical treatment option in terms of probability of living versus probability of dying substantially affected the perceived attractiveness of that option relative to other treatment options.

The hedonic versus utilitarian nature of an item can impact the degree of loss aversion. Wertenbroch and Dhar (2000) found that, when choosing to acquire either a hedonic item (like an apartment with a nice view) or a utilitarian item (like an apartment with a short commute to work), people usually choose to acquire the utilitarian item. But when choosing to give up a hedonic item or a utilitarian item, people usually choose to give up the utilitarian item.

The Endowment Effect: Is ownership involved?

Thaler (1980) identified the *endowment effect*, related to loss aversion, in which the sense of loss associated with giving up an item is greater than the sense of gain associated with receiving the same item; ownership increases the perception of value. Aligned with this concept, Kahneman, Knetsch and Thaler (1990) found that the seller of an item is more likely to ask for a price that is higher than a buyer would otherwise offer to pay.

The Status Quo Bias: Is there a default choice?

Samuelson and Zeckhauser (1988) identified the *status quo bias*, in which people overwhelmingly tend to select a default option when one is available. For example, Madrian and Shea (2001) found that 401(k) plan enrollment substantially increases when enrollment is the default option.

Affective Forecasting Error: Are participants attempting to predict their future emotions?

Numerous experiments have found that people's predictions of their future emotional states tend to be inaccurate, even in the short term (for an overview, see Loewenstein and Schkade, 1999). For example, Simonson (1990) found that when people make long-term decisions, they tend to favor more variety than they actually want when the future outcome occurs. Specifically, when people purchase several items in advance and consume them over time, they tend to seek more variety than when they purchase items with the intention of immediately consuming them. Gilbert et al. (1998) found that people tend to "overestimate the duration of their affective reactions to negative events" (p. 617) that might occur in the future, for example, a romantic breakup or the death of a child. Loewenstein (1996) found that, when in a "cold" state, people have difficulty predicting their feelings in a "hot" state (such as hunger or sexual arousal).

Context-Dependent Preferences: How many options are there?

Several experiments indicate that the number of options present in a decision-making scenario can influence preference. Simonson and Tversky (1992) found that intermediate options, in general, are most appealing; people tend to exhibit *extremeness aversion*. In another study, Tversky and Simonson (1993) found that, when selecting between two options, the introduction of a third option can greatly influence the way the original two options are perceived in comparison, and can even cause a reversal of preferences relative to the original two options. Additionally, Hsee and LeClerc (1998) found that comparing two attractive items in a joint evaluation decreases their overall attractiveness, whereas comparing two unattractive items in a joint evaluation increases their overall attractiveness.

Affective-Cognitive Decision Making: Are cognitive resources limited?

Shiv and Fedorikhin (1999) found that when cognitive resources are limited, people are more likely to be influenced by their affective rather than cognitive reactions when making a decision. Specifically, they conducted an experiment in which participants were told to memorize either a two-digit number (low cognitive load) or a seven-digit number (high cognitive load), and then walk to a different room and tell the number to another researcher. While walking to the other room and keeping the number in mind, participants were asked to select a snack, either fruit salad or chocolate cake, that they would receive for having participated in the study. Participants with the higher cognitive load were much more likely to select chocolate cake over fruit salad; they were more likely to be influenced by their affective reactions because their cognitive resources were limited.

Introspection and Consideration Override: Are participants being asked to analyze their preferences?

Numerous findings suggest that what people think they like, need, or want can change depending on whether or not they are instructed to analyze their preferences. In most cases this appears to result in more rational decision making, by overriding cognitive biases like loss aversion. For example, Amir and Ariely (2007) found that people tend to exhibit inconsistent preferences when primed to think about the pleasure (gain) associated with an option, versus the payment (loss) associated with an option – but when participants are asked to carefully consider their preferences, that inconsistency is reduced. This concept is referred to as *consideration override*.

But heightened rationality may not always result in optimal decision making. Wilson and Schooler (1991) found that asking people to analyze their preferences for strawberry jams caused “them to base their subsequent choices on [non-optimal] criteria” (p. 181), thus resulting in less optimal choices, compared to those of an expert. This suggests the possibility that people are not always aware of the motivations for their preferences, and that asking them to analyze those preferences may result in post-rationalization that causes the initial preferences to change.

Implications for design research

In light of these and similar findings, it is possible that minor variants in the structure, framing, and phrasing of design research activities may unintentionally elicit more biased participant responses than currently recognized. In particular, design research activities that require participants to make and analyze preference decisions should be thoughtfully examined with an eye toward the cognitive biases they might unintentionally induce.

In the next section, we evaluate three design research activities through the lens of behavioral economics and cognitive psychology. In the following section, we propose experiments to test the implications of our evaluations. Finally, we discuss insights into the challenges and limitations of the experiment design, which were identified during a short-term pilot study.

Evaluating three design research activities

We set out to evaluate the following design research activities through the lens of behavioral economics and cognitive psychology:

1. A product comparison task, in which participants indicate which product they prefer;
2. A feature selection task, in which participants construct a set of desirable product features from a provided list of possible features;
3. A storytelling task, in which participants tell stories about previous life experiences.

In this evaluation we identified three concepts from behavioral economics as particularly relevant: context-dependent preferences, loss aversion, and anchoring and availability (see Literature Review).

Evaluation of research activity 1: A product comparison task

Consider a design research activity related to product comparison in which participants face a set of items to compare and are asked to indicate their preference. Such a scenario may occur as part of a structured activity, for example during a lab-based prototype test, or more informally, for example during a shop-along in which participants decide which items to purchase.

Two behavioral tendencies discussed in the literature review are particularly relevant to such an activity: context-dependent preferences and extremeness aversion. Previous research related to these tendencies (Simonson & Tversky, 1992; Tversky & Simonson, 1993) leads us to believe that the number of items being compared in a product comparison task may substantially impact a participant's preferences. Specifically, we hypothesize that in a three-item product comparison, participants will be more likely to express a preference for the intermediate option than when that same option is included in a two-item comparison.

Evaluation of research activity 2: A feature selection task

Consider design research tasks in which participants are asked to indicate which features they like most from a provided set of features. The activity could easily be framed as a gain ("Which features would you keep?") or as a loss ("Which features would you get rid of?").

Loss aversion, a behavioral tendency discussed in the literature review, is particularly relevant to such an activity. Previous research on loss aversion (Kahneman & Tversky, 1979; Tversky & Kahneman, 1991) leads us to believe that framing a feature selection task as a loss may result in fewer items being selected for removal because participants attempt to avoid losses. Specifically, we hypothesize that framing a feature selection task as a loss will result in a larger set of desired features than when the task is framed as a gain.

Evaluation of research activity 3: A storytelling task

Consider design research scenarios in which participants are prompted to relate personal stories. This commonly occurs during contextual and ethnographic interviews.

Availability, a judgmental heuristic discussed in the literature review, is particularly relevant to storytelling activities. Previous research on availability (Tversky & Kahneman, 1974) leads us to believe that design research activities requiring a participant to tell a story could increase the participant's perception of the story's saliency, particularly if the story involves hedonic or visceral elements. Storytelling activities might increase the availability of the recounted and similar memories, thus affecting the participant's perception of the probability of similar events occurring. We hypothesize that storytelling could act as an inadvertent form of priming – that anecdotes brought up during storytelling have heightened saliency, and therefore may influence participant responses during subsequent research activities.

Experiment design

Following the evaluation of the three design research activities above, three experiments were developed as a first step in exploring how minor variations in framing, phrasing, and execution of these design research activities might lead to consistently biased results. All three experiments were designed to be part of a hypothetical design research study related to the iRobot Roomba, a robotic vacuum cleaner.

Design of experiment 1: Variations on a product comparison task

We hypothesized that in a three-item product comparison participants will be more likely to express a preference for the intermediate option than when that same option is included in a two-item comparison.

Thus, we propose an experiment in which half the participants engage in a two-item comparison (Group A), while the other half engages in a three-item comparison (Group B).

Participants in Group A will be presented with worksheets containing images and feature descriptions of two robotic vacuum cleaners (see Figure 1) – a low-feature, low-price product and a medium-feature, medium-price product – and asked to indicate their preference. Participants in Group B will be presented with worksheets containing image and feature descriptions of three robotic vacuum cleaners (see Figure 2) – the two options presented to Group A plus a high-feature, high-price product – and asked to indicate their preference.

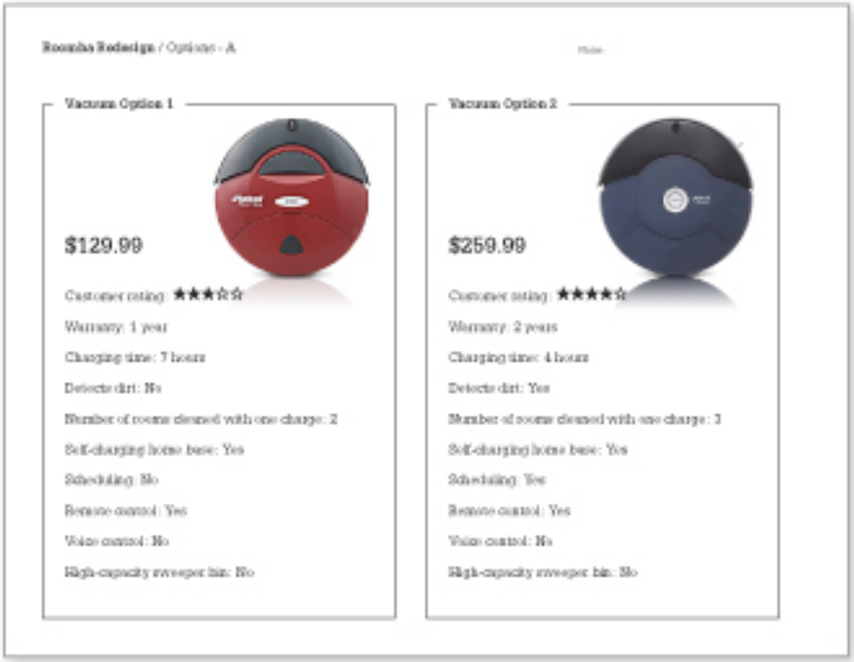

Figure 1 Product comparison worksheet for Group A

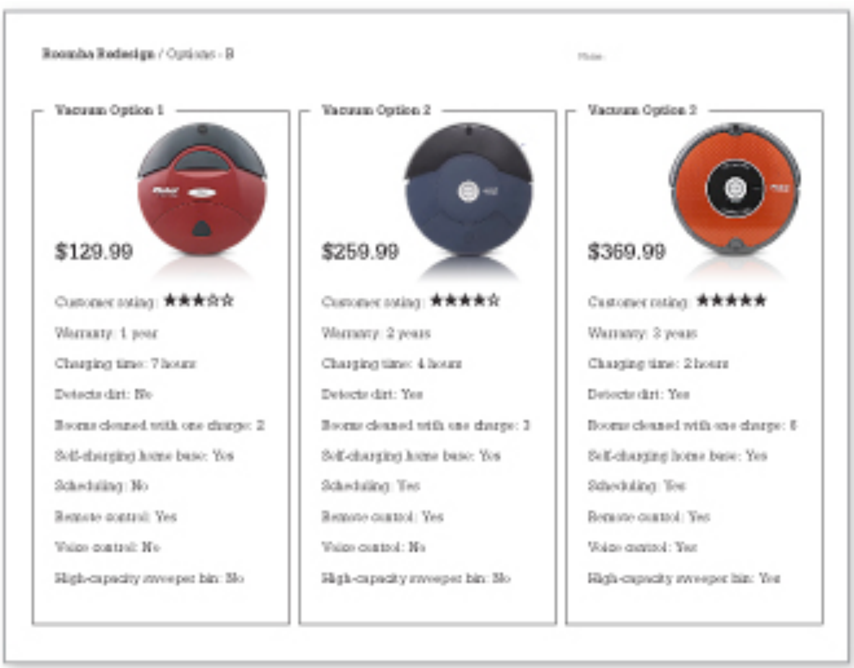

Figure 2 Product comparison worksheet for Group B

Design of experiment for activity 2: Variations on a feature selection task

We hypothesized that framing a feature selection task as a loss will result in a larger set of desired features than when the task is framed as a gain.

Thus, we propose an experiment in which half the participants engage in a feature selection task framed as a loss (Group A), while the other half engages in a feature selection task framed as a gain (Group B).

Participants in Group A will be presented with a set of 18 possible features for a robotic vacuum cleaner and asked to remove the features they would not include in the final design (the loss frame). Participants in Group B will be presented with the same 18 possible features and asked to select the features they would include in the final design (the gain frame). Each participant will receive 18 strips of paper naming the features along with a worksheet upon which to arrange them (see Figures 3, 4).

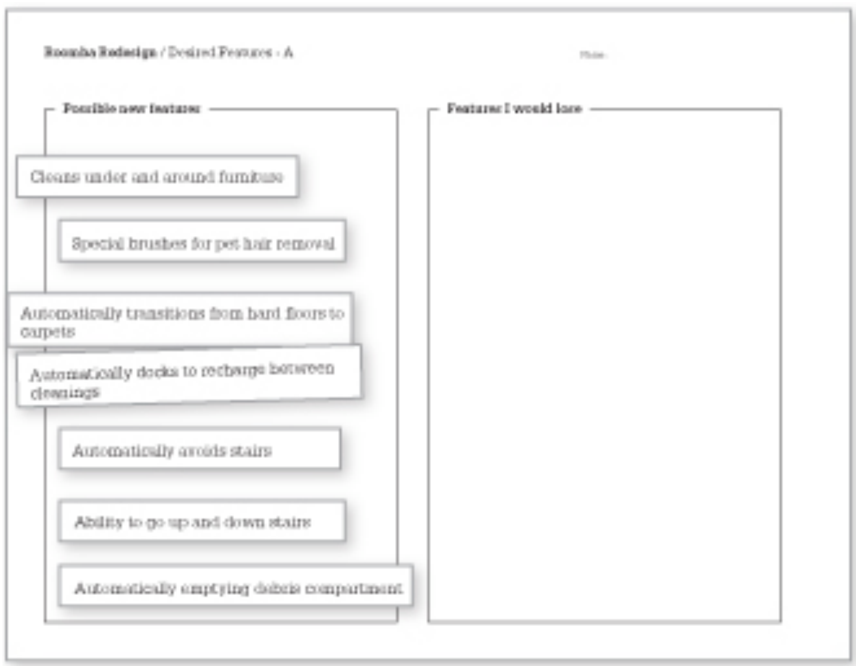

Figure 3 Feature selection worksheet for Group A (loss frame), showing a subset of features

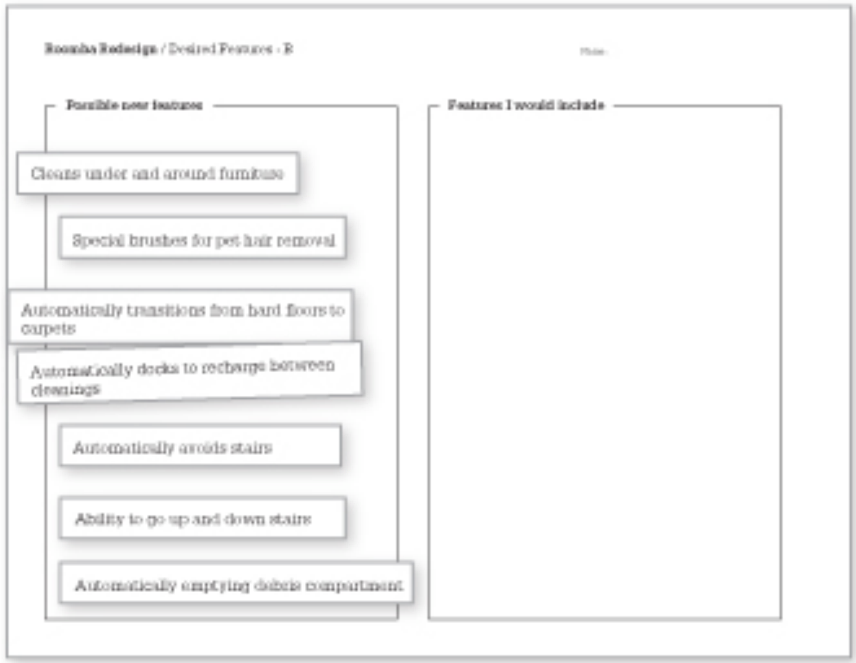

Figure 4 Feature selection worksheet for Group B (gain frame), showing a subset of features

Design of experiment for activity 3: Variations on a storytelling task

We hypothesized that storytelling could act as an inadvertent form of priming – that anecdotes brought up during storytelling have heightened saliency, and therefore may influence participant responses during subsequent research activities.

Thus, we propose an experiment in which half the participants describe positive memories indirectly related to a product (Group A), and the other half describe negative memories indirectly related to the same product (Group B). All participants are then asked to evaluate their interest in purchasing that product now or in the future.

Participants in Group A will be asked to recall and describe a time when their home was clean and it made them happy (see Figure 7). Participants in Group B will be asked to recall and describe a time when they had a frustrating experience with technology (see Figure 8). All participants will then be asked to rate their interest in purchasing a robotic vacuum cleaner now or in the future, on a scale of 1-5 (5 being most interested).

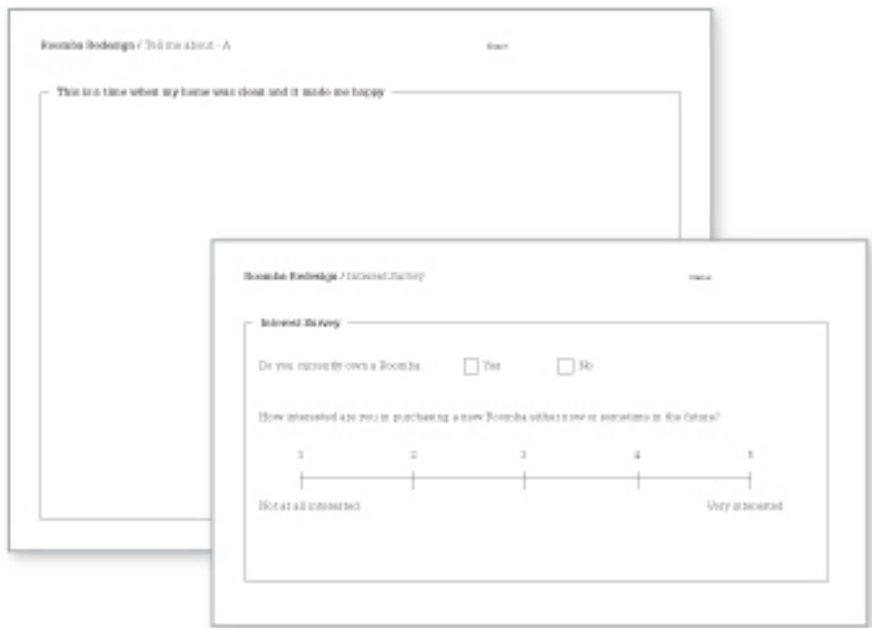

Figure 7 Storytelling and interest rating worksheets for Group A (positive story)

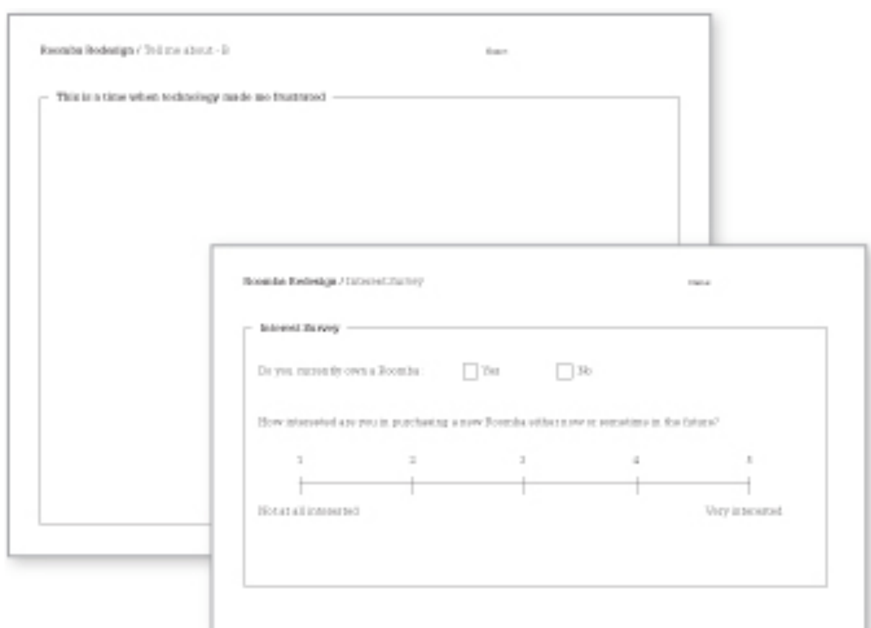

Figure 8 Storytelling and interest rating worksheet for Group B (negative story)

Note that in real one-on-one design research interviews, the storytelling prompts would likely be less leading. For the purposes of this experiment, we specifically wanted to compare the effect of a participant recalling and sharing a positive story versus a negative story on his or her subsequent behavior and decisions.

Challenges and limitations identified during a pilot study

After designing the three experiments described above, the first author executed an exploratory pilot study in November and December 2009. The primary aim of the pilot study was to identify challenges and limitations related to the design and conduct of the experiments, which could inform future work.

For the pilot study, ten Master's of Design student participants (three males, seven females) were recruited from the IIT Institute of Design. They were invited to participate in a study about Roomba vacuum cleaners and were not aware that the study was actually concerned with the evaluation of design research activities informed by behavioral economics and cognitive psychology. Of the ten participants, three were Roomba owners.

Pilot study sessions were conducted one-on-one (one participant with the first author as facilitator). In each session, participants completed the three design experiments described above[2]. The order of the activities remained consistent across all sessions. While it may have been desirable to randomize the order in theory, the placement of the storytelling activity could affect the outcome of the other activities in a session. The A/B variation within each design research activity was randomly determined for an equal distribution of the variations across participants.

Reporting on the pilot study is intended only as an exploratory foundation for additional research in this area; given the small number of participants, the pilot study was not intended to provide conclusive, robust or statistically significant results. Future studies should be planned that feature revised and more extensive experiments, utilize a much larger and more diverse sample, and are potentially double blind to prevent facilitator behavior or knowledge of the experiment from influencing participant behavior.

While they are neither conclusive nor statistically significant, findings from pilot study experiments are aligned with the initial hypotheses.

Reflecting on experiment 1: Variations on a product comparison task

In the pilot study, Group A (n=6) was presented with the two-product comparison, and Group B (n=4)[3] was presented with the three-product comparison. In Group A, two participants selected the low-feature option, and four participants selected the medium-feature option. In Group B, however, all four participants selected the medium-feature option.

We recognize that special care needs to be taken when selecting the products and features to be included in the product comparisons. For example, if one product appears more utilitarian or hedonic than the others, or if one product evokes a sense of ownership, preferences may be additionally impacted by loss aversion and the endowment effect, respectively. While these would be interesting effects to consider in the context of a product comparison activity, their presence in this particular experiment

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[2] In between the second and third experiments described above, pilot study participants also completed a point distribution activity, which we do not discuss here due to space limitations.

[3] The 6-4 breakdown of participants, as opposed to a desired 5-5 breakdown, was the result of human error during the random group assignment.

may make it difficult to evaluate the impact of changes to the number of products being compared on participant preferences.

Additionally, during the pilot study participants referred to their current vacuum cleaners and their budgetary constraints in relation to their preferences; these variables should be controlled for in future studies.

Reflecting on experiment 2: Variations on a feature selection task

In the pilot study, Group A (n=5) was presented with the loss frame and Group B (n=5) was presented with the gain frame. Out of 18 possible features, Group A produced a feature inclusion set of average size 11.2, whereas Group B produced a feature inclusion set of average size 8.8.

We recognize that participants' starting reference points may be influenced by their current vacuum cleaner in addition to the 18 product features presented. Removing a feature may not only represent a loss relative to the starting set of 18 features, but a loss relative to the features on their current vacuum cleaners, amplifying the overall sense of loss. To better understand results from this experiment, information about participants' current vacuum cleaners should be collected.

We also note that the type of features presented may affect participant preferences. According to Wertenbroch and Dhar (2000), when people are faced with acquiring either a utilitarian or hedonic item, they tend to select the utilitarian item. But when people are faced with forfeiting either a utilitarian or hedonic item, they tend to keep the hedonic item. As such, the hedonic/utilitarian nature of the features may impact preferences, particularly as they relate to participants' current vacuum cleaners.

Reflecting on experiment 3: Variations on a storytelling task

In the pilot study, each participant in Group A (n=5) was asked to recall a positive memory whereas those in Group B (n=5) were asked to recall a negative memory. Group A indicated an average interest rating of 4.3, whereas Group B indicated an average interest rating of 3.1.

Moreover, non-owners' interest ratings seemed to be more affected by the impact of telling a negative story than those of Roomba owners. Of the non-owners, those who told the positive story (n=4) indicated an average interest rating of 4.125, whereas those who told the negative story (n=3) indicated an average interest rating of 2.5.

This may suggest that when an existing reference point is lacking, storytelling may have greater influence on a participant's behavior during subsequent research activities. This may also be indicative of owners post-rationalizing their purchases, or attributing increased value to the Roombas they already own (viz. the endowment effect). Current Roomba ownership, then, would be an important factor to control for in future studies.

We also note that, while the storytelling worksheet for both groups in this experiment provided a space for sketching a picture to go along with the story being told, only a few participants made sketches. It's possible that the act of sketching increases the saliency of a story – and as such all participants in future experiments should be instructed either to sketch or not to sketch along with their stories.

Discussion

As design researchers, we attempt to plan and conduct user research activities that help us uncover participants' underlying desires and latent needs. Given the prevalence of cognitive biases, we need to carefully plan the tasks and contexts involved in design research to understand how the structure and conduct of design research activities may influence the ways participants perceive information, assess options, and ultimately make decisions. We argue that small changes in design research activities may lead to predictably biased participant responses, aligned with findings from behavioral economics and cognitive psychology.

Failing to understand cognitive biases in the context of design research could lead to: (1) inaccurate research findings because participants are being unintentionally and unknowingly influenced into producing biased responses; (2) inappropriate interpretations of research findings that fail to account for cognitive biases that may be induced by the task or context at hand; or (3) inappropriate extrapolation of research findings to other contexts without an understanding of how cognitive biases may change across contexts.

An awareness and understanding of cognitive biases will allow design researchers to better avoid unknowingly influencing participants in subtle and non-obvious ways via activity- and context-induced biases. Changes in research techniques and activity design may be necessary to produce more accurate participant responses. However, it is natural to ask: is it possible, or even desirable, for design research activities to be truly neutral? Is it possible for our research to avoid inducing any and all cognitive biases, in favor of strictly rational decision making?

Given the directionality and intention of design projects, there likely does not exist a design research activity that exerts no influence on participants, nor one that reveals direct insight into a participant's true preferences. But this should not discourage us. Based on research from behavioral economics and cognitive psychology, it seems that user preferences are not stable but rather that preferences change based on context, framing, and the set of options being considered at a given time. Amir and Levav (2008) propose that, rather than ever really deliberately constructing preferences, people often "learn context-specific choice strategies without ever really engaging in difficult subjective value assessment… they simply learn to repeatedly use contextual cues" (pp. 155-156).

Assuming that participant preferences are dynamic in nature, and both affect- and context-sensitive, design research has an opportunity to explore the nuances of how a preference changes across contexts. This might suggest a shift in the way we model users' preferences: rather than assuming that users have inherent preferences, we should recognize and take advantage of the fact that users have dynamic and context-sensitive preferences.

Finally, a deeper understanding of cognitive biases could allow design researchers to explicitly design research activities that induce certain biases, in order to mimic biases present in other real-world scenarios or contexts. For example, when attempting to understand preferences as they exist in the current marketplace, design research activities should attempt to evoke the conditions of the marketplace. Given that consumers' choices are affected by cognitive biases that may result in seemingly 'irrational' decisions, it would not be beneficial to artificially de-bias users during a design research activity and then take those results as representative of real-world behavior.

Findings from behavioral economics may offer new insights into how to better replicate and model participant decision making in real-world scenarios.

Conclusion

In this paper, we evaluated three common design research activities in light of experimentally documented cognitive biases and judgemental heuristics. Whether or not existing design research protocols could be improved given this knowledge, it will benefit design researchers and designers to be informed about – and possibly participate in – ongoing research in the realm of behavioral economics and decision making. Hopefully this paper will spark additional discussion and research in this space.

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Designing for the periphery of our attention: a study on Ambient Information Systems

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Abstract

This article discusses a specific category of information systems known as Ambient Information Systems. These systems present information in a non-intrusive manner, acting mostly on the periphery of our attention, following Mark Weiser's concept of *calm technology*.

The major concern that drives the development of these systems can be summarized in two aspects: first, as pervasive computing increases, ordinary objects are becoming capable of processing and displaying data, thus the consumption of information will occur in many different contexts, which may contribute to an information overload, generating stress. The second aspect is that Design plays a major role in developing better ways to deal with this information overload. For a long time designers have been studying how to design communication systems that drive our attention, but little research has been done in exploring how to design communication systems that act upon the periphery of our attention.

In this article four Ambient Information Systems are discussed, highlighting their characteristics and limitations. As a conclusion, the author proposes an agenda of topics that should be tackled to advance future research on this subject.

Keywords

Pervasive computing; interaction design; information design; preattentive processing

Amid the rush and bustle of urban centers, we are exposed to many different information systems[1]. Although the presence of such systems can be easily perceived, it is possible to go by without noticing them, usually because we don't feel the need to consult the data they present, or because we have our attention focused on other tasks. Public clocks, traffic status displays, are some of the most obvious examples of these systems. Advertising posters and outdoors that populate our urban landscape are also information systems with which we deal every day and often go unnoticed. Their presence does not require our immediate attention, staying mostly on the periphery of our perception. When these information systems are augmented with computer technology, they are also called peripheral displays (Mankoff & Dey, 2003).

Much has been said about the overwhelming amount of information to which we have been exposed lately. This is partially due to the increasing use of computers in the beginning of this century, which not only has made it easier to produce and distribute data, but also has increased the connectivity between different systems, cultures and people all over the world. The changes we experience are so intense that it is common to use terms like "digital revolution", "information technology revolution", "information revolution" to describe them. The word "revolution", common

[1] **Information systems** refers to all the persons, procedures and equipment designed, built, operated and maintained in order to collect, record, process, store, retrieve and display information, using different technologies (Houaiss & Villar, 2001). In this article we are especially interested in (but not limited to) systems that use computer technology to collect, record, process and display information.

to these definitions, implies that radical changes are underway, in the sense that there is a rupture, which extends from the global economy to the private activities of an individual.

As a side effect of this digital revolution, information now comes from many sources and in different formats, such as text messages and Twitter tweets in our mobile phones, RSS Feeds, Facebook friend's updates, instant messages on our desktop computers, e-mail, and so on. Although it seems to be almost impossible to keep track of this amount of data on daily basis, as Hemp (2009) points out, we're still compelled to do so, even if it make us feel uncomfortable:

> The flood of information that swamps me daily seems to produce more pain than gain. And it's not just the incoming tidal wave of e-mail messages and RSS feeds that causes me grief. It's also the vast ocean of information I feel compelled to go out and explore in order to keep up in my job (Hemp, 2009, p.2).

As ubiquitous and pervasive computing increases, ordinary objects are becoming capable of processing and displaying information. Therefore, the consumption of information will occur in many different contexts and situations, which may contribute even more to this information overload, generating stress in a higher level.

Design plays a major role in developing better ways to deal with this information overload. Although designers have been studying how to design communication systems that drive our attention for a long time, little research has been done in exploring how to design communication systems that act upon the periphery of our perception. Considering that not all information needs to be in the center of our attention all the time, we should investigate innovative ways to present information into the periphery, taking advantage of our preattentive processing. As Weiser and Brown described, "By placing things in the periphery, we are able to attune to many more things than we could if everything had to be at the center. Things in the periphery are attuned to by the large portion of our brains devoted to peripheral (sensory) processing. Thus, the periphery is informing without overburdening" (Weiser & Brown, 1996, p.9).

Ambient Information Systems describe a set of applications that publish information in a non-intrusive manner, mostly acting on the periphery of our attention. The community of Human-Computer Interaction professionals has been exploring this subject for a while, but with little participation of the Design community. Although there are already interesting results on ambient information systems, I believe that Design has much to contribute to advance the research in this area. In this article, some ambient information systems are discussed, highlighting their characteristics and limitations. As a conclusion, I propose an agenda of topics that should be tackled to advance future research on this subject.. In order to be able to deal with this increasing information overload, we should have a better understanding of what it means to design for the periphery of our attention.

Ambient information systems

Ambient Information Systems are information systems that continuously present information that can be monitored by people without requiring the focus of their attention. In these systems data is presented mostly to the periphery of human attention. Presenting outside the main focus requires less cognitive effort for its consumption. This form of information delivery has manifested in several different implementations, but the overall theme revolves around how best to embed information into our surroundings (Hazlewood et al, 2008).

In these systems the major concern is how to present information in a discreet way, without being necessary to stop any activity to perceive them. In a world with an increasing number of information sources, which can be accessed from many devices and in different contexts, Ambient Information Systems represent an attempt to minimize the effort required to keep up with so much data. This concern is intensified with the rise of pervasive computing, as the most common objects may become information systems. It is necessary to find alternatives to prioritize the sources of sensory stimuli around us. An interesting strategy is to relegate to the background of our attention the information that is not essential, but which we can access at any time.

One of the earliest known examples of this type of information system is the Dangling String (also known as Live Wire), a project developed by artist Natalie Jeremijenko at Xerox Palo Alto Research Center (Xerox PARC). This system was in fact an installation in which a plastic wire was connected to an electric motor installed in the ceiling of a room. The engine was connected to the network of the institution by an Ethernet cable, so that the flow of network data directly interfered in its motion: when there was a heavy data flow, the engine turned faster, while a reduced flow caused the motor to turn slowly. The plastic wire followed the movement of the engine, producing a noise when moving fast. The combination of movement and noise was easily perceived from a distance, without interfering in any action that was occurring. The idea of the installation was not to accurately report the amount of data traveling through the institution network, but to give a sense of its flow and enable people to have a visual cue that could be associated with data traffic.

Figure 1: Dangling String (http://nano.xerox.com/weiser/calmtech/calmtech.htm)

The Dangling String is a typical example of an ambient information system. These systems usually present information in a discreet way, without drawing too much attention to itself, giving constant support to the monitoring of non-critical information.

This concern with discretion and with a non-intrusive information presentation has its roots in the work of Mark Weiser, precursor of research in ubiquitous computing. Unlike much research on computers occurring at that time, when he started the program on ubiquitous computing in the late 80's, Weiser was less interested in technical issues and more in the context of use or the impact that the increasing presence of computer technology would have on our lives:

> The program was at first envisioned only as a radical answer to what was wrong with the personal computer: too complex and hard to use; too demanding of attention; too isolating from other people and activities; and too dominating as it colonized our desktops and our lives. We wanted to put computing back in its place, to reposition it into the environmental background, to concentrate on *human-to-human* interfaces and less on *human-to-computer* ones (Weiser, Brown & Gold, 1999, p.693).

In anticipation to the proliferation of information sources competing for our attention due to the integration of computing devices to everyday objects, Weiser showed special interest in making the use of these systems simple. The goal then was to make the computers "disappear" into a given task and become as a simple tool that could be used without demanding our attention:

> In the last several years a few of us at PARC have begun to speak of *calm computing* as the goal, describing the desired state of mind of the user, as opposed to the hardware configuration of the computer. Just as a good, well-balanced hammer “disappears” in the hands of a carpenter and allows him or her to concentrate on the big picture, we hope that computers can participate in a similar magic disappearing act (Weiser, Brown & Gold, 1999, p.695).

Weiser, Brown and Gold believed that the most profound technologies are those that "disappear" by being so embedded in our lives. As stated by the authors, the idea of calm technology indicates a stage of computing evolution in which we use this technology without realizing it. It is precisely the idea of calm technology that underpins many of the ambient information systems. The information almost "disappears", being presented in a discreet manner, but can be easily brought to the center of our attention and used whenever necessary. This displacement between periphery and center of our attention is one of the main features of calm technology.

It's important to notice that in what regards Ambient Information Systems, information is meant to be perceived, which implies a specific type of communication. Ambient Information Systems are not suitable for complex data, which require detailed analysis. Rather, the intention is to present data in a subtle way, so that the information is perceived without effort and causes no disturbance. Normally, the Ambient Information Systems are used in situations that are not task oriented, that do not require immediate action in response to the information displayed. This type of interface does not apply, for example, to an air traffic control terminal, where operation requires a high level of attention from its operator. As highlighted by Weiser and Brown (1996), not every situation is suitable for a calm technology approach. Designing systems that act on the periphery of our attention requires special care:

> Not all technology need be calm. A calm videogame would get little use; the point is to be excited. But too much design focuses on the object itself and its surface features without regard for context. We must learn to design for the periphery so that we can most fully command technology without being dominated by it (Weiser & Brown, 1996).

As previously noted, the ability to move information between the center and periphery of our perception is a central issue for the calm technology concept, one that still guides the research on ubiquitous computing. Much research in this field seeks to develop "intelligent" products and systems which can operate independently, without our assistance. In theory, while at the same time the advances in technology allows the creation of objects with computational and informational resources, capable of communicating with each other constantly, this interconnected environment would not be a burden to us precisely because it would be possible to move the information provided by these systems to the background, without requiring our direct attention.

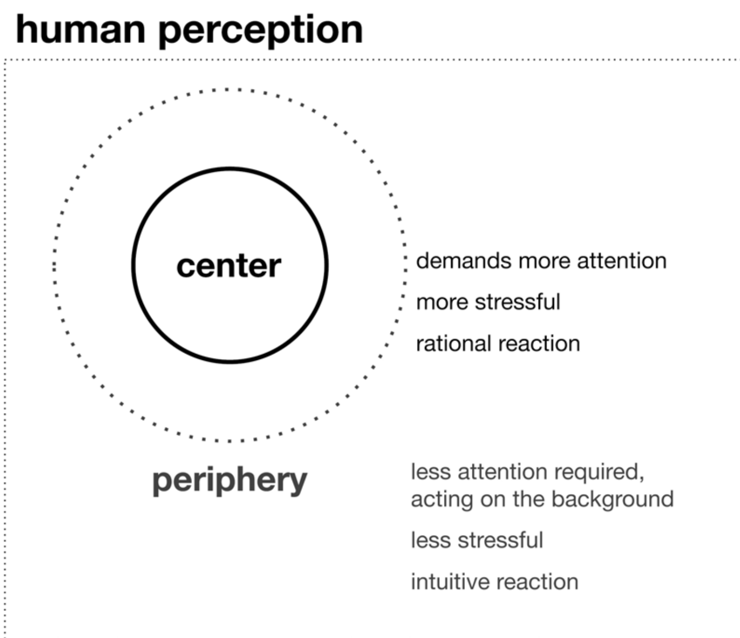

Figure 2: the center and periphery of human perception

From a more modest scope, yet aligned with the idea of reducing the cognitive effort required for information consumption, the Ambient Information Systems are an application of the calm technology concept, without requiring complex contextual data analysis or advanced artificial intelligence systems. Many projects on this field are based on the enrichment of our peripheral attention, presenting information in such a way that it can be perceived without demanding effort, assisting in the intuitive understanding of a more complex situation. This approach is also based in our preattentive processing (Healey, 2007; Healey et al, 1996), which is normally associated with visual perception, but may also occur through the stimulation of other senses (Lima, 2005).

Consider the communicative act itself, occurring through different media, as an example of this enrichment of our peripheral attention. In a telephone conversation, part of the understanding of what is said occurs by the way we talk. That is a level of information that goes beyond the "text" that is enunciated. Subtle variations in the intonation of the speech can bring more information, underlying what is said. In a similar way, in a videoconference, the image of the speakers provides more information that acts upon the periphery of our attention. By viewing the subjects and their behavior, we can have a better understanding of the discourse, even though we're not focusing our attention to this subtle information. In e-mail communication, which relies solely on the written word, disagreements often occur due to the reduced peripheral information that could help in understanding the message, demanding greater attention to the writing of the text, what probably wouldn't be required in a face-to-face conversation. Voice inflections, body movements and facial expressions are peripheral information that help us to communicate without requiring greater cognitive effort, as they are perceived intuitively.

To better understand how we can apply these principles to the design of Ambient Information Systems, four projects are described bellow, which in different ways deal with non-intrusive presentation of data. The limitations of these projects will be highlighted and possible improvements discussed.

Ambient Umbrella

The goal of this product is to solve a trivial problem: decide whether or not to take an umbrella when leaving home. Normally, a person would try to get informed about the weather conditions of the day to decide that. This could be done by reading the weather forecast in the newspaper, or accessing a website that provides the weather forecast, or watching the weather channel on the TV. In addition, of course, one could look through the window to see if there are any signs of rain.

In any of the options described above on how to get informed about the weather conditions, some steps would be necessary before taking a final decision on whether or not to take the umbrella. If a person does not have the signature of a daily newspaper, would have to go out and try to buy one. Another alternative is to consult the Weather Channel on TV. In the absence of a television channel with the weather forecast, and without a newspaper at home, one would have only left the option to look out the window and make a guess, or use the computer to seek the information on a website which presents the forecast for the day. This operation in turn requires more time and energy: it would be necessary to turn on the computer to access a particular site, request the information, interpret the information received, and only then would one be able to know what would be the chances of raining on that day. A series of steps to get some basic information, which would take time, require cognitive effort and certainly a good dose of patience.

The Ambient Umbrella addresses this issue in a relatively simple way. The umbrella actually "tells" you if it will rain. If the weather forecast for the day is rain or snow, the umbrella illuminates its handle. The concept is similar to the Weather Rooster (see Figure 3), which changed its color according to the humidity in the environment, indicating the possibility of rain.

Figure 3: The weather rooster (galinho meteorológico) is an interesting Brazilian predecessor of the Ambient Umbrella, without needing any computing device. The rooster is coated with layers of cobalt chloride, a chemical with the property of

changing its color depending on the humidity of the air. The blue color indicates low humidity, while the shades of pink indicate an environment with higher humidity in the air. Obviously the accuracy of this system is limited, since the humidity of an environment is not related only to the weather conditions, hence the cobalt chloride could be affected by other factors than climatic conditions. (Personal archive)

While the weather rooster has a relatively simple operation, its modern equivalent is based on a more complex system. The Ambient Umbrella receives weather forecast from a specialized website through radio waves. Depending on the forecast, the handle lights up indicating rain, drizzle, snow, and thunderstorms. From the user's standpoint, it is an umbrella, which simply lights its handle when it will rain. The idea is really that the technology involved in the process should not be perceived.

Figure 4: The Ambient Umbrella lights its handle when there is chance of rain, thunderstorms or snow. The system is connected to a weather service. (http://www.ambientdevices.com)

The information here is presented in a discreet, non-intrusive way, without disrupting any activity that occurs simultaneously in the environment. Whenever one needs to decide if taking the umbrella would be necessary, a quick look at the handle already gives the answer in a prompt, accurate and intuitive way, without requiring any effort. That's an exemplary application of the calm technology and pervasive computing principles, using computational resources to turn an ordinary object into an information system that requires little attention to be used.

The Good Night Lamp

This project seeks to communicate the act of coming home to loved ones, making use of an object as simple as a lamp. When one gets home and turns on the lamp, a signal is sent to other similar devices remotely connected to the emitter, and the light of these receptors is simultaneously lit. This way one can tell when he/she is "connected". The remote lamps, with their lights on, show that one person turned on his/her lamp, which by convention indicates their presence at home.

Figure 5: The Good Night Lamp: each lamp has a corresponding lamp in a different scale, which are connected remotely. When lighting the lamp, its correspondents will also have the light turned on, indicating that the person is at home.
(http://www.goodnightlamp.com)

The designer Alexandra Deschamps-Sonsino, who created the lamp, believes that the way people live in society is changing; we now have a constant need of being accessible. In fact, in recent years it's noticeable the growing popularity of social network sites like Facebook, Orkut, Twitter and instant messengers such as MSN Messenger, Skype, from which it's possible to keep in touch with our friends, even those that we don't see very often. Using these services it is possible to monitor the daily routine of our friends, expressed through their posts, their comments, photographs and other personal information made public online. Similarly, the increased use of mobile phones has generated a sense that we are always accessible, traceable, linked to these devices in such a way that they have been called "digital leashes" (Weerakkody, 2008). This type of behavior reinforces what Deschamps-Sonsino calls a feeling of being always on, sometimes off. The designer believes that in the future "we will learn to share parts of our lives with our families, friends and lovers in more subtle ways with the help of an ever sensitive, invisible and intelligent technology". (Deschamps-Sonsino, 2008)

Here we see the application of a principle present in many instant messengers, in which the interfaces usually present a list of the user's acquaintances, named "contact list". Each person in the contact list has his/her status indicated by an icon. If a person is online, with the program running, but is busy on other tasks, he/she can change his/her status so that the program will display an icon indicating that the person is busy. Similarly, there are visual conventions for different states of the users (online, invisible, busy, available, away, etc.).

The appropriation of this principle, used in instant messengers, to visually indicate the status of a person in the system (in the case of Good Night Lamp, the light turned on indicating the presence, the light turned off indicating that the person is absent) applied to an object as ordinary as a lamp is an example of an ambient information system. An information system integrated to the environment, with the amount of data reduced to a minimum so that the communication does not interfere with other tasks, staying on the periphery of our attention. The instant messengers, so far, are computer programs that run mostly in "conventional" computers and imply particular contexts of use, which in no way resemble the calm technology approach. The Good Night Lamp becomes part of the house, working without interfering with the actions of its residents, and conveys the sense of presence and proximity with people far away. Although in the current proposal only two binary situations are represented (on/off or present/absent), it could be possible to create other states, using variations in brightness, glowing effects, so that each light situation would indicate a different state of the user (present but busy, for example).

Thirsty Light

This project aims to help on the maintenance of houseplants by constantly monitoring the plant's soil to check its moisture, and warning when it is necessary to water the plants. The apparatus consists basically of a rod with a bulb containing a LED alert at one end and a humidity sensor at the other end. The operation is relatively simple: bury the pod with the sensor in a potted plant and it will measure the soil's moisture. When the moisture reaches a certain level, considered low for the maintenance of the plant, the light at the opposite end of the probe starts blinking. The lower the humidity of the soil, the faster the LED flashes, indicating the urgency of watering the plant. The whole system is based on technology called Drypoint, consisting of the humidity sensor and the digital circuit contained in the upper bulb, which receives and interprets the information sent by the sensor, and makes the LED flashes according to parameters received. The sensor works with 5 different levels of moisture, allowing it to be adapted to specific plant's needs.

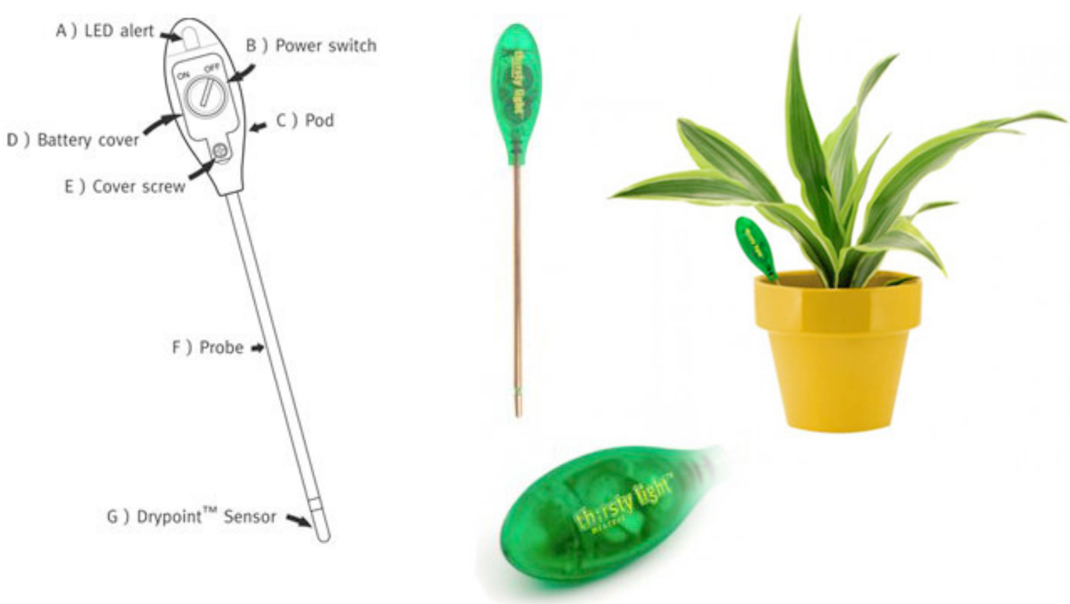

Figure 6: Thirsty Light, appliance designed to monitor the moisture of the soil and alert you when the plants need to be watered. (http://www.thirstylight.com)

Although the system is relatively simple, it is still necessary that the person pay attention to the plant's characteristics and specific needs. While some species prefer more moisture, others survive better with less water. On the product's website there is a disclaimer, advising the user to pay attention to the behavior of the plants in order to set the device properly, according to the characteristics of each species. If a plant absorbs moisture faster than others, the rod should be positioned with the sensor closer to the surface, a region that tends to dry faster.

As we can see, even though the Thirsty Light can assist in the maintenance of home plants, it is still necessary to have some knowledge about each plant's needs, at least on the early stage when it is necessary to perform a "fine tuning" on each probe, by placing the sensor on a position that best responds to each plant. But once these initial adjustments are made, the behavior of the system is quite non-intrusive, blending into the surroundings while at the same time constantly monitoring the condition of the plant's soil, and thus, acting as an ambient information system. It gathers data and presents it to its user without disturbance.

Ladybag

Developed by students of the School of Interactive Arts and Technology at Simon Fraser University, Canada, this project is about an ordinary object, a woman’s handbag. Using electronic components, the proposal is to make a bag as a mirror of its user's emotions. In this case the bag is classified as an Affective Communication System (ACS). In addition, the bag is able to identify the presence or absence of the most important items normally found in a woman’s handbag, according to its creators: keys, wallet and cell phone[2]. In this case, the bag acts as an Effective Organizing System (EOS).

To act as an Affective Communication System, the bag has to be pressed on specific points, where pressure sensors are located. Once pressed, the sensors trigger the bag's LED screen, on the outer surface of the bag, displaying an icon corresponding to a different emotional state. For each sensor there is a set of emotional states, which vary according to the applied pressure. The user must memorize the location of each sensor, and the corresponding emotional states, so she can express herself correctly through the Ladybag.

[2] Curiously, the three items selected as essential items to be tracked by the Ladybag system, were also identified as the most frequent items to be found in the bags of people from different cultures around the world, according to the research conducted by Chipchase et al (2005). The date of the creation of the Ladybag project is prior to this research, discarding the possibility that the authors of the Ladybag have selected these three items based on the findings of the research conducted by the Nokia research group. The choice of which items would be essential to keep tracking, however, was similar to what was identified by the Nokia research group. The difference is that in the study conducted by Chipchase, besides the cell phone and keys, money was the third item, instead of the wallet.

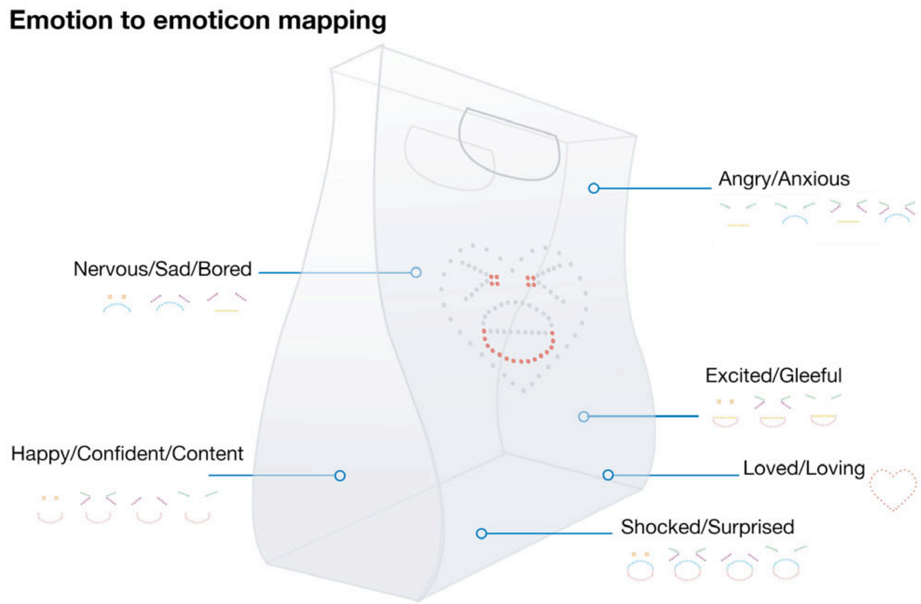

Figure 7: Ladybag: diagram showing the location of the sensors and the corresponding emotions (http://www.ladybag.official.ws/)

To operate as an Effective Organizing System, the bag uses RFID technology to keep track of the objects placed inside, depending less on the user's action. Basically, objects with radio frequency identification tags (RFID tags) are tracked by a RFID reader in the bag. If one of the items is out of reach, the sensor activates the bag's LED screen on the outer surface, indicating which object is missing.

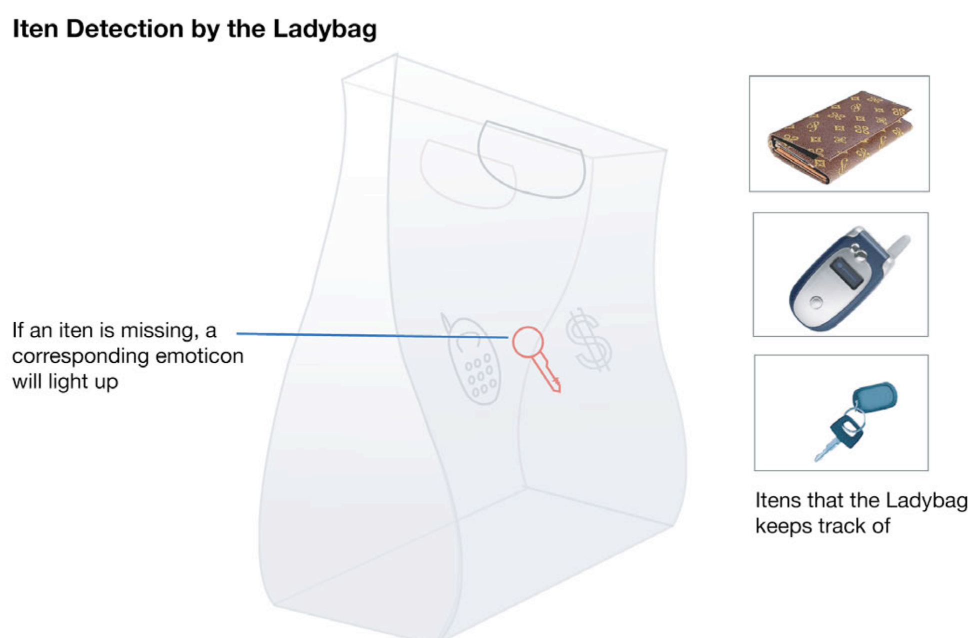

Figure 8: Ladybag as Effective Organizing System (http://www.ladybag.official.ws/)

In both versions of Ladybag, either as an Affective Communication System (AOS) or as an Effective Organizing System (EOS), the outer surface of the bag works as an ambient information system, providing information on the status of both the user's emotional state or the absence of objects linked to the system, in a discreet and unobtrusive way.

It should be noted that the AOS version of the Ladybag depends on a direct action of the user to enable it to express her emotions. So, while it may be seen as an ambient information system, since it presents information in a discreet way, it is necessary a conscious action from the user for the system to act. This way, it is possible to argue that this project cannot be classified as calm technology[3]. Alternatively, to make the system less depending on the user's action, biometric sensors could be used to constantly monitor the user's body, in order to notice changes in her emotional state without requiring a conscious action to display this information.

Discussion and further research

The projects described above have in common the fact that they present non-critical information in a discreet manner, acting mainly into the periphery of our attention. As we have seen, this is particularly interesting considering that computer technology and information systems have become widespread in our lives, and will increase even more in the years to come. Pervasive computing opens up new possibilities for accessing information, by augmenting ordinary objects with computational resources, allowing them to perform many different tasks such as warning us about weather change, letting us know when our friends come home, reminding us that plants needs to be watered, communicating our emotional state. On the other hand, ubiquitous computing also increases the amount of information to which we are exposed. Design has much to contribute in creating novel interfaces that can guarantee that this information overload won't turn into noise, generate stress or become a burden.

There are many issues that still require research regarding the design of Ambient Information Systems. How to evaluate the effectiveness of a system that should not be intentionally perceived by its users? The most known evaluation methods, which usually are task-oriented, don't seem to be suitable for this kind of system. Which metrics, heuristics and evaluation methods should be used, considering that in most cases there isn't an explicit task to be performed by users? Research in the field of visual perception and cognitive psychology (Healey, 2007, 1996; Lima, 2005) and specific studies on Ambient Information Systems (Hazlewood et al, 2008, 2007; Mankoff & Dey, 2003; Tomitsch et al, 2007) are being conducted, bringing a better understanding about this subject, but much remains to be investigated. Is there some kind of information that is more appropriate for this type of system? What does it mean to design for the periphery of our attention, considering that we are not restricted to our vision, that we could also explore the sense of touch, hearing and smell?

The answers to these questions are beyond the scope of this article. It is clear, though, that the design of Ambient Information Systems is a relatively new field for designers, and thus it is essential to deepen the research on this subject. This article is a preliminary result of an exploratory research being conducted on this subject, and the main intention was to stimulate the debate on the Design community about Ambient Information Systems, whose importance tends to grow in the near future.

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[3] After performing some user tests, the authors of the Ladybag found that using pressure sensors to report emotional states was considered relatively complex, due to the difficulty of memorizing their location, and to relate each pressure point with a corresponding emotion. As it turned out to demand the user's attention to fully operate the system, the Ladybag cannot be considered a calm technology device, at least from the standpoint of its users. However, it can be considered an ambient information system as it communicates the emotional state of its user discreetly for those who are around.

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Developing a theoretical framework for understanding (staged) authentic retail settings in relation to the current experience economy.

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Abstract

In the current experience economy, some retailers and retail designers aim at triggering customer experiences by associating the retail store's design with 'authenticity'. The notion of authenticity, however, is complex and layered and has been studied in several scientific disciplines. But within retail design, only limited research on authenticity is available. This paper aims to clarify the complex concept of authenticity in relation to retail design. Retail design as part of interior architecture is an emerging discipline. By establishing its theoretical basis, authors mostly rely on the knowledge of background disciplines; as in this paper, where we look at theories developed in marketing and philosophy to investigate how (staged) authentic retail settings be can situated in relation to the current experience economy.

The paper contains three large sections. The opening section presents a review of literature on retail design and the experience economy in relation to authenticity. The second section explores authenticity as defined through the theory on simulacrum by Plato, Baudrillard en Deleuze. In the third section, these theoretical insights are translated to the actual retail environment by surveying (staged) 'authentic' retail stores in three shopping cities in Flanders (Belgium). Based on this survey, seven different groups of authentic stores are defined, moving from 'real' to 'hyperreal'. This grouping should not be seen as a classification system but rather as a mental scheme to investigate and report on different approaches towards authenticity in retail store environments. The scheme can be applied in the field of consumer research as well as in retail (design) practice.

Keywords

Authenticity; Retail Design; Simulacra; Experience Economy

Authenticity is a layered concept, which has been studied in different scientific disciplines, such as philosophy, architecture, heritage conservation and marketing. Yet, to the authors' knowledge, the notion of authenticity in the design of retail environments has not received similar attention. Retailers and customers increasingly label retail stores 'authentic', irrespective of its historical, cultural and architectural background (Pine & Gilmore, 2007).

Competing in today's global market is becoming increasingly difficult. Since customers often perceive products and services as homogeneous, retailers and manufacturers continuously need to look for differentiation strategies (Petermans & Van Cleempoel, 2009). Differentiating oneself from the competitor by creating memorable customer experiences is therefore becoming one of the central objectives of many retail store environments (Verhoef et al., 2009). In the current experience economy, customers ask and expect more than just being satisfied with the purchased brand or product and the delivered service level. Instead, they look for personal, intuitive relationships with brands and retailers (Van Tongeren, 2003, 2004). Directing the store's retail design towards the creation of memorable customer experiences by appealing to customers' senses, emotions and values can contribute to the creation of such company-client relationships. Since customer experiences in retail settings appear to immerse customers at a cognitive, emotional and intuitive level (Healy et al., 2007), they can be considered as a new source for value creation. A retail experience which succeeds in delivering value to the customer can become the key to long-term retailer success. One approach which seems successful in Western economies today, is focusing the retail store's design on '(staged) authenticity'. Besides 'truly' authentic retail stores, retailers increasingly focus their retail store's design on staging authenticity in the stores' interior, exterior and/or the products sold in the store.

The research question is the following: How can (staged) authentic retail settings be situated in relation to the current experience economy? As retail design in interior architecture is an emerging discipline, theories are build by utilizing theoretical approaches of background theories. The purpose of this article is to (a) explore issues related to the design of a (staged) authentic retail environment through a literature review, (b) present cases of Flemish retail stores that were designed to be perceived as (staged) authentic retail settings and (c) describe and discuss the implications of these approaches for retail designers. The opening section of the paper discusses literature on retail design and customer experiences by focusing on the importance of designing appealing retail environments in the current experience economy in relation to authenticity. The second section approaches the concept of authenticity through the theory of simulacra by Plato, Baudrillard and Deleuze. The third section translates this theoretical framework into retail design practice by analyzing an inventory of (staged) 'authentic' retail stores in the three most important shopping cities in Flanders: Antwerp, Ghent and Hasselt (Llo, 2009).

Designing retail environments in today's experience economy

In the contemporary market, consumer choice is often emotionally guided and based on values (Holbrook & Hirschman, 1982; Babin et al., 1994; Mathwick et al., 2001). Hence, retailers need to be aware of the importance of designing retail environments, creating personal and memorable customer experiences. But what is retail design and how is it linked to the concept of an experience economy.

Retail design

Retail design refers to various aspects that deal with the interior and exterior of commercial spaces. There is particular attention as to how a store will work commercially through a functional and aesthetical environment. It entails, for example, an understanding of customer behaviour in relation to tangible (material) and intangible (atmospheric) design elements. Equally, the store's interior has to meet regulations concerning the use of a public space (Kindleysides, 2007; Petermans & Van Cleempoel, 2009, 2010).

When customers visit a retail store, they immediately make an association between the products sold in the store, their price, the store's 'tone of voice' and ambience and the retailer's presence and identity. As a result, retail design and retail branding can not be disconnected from each another (any more). The role of retail design is to translate and develop retail branding into the practice of a retail store environment, in accordance with specific societal and temporal conditions (Van Tongeren, 2003, 2004).

Authenticity in the experience economy

The concept 'customer experience' was formulated in 1982 by Holbrook and Hirschman as a new experiential approach to consumer behavior. However, it lasted until 1999 before the 'experience' concept came to the fore in the management and marketing discipline with the publication of Pine & Gilmore's book on the Experience Economy. They present experiences as a new economic paradigm, which emerges as the next step after an economy of commodities, goods and services. They were the first authors to describe the contemporary market culture as an ‘experience economy’.

How can retail stores appealingly be ‘designed for experience’ in the current experience economy? And how do individual customers perceive these retail environments? Until now, most of the existing literature on retail stores has focused on the isolated testing of individual in-store atmospheric stimuli, such as lighting (Areni & Kim, 1993). However, experiential elements do not work in isolation; rather, they function as a holistic mechanism, driving the customer’s experience (Healy et al., 2007). Customer experiences originate from the interplay between a personal, social and physical context (in casu: the retail store) a consumer finds him- or herself in (Falk & Dierking, 1992).

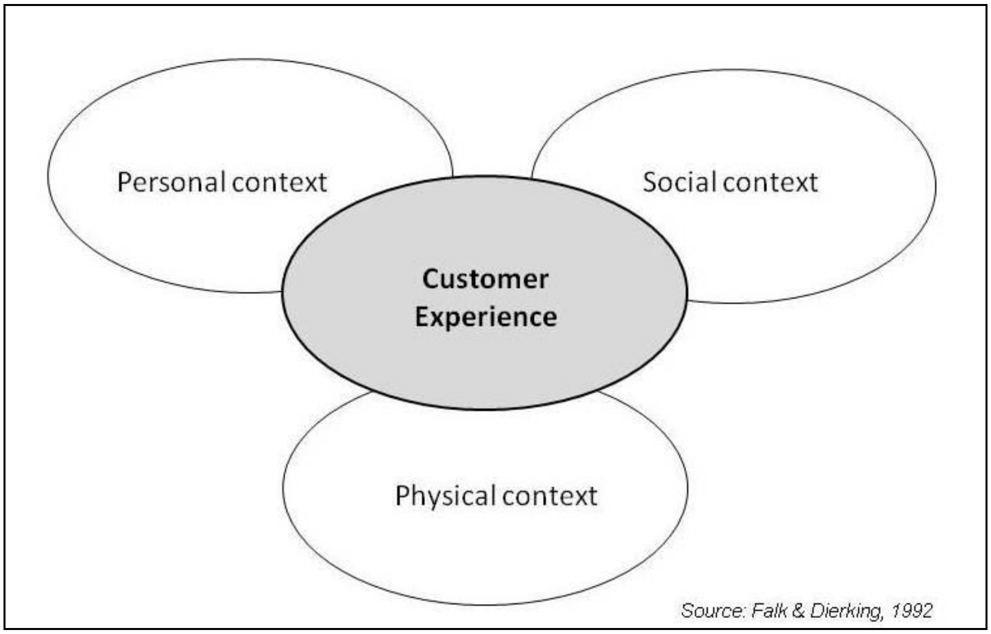

Fig. 1 Interactive experience model

The concept of ‘personal context’ refers to the personal, emotional, cognitive and socio-demographic characteristics, attitudes, norms, values, … of the individual customer. The concept ‘social context’ does not only concern the people, accompanying the customer on a store visit, but also the presence and behavior of the in-store personnel. Finally, the ‘physical context’ encompasses different elements: (1) architecture and design (2) the lay-out of the environment (in and outside the store) (3) the feeling the environment invokes with its users (4) the objects and activities, present within the physical environment.

The combination of these three contexts continuously influence the individual customer. The interaction between these contexts ultimately results in customer experiences. Hence, customer experiences are always personal and subjective: each individual comprehends, organizes and interprets in-store information in a unique way, reacting with a different interpretation to in-store stimuli because of his or her particular cultural, social and personal backgrounds (Klingmann, 2008).

Consumers’ holistic attitudes about a given store can influence their overall preference for that store (Thang & Tan, 2003). When consumers perceive a store environment or element of that environment positively, they are more likely to remain in a store for a longer period of time, to touch or examine merchandise and to indicate an intention to purchase (Hyllegard et al., 2006). Orchestrated experiences can encourage loyalty, not only through a functional design, but also by creating emotional connection through an engaging, compelling and consistent context (Pullman & Gross, 2004).

In today's retail practice, different kinds of experiential retail settings seem to exist. Kozinets et al. (2002) differentiate between flagship brand stores (eg. Nike Town), themed entertainment brand store (eg. The Hard Rock Café) and themed flagship brand stores (eg. The World of Coca Cola Museum, Atlanta). The spectacular and entertaining aspect, used by these kinds of stores to differentiate from competitors, has inspired an increasing number of retail stores.

In today's experience economy, customers in Western Europe want retailers to take into account their true and authentic feelings, desires, and personalities. Customers no longer want to be considered as mere 'consumers'. They want to achieve goals in life, realize ideals and contribute to aspects they value important (Pine & Gilmore, 2007; Petermans & Van Cleempoel, 2009). Retailers and retail designers need to take this evolution into account when designing appealing experiential retail environments.

Currently, the concept of 'authenticity' is being used as a way to answer these customers' concerns. Retailers try to appeal to customers by for instance choosing historic locations for their retail store, by integrating authentic elements in their retail store's design, or even by designing completely new 'authentic' retail stores.

The simulacrum: Plato, Deleuze and Baudrillard

The paradigm of the simulacrum has been discussed in relation to postmodern consumer culture to explain that the boundaries between real and imaginary are becoming blurred and how this effects the marketplace (Firat & Venkatesh, 1995; Hollenbeck et al., 2008). So far however, this theory has not been applied to the actual retail environment. In this paper, the theory on simulacrum creates a better understanding of contemporary retail settings in relation to authenticity and staged authenticity.

Plato and the simulacrum

The concept of authenticity originated in Plato's theory of Ideas which distinguish the true (metaphysical) object and its image, the original and the copy, the model and the simulacrum, the authentic and the inauthentic (Deleuze, 1983, pp. 45-46). The distinction moves between two sorts of images: on the one hand iconic copies, on the other hand phantasmatic simulacra. Icons are good, well-founded images of the Idea, endowed with resemblance. An iconic copy is 'modeled' in the Idea. Simulacra are insinuations, subversions and are made without passing through the Idea. However, a simulacrum is not a copy of a copy or an endlessly degraded icon. Where the icon is an image endowed with resemblance, the simulacrum is an image without any resemblance (p. 48).

The whole Platonic motive is a matter of distinguishing the good from the false copies. For the observer, to judge on an image, one should have true knowledge of the Idea. But *'the simulacrum implies great dimensions, depths, and distances which the observer cannot dominate. It is because he cannot master them that he has an impression of resemblance. The simulacrum includes within itself the differential point of view, and the spectator is made part of the simulacrum, which is transformed and deformed according to his point of view'* (Deleuze, 1983, p. 49).

Baudrillard: reality and hyperreality

In contrast with Plato, Baudrillard does not believe in objective reality or truth but only in the individual interpretation of it (Lepers, 2009, p. 122). He approaches the concept of simulacra within his critic on the consumer society. According to Baudrillard, we live in the era of simulation, inaugurated by a liquidation of all referentials: the model of the real has no origin or real anymore. It is no longer a question of imitation, nor duplication, nor even parody. He described this 'decay of the real' in four steps:

'Whereas representation attempts to absorb simulation by interpreting it a false representation, simulation envelops the whole edifice of representation as itself a simulacrum. Such would be the successive phases of the image:

- *It is the reflection of a profound reality*
- *It masks and perverts a profound reality*
- *It masks the absence of a profound reality*
- *It bears no relation to any reality whatever: it is its own pure simulacrum'* (Baudrillard, 1994, pp. 16-17)

This final phase is supposed by Baudrillard to supersede all others. Where in the first phase there is still a real to refer to, in the final phase simulation no longer copies anything and reality is replaced by nostalgia which is the plethora of truth, of secondary objectivity, and authenticity (Hegarty, 2004, pp. 50-52).

Baudrillard argues that in the era of nostalgia, reality is replaced by hyperreality. He gives Disneyland, among many other examples, as a perfect model of the hyperreal. In the first place, Disneyland is an imaginary world which ensures the success of the operation but it also is a social microcosm, a miniaturized pleasure of real America. Disneyland is presented as imaginary in order to make us believe that the rest is real; whereas all of Los Angeles and the America that surrounds it are no longer real, but belong to the hyperreal order and to the order of simulation (Baudrillard, 1994, pp. 12-14).

Deleuze and the upgrading of the simulacrum

In his article "Plato and the simulacrum", Deleuze takes the theory on simulacra even further (1983). He starts from a similar definition of simulacrum as Baudrillard but he undermines the very distinction between copy and model (Massumi, 1987). Deleuze says the simulacrum is not a degraded copy, rather it contains a positive power which negates both original and copy, both model and reproduction; the simulation is a process that produces the real. Deleuze describes the era of simulation as the 'overthrow of Platonism' which means to raise up simulacra, to assert their rights over icons or copies (Deleuze, 1983, p. 53).

Understanding the retail environment

The distinction between real and hyperreal can be recognized in contemporary retail settings.

Today, we can still find some "real" authentic stores which have a continuous, and even renewed, attraction on consumers. In such stores there is emphasis on original characteristics, tangible as well as intangible, of the retail environment and their design has remained unaffected in the course of time (Grimmeau & Wayens, 2003). The designers and retailers of such stores often deal with aspects of conservation taking the international documents on heritage conservation as a reference (ICOMOS, 1964, 1994, 1996). An interesting example is 'Galeries Saint-Hubert' in Brussels, a 19th century shopping arcade (Galeries Saint-Hubert, 2010). The program of the passage was threefold: a well-thought combination between a public space meant to solve traffic problems, a commercial, sales oriented space and an official national monument expressing a new politic reality after the independency of Belgium in 1830 (Geist, 1979). From its foundation, the Galeries Saint-Hubert was continually in use and in 1997, the buildings were completely restored (Dienst Monumenten en Landschappen van het Brussels Hoofdstedelijk Gewest, 1998). The restoration project preserved both the versatility of the initial project as well as the physical architectural qualities of the building (Plevoets & Van Cleempoel, 2009a).

On the other side of the spectrum, there exist “hyperreal” retail settings. An example is ‘Bataviastad’, an outlet shopping village in the Netherlands (Bataviastad, 2010), created as a themed park around the shipyard of the 17th century vessel ‘Batavia’. The design of Bataviastad is conceived as a reconstructed fortified town; aesthetically the village is a pastiche of historicised architectural elements inspired partly on Marken Island and partly on colonial architecture from the Caribbean where the original ship Batavia used to sail to (Groenendijk & Vollaard, 2006, p. 93).

Fig. 2 Galleries Saint-Hubert

Fig. 3 Bataviastad

But as suggested by Baudrillard (1993, p. 38; 1994, p. 6) and Deleuze (1983, p. 53), in contemporary society the borders between true (i.e. ‘real authentic’) and false (i.e. ‘staged authentic’) are becoming blurred. As one of the goals of this paper is to present cases of retail stores that were designed to be perceived as (staged) authentic, the authors want to test the value of Baudrillard and Deleuze’s idea in contemporary retail practice.

To gather relevant data, (staged) authentic retail settings in the three most important shopping cities in Flanders - Antwerp, Ghent and Hasselt (Llo, 2009) – have been surveyed. Two students from the master (interior)architecture helped to collect data. After the completion of the survey, all studied retail settings needed to be classified according to the developed theoretical framework. Our attempts in doing so soon made clear that most studied stores could not be classified as ‘truly’ or ‘falsely’ authentic; they mostly represented an intermediate type of authenticity.

As a consequence, the authors distinguished different groups of authentic stores. Three parameters were used to inform the different groups: the (staged) authenticity of the store interior, the (staged) authenticity of the store exterior and the (staged) authenticity of the products sold in the store. As a result seven different groups of authentic stores, moving from ‘real’ to ‘hyperreal’ were distinguished. These groups can be put into an axe on which retail spaces can be organized. Figure 4 presents a classification of retail settings based on the shifting between ‘real’ and ‘hyperreal’:

- *Historically authentic*
  Despite retail being a rapidly evolving business subjected to constant change (Christiaans & Van Amerongen, 2004), some stores survived the course of time and remained unchanged since their foundation (Grimmeau & Wayens, 2003). These 'historic' retail settings can be considered heritage and as such their authenticity can be evaluated by applying heritage-related definitions such as these implied by international documents on heritage conservation (ICOMOS, 1964, 1994, 1996). In many cases, the preserved historic elements are limited to the store front (English Heritage, 1999, 2002) but some examples exist where both the exterior and interior elements are kept and where the store is still selling the original product.

  An example is 'Tierenteyn-Verlent', founded in 1790 and located in the historic centre of Ghent. From its foundation, the store specialised in producing and selling home-made mustard. Over continuous generations, its owners have maintained the original shop front and store interior (Tierenteyn-Verlent, 2009). Today the stores exterior and interior are protected as a monument by the Flemish government.

- *Historically authentic setting*
  Increasingly retailers look for existing buildings that are historically or architecturally significant. Reusing significant buildings have advantages as to differentiating oneself against competitive retailers as well as to sustainable design. Moreover, historic buildings are often located on A-locations inside the city centre which make them very attractive for the retail sector (Plevoets & Van Cleempoel, 2009b, 2009c). Although the hosted building can often be considered authentic from heritage perspective, it does not obviously imply that the store is considered 'authentic' from the point of view of retail design.

  Bookstore Selexyz Dominicanen in Maastricht (NL) is an example of a store located in a historic building; the host space of the store is the 13th century church of the former Dominican convent. The casco of the church was completely restored and contrasts strongly with the contemporary design of the bookshop's interior. In the centre of the church, a large bookshelf of two floors high is build up as a steal construction. On the one hand this volume stresses the dimensions of the church and on the other hand, from the upper floors of the bookshelf, visitors can observe the architectural details from the church. As a result, host space and contemporary interior enhance one another (Merkx+Girod Architecten, 2010).

- *Historically authentic interior*
  Just as retailers use historic exteriors to render an authentic store image, also authentic interiors can be introduced for creating an atmosphere of nostalgia. Many examples are at hand where historic furniture aims to ad a sense of timelessness to the store.
  Daniel Ost calls himself a floral artist and sculpture (Ost, 2010). His store in Brussels is located in the former Chemiserie Niguet, designed by the art nouveau architect Paul Hankar in the late 19th century. Not only the shop front but also the interior elements of the store were restored in all their details (Heymans, 2006).

- *Authentic product*
  Some retailers or brands distinguish oneself by offering traditional, often handicraft made products that are appreciated by customers still today for reasons of quality, originality or even rareness. To survive increasing market competition, these retailers often present themselves through an innovative retail design that represents the taste of their target public (Berckmans & Gaiardo, 2003).

The Belgian *chocolatier* Neuhaus has more than 150 years of experience in producing high quality chocolates. Although the process of production has evolved since its foundation in 1857, the quality of the used ingredients, the recipes and the production techniques are still given major attention today. The oldest store of Neuhaus is located in the Galeries Saint-Hubert in Brussels and its interior dates back to the early 20th century. But other Neuhaus stores have been founded all over the world and their design is adapted to contemporary fashion, taste and techniques (Neuhaus, 2010).

- *Staged authentic*
  Beyond using buildings and interiors that are authentic from heritage-perspective, retailers also 'stage' authenticity in their new design. The new design can be staged in different aspects: firstly it can stage a historic architectural style, secondly it can stage a regional architectural style from a specific area or country or thirdly it can stage a specific atmosphere.

  The bakery chain 'Le Pain Quotidian' stages authenticity in the products they sell, but also in the design of their retail spaces. Their bread and pastry look traditionally produced and are served hand cut. The interior of the store and the adjoining tearoom have a domestic atmosphere; the furniture is made of reclaimed massive wood and customer's can have breakfast together at the long table, centrally in the tearoom (Le Pain Quotidien, 2010).

- *Pastiche*
  A pastiche is a combination of various historic and historicized elements. Axel Vervoordt for instance is a collector of art and antique objects from a large variety of periods and regions. When furnishing or decorating a space, he aims to give the space its own identity by bringing together objects from different cultures; hence, a certain tension is created between the different objects and between the objects and the room. Most of his projects concern private houses and apartments. His personal residence is a castle in s' Gravenwezel, near Antwerp, and is opened for the public twice a year. At these occasions, people are free to buy certain objects (Vervoordt, 2010).

- *Hyperreal*
  A hyperreal retail setting does not refer to any profound reality but aims to create a world of phantasm. An example, Bataviastad (NL), has been given above.

But as suggested in figure 4, the different types of authentic stores should not be seen as a classification system with strict borders between the different groups. The scheme can be used as a mental scheme to investigate and report on different approaches towards authenticity in retail store environments. It can be used as a transparent interdisciplinary communication tool. It is, however, not meant as a quantitative methodology that would allow 'measuring' the level of authenticity in retail spaces.

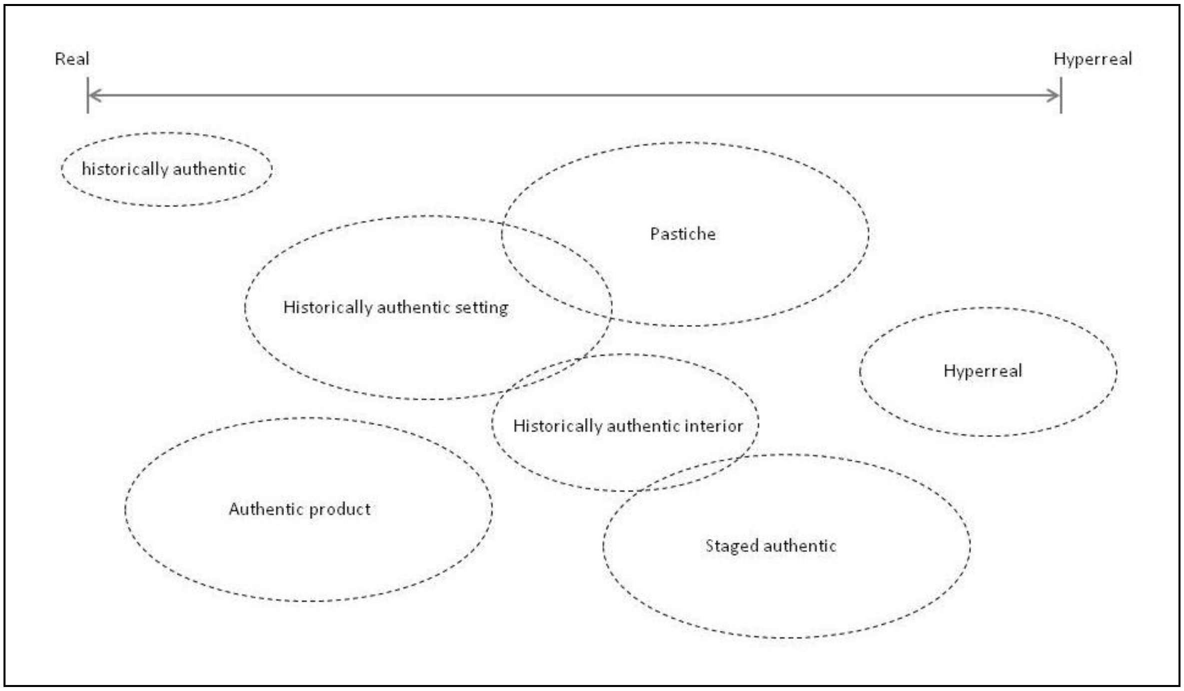

Fig. 4 Groups of (staged) authentic retail settings

Conclusion

This paper aims to present a first attempt in developping a theoretical framework on the complex concept of authenticity in relation to retail design. Although in certain disciplines a definition of authenticity could be formulated (e.g. heritage conservation: ICOMOS, 1994), the authors did not, as yet, aim to develop a normative definition of authenticity for the retail design discipline. More than defining the meaning of authenticity in retail design in this paper, the authors firstly studied the concept through the theory of simulacra as developed and described by Plato, Baudrillard and Deleuze, and secondly, described and clarified the concept by studying retail design practice in Flanders.

Based on the intermediate positions between 'real' and 'hyperreal' (Deleuze, 1983; Baudrillard, 1994), the authors have presented a classification scheme which can be used to study 'authentic' retail settings. However, the authors do not take a dogmatic position in favor of one of these two approaches to authenticity, all the more since recent consumer research illustrated that people's perceptions on authenticity vary (Beverland & Farrelly, 2010). Beverland and Farrelly's research (2010) demonstrated that the process of authenticating an experience is contingent on consumers' goals. After in-depth interviews with 21 informants about their understanding of authenticity, some labelled ubiquitous, mass-market objects as 'authentic'.

But Beverland and Farrelly's results contradict with results from earlier consumer research that illustrated that commercialisation can have a negative effect on the way consumers experience authenticity (Grayson & Martinec, 2004; Maclaran & Brown, 2005). One of the possible explanations of these contradicting results may be caused by the lack of a clear definition or delineation of the concept of authenticity in retail design. As such, a first application of the classification scheme could exist in the field of consumer research; In future consumer research on authenticity in retail setting, the proposed scheme may be used to indicate more specifically the meaning of authenticity in the researched setting. As such the internal validity of results could be enlarged (Yin, 2009).

Further research could investigate if the type of customer differs between the different groups of (staged) authentic stores. If this should be the case, a second field of application of the scheme may be in the retail (design) practise; by knowing who their target customers are, retailers and designers could adapt their retail store's design to their customers' current needs and wants.

Given that the survey of the actual retail environment in this contribution only covers three important shopping cities in Flanders, the valorization of results is limited to the Flemish retail context. As consumer preferences are strongly culture specific (Millan & Howard, 2007), results could be different when studying actual retail settings in other cultural environments. Hence, further research could focus on developing a comparative study between the actual retail settings in different cultures or geographical regions, to provide a better understanding of the implications of cultural differences in consumer preferences for retail design. Another possible direction for future research could be the elaboration of the scheme, here presented.

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A new atlas for abstract spaces. Visual tools for the exploration of complex contexts.

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Abstract

In the tradition of research, text is the preferred solution for research and communication. The linear sequence of writing explains reality: it transforms synchronic scenes into a sequence of codes that describe it diachronically. Nonetheless, while textual representation still remains extremely useful in scientific communication, the linearity of writing is lately appearing as inadequate to the latest models of science and to the representation of current knowledge systems.

In this context the language of cartography in particular seems to be fit to work as a structural model for the representation of complex systems, and Design can find in the atlas a model for the communication of complex contexts. As a tool designed to describe and act upon complex context, the atlas provides a model to strategically describe highly heterogeneous knowledge spaces. As a communication device, the atlas sets up a strategic network of images in order to achieve a set of communicative goals: maps, illustrations, graphs, and texts work together to describe and act upon space.

In the first part of this paper, we examine the structure of the atlas in order to expose the mechanisms that allow actions of exploration of complex and heterogeneous contexts. In the second part of the paper, the format of the atlas is discussed in its transfer to the digital domain and in its application to knowledge contexts. The first experimental results of such an approach are displayed by presenting a software tool for the collaborative management of design knowledge resources.

Keywords
Communication Design; Interface Design; Knowledge Visualization; Information Visualization; Cartography; Atlas.

In the tradition of research, text constitutes the preferred solution for research and communication. The linear sequence of writing *explains* (from the Latin verb *explico:* to unfold) reality, it transforms a synchronic scene into a sequence of codes that describe it diachronically, slicing it in discrete elements. The subdivision of reality in discrete elements allows the reasoning of scientific thought: logical reasoning, proof and deductive processes build upon the linear narrative created by writing to give an order to the scientific process. The linearity of the text, in other words, matches perfectly the logical nature of the scientific-deductive method, which ultimately represent the ultimate expression of historical consciousness (Flusser, 1997). Nonetheless, while textual representation still remains an extremely useful in scientific communication, the linearity of writing is lately appearing to be not enough to the latest models of science, and to the representation of current knowledge systems.

The changes that the current knowledge paradigm is undergoing can be summarized in two main aspects. On the one hand, the developments of systems theories and epistemologies of complexity are transforming the scientific discourse in a model that aims to describe complex phenomena in their entirety. The focus is not so much in the sequence of an explanation, but on the relationships that link the components of a system irreducible to its analytical decomposition. On the other hand, the explosion of social knowledge paradigms that surpass the models of idealism are changing the structure of knowledge itself, exposing the social and relational dimensions of cultural processes that were gradually hidden by writing and printing technologies.

Knowledge is less and less considered in terms of *possession*, and increasingly in terms of *access* to information and skills. Knowing means having access to social and technological networks able to provide necessary information and insight at the time of need. The rigid and permanent structures of disciplines and subject areas are therefore progressively replaced by fluid and dynamic spaces in permanent movement and evolution, able to define cross-cutting paths, areas of interest and clusters.

Although a new paradigm for knowledge is clearly emerging, appropriate narratives for its representation are still lacking. Traditional interfaces based on the linearity on text or the hierarchical models of knowledge struggle to meet the needs of increasingly complex and ever-changing research contexts, in which relationships between elements part of the knowledge system are as important as the elements themselves.

Maps for the exploration of complex contexts

In this context, design is involved on two different levels:

On the one hand, the nature of design process requires the designer to be confronted daily with complex and transdisciplinary systems, in which the different design dimensions cannot be analyzed separately. As a synthetic discipline, Design is focused on keeping together, rather than distinguishing between heterogeneous elements. Social, semiotic, linguistic, cultural components appear as an irreducible system that has to be synthesized in the design process.

On the other hand, Design in general, and Communication Design in particular, is responsible for the creation of formats and tools able harness the characteristics of images in order to address this kind of communication needs. Designers are responsible for the creation of a new rhetoric of complexity, a visual rhetoric not limited to the elusive search for scientific neutrality, but a language aware of its involvement in the creation of a cultural artifact in which the author is an expression of a cultural and social context.

The challenge to be addressed is no longer that of creating better analytical structure to subdivide and classify elements of reality. On the contrary, the current urgency is to ‘keep together’ the elements of the system in a single representation.

In this context, the languages of visual communication acquire a role complementary to textual communication, and the language of *cartography* in particular seems to be fit to work as a structural model for the representation of complex systems. In the history of image-tools, for thousands of years maps have been providing an interface to describe and act upon the complexity of the territory.

As narratives, maps are the expression of communication goals: they operate selections on reality, distort events, classify and clarify the world in order to better tell a particular aspect of a territory. Maps, in other words, can be seen as a ‘visual narrative’ of space: cultural artifacts created by an author in order to describe a space in terms of a goal.

As instruments, maps are tools that allow to reach otherwise unattainable goals. They allow not only to do things better, more efficiently, but also to create new realities. Maps describe the territory, highlight positions, distances, spatial distributions, groups, boundaries. They serve as tools to act on the space: to orient navigations, to mark paths, to plan trips, to explore territories. Or they can be used as design tools: plans for the construction and modification of space.

As with all codes that can boast such a long history, the cartographic representation of space has come to be regarded as a “natural” match between the represented space of the territory and the representing spaces of the map. However, nothing is natural about cartographic representation. As cultural artifact and political tool, maps create a virtual reality that allows the user to perform operations on the area represented. Exploration maps, nautical charts, building plans and world globes all carry with them an intended use and a number of functional purposes.

Building on this heritage, the operative concepts, tools and formats of cartography provide a perfect match for the representation of complex contexts, and their application can be extended to spaces that are no longer strictly geographic spaces. By looking at the theoretical critique of cartography developed by the critical cartography movement, the definition of the map takes on the connotations of a much more general cultural artifact. Moving away from the geographical space as its only object of investigation, maps becomes a “graphic representations that facilitate a spatial understanding of things, concepts, conditions, processes or events in the human world” (J.B.Harley and David Woodward, 1987, p. xvi). Space becomes an abstract substrate similar to the anthropological space defined by Levy as “a system of proximity unique to the world of humanity and thus dependent on human technologies, signification, language, culture, conventions, representations, and emotions” (Levy, 1997).

This metaphorical space fits perfectly in the realms of research and science. Unlike the structures used over the centuries to manage knowledge by subdividing it in discrete areas, space is a continuous substrate: it doesn’t divide culture in sections, it doesn’t create hierarchies or define order in absolute terms, but on the contrary, it defines relations, proximities. Space creates clusters, identifies pathways and highlights priorities in a dynamic structure, and likewise it allows to locate, to remember, to relate.

From the moment in which the complexity of the knowledge structure becomes untamable, the metaphor of the ‘journey through the territories of knowledge’ replaces the institutionalized metaphor of the ‘tree of knowledge’ that in turn loses most of its ability to provide tools for interpretation of reality. Even D’Alembert, in the prologue to the *Encyclopédie* feels the need to suggest an image that goes beyond the typical representations of the time, proposing a representation of a territory that expresses perfectly the complexities of the project:

> [The Encyclopédie] is a kind of world map which shows the main countries, their position and their mutual dependence, the road that leads directly from one to the other. This road is often cut by a thousand obstacles, which are known in each country only to the inhabitants or to travelers, and which cannot be represented except in individual, highly detailed maps. These individual maps will be different articles of the Encyclopedia and the Tree or Systematic Chart will be its world map.
>
> But as in the case of the general maps of the globe we inhabit, objects will be near or far and will have different appearances according to the vantage point at which the eye is placed by the geographer constructing the map, likewise the form of the encyclopedic tree will depend on the vantage point one assumes in viewing the universe of letters. Thus one can create as many different systems of human knowledge as there are world maps having different projections, and each one of these systems might even have some particular advantage possessed by none of the others. (D'Alembert, 1751)

Knowledge becomes impossible to draw as a whole in a truthful manner, but only through the choice of a point of view that is both arbitrary and inevitable. Like the geographical and human space of territory, the complexity of knowledge needs useful abstractions, cultural interfaces able to transform the space in map. Although the maps of D’Alembert never actually found any representation beyond the linguistic metaphor, the idea of an atlas of possible trees and maps already emerges as a possible approach to the representation of tightly interconnected knowledge spaces.

An atlas for knowledge spaces

The Atlas as a communication format

Like any good metaphor, the cartographic analogy applied to knowledge is not limited to a lexical transfer from a proper domain to a figurate domain, but it allows the transfer of knowledge from a known field to one yet unexplored. In the context of knowledge representation, the Atlas is here proposed as a tool and an approach capable of exploiting the representation codes for complex realities developed by cartography in its thousands-years tradition. Just like traditional atlases, these ‘new atlases’ provide a format to represent heterogeneous and complex territories, creating a tool to allow a connection, a comparison, a relationship.

The concept of ‘atlas’ in this context doesn’t depict so much a list of maps, as rather a system for the representation of space, a communication device aimed at representing complex contexts through the use of many partial overlapping narrations. A tool combining multiple images with the aim to describe the many aspects that make up a space.

> Atlases belong to a particular type of communication formats: as containers they collect information and visual documents about territorial entities. In the same manner, they are also containers of viewpoints: they expose different dimensional scales, techniques and languages of representation, and they express different subjectivities: readings and interpretations that mix descriptions in order to create stories. They have a strong intermedial nature: different media interact with each other in a dialectic relationship (the story told by one media, is confirmed, strengthened, completed by the other media) and they contribute to the construction of a single communicative framework. (Baule 2007b)

In opposition to the totalizing approach of hierarchical models that try to present in a single image the ‘true’ structure of knowledge (in the Middle Ages) or its most useful representation (in the Enlightenment), the atlas presents a network of partial (incomplete and biased) stories, expressing authorial points of view with no claims of objectivity or comprehensiveness. The ‘description of the universe’ proposed by the first cartographic atlases is the result of a complex work of collection, amendment, interpretation and comparison of maps, indexes, diagrams, pictures and stories gathered over time from various sources.

The reason for this approach is clearly exposed in one of the definitions of complexity itself, which finds the core of complexity in its inability of being adequately captured in all of its properties by any one formalism (Vries e Goudsblom, 2002). Any given model of any complex system will be ‘by definition’ partial, unfinished, and incomplete. Only a system of representations, carrying different views of the same real-world phenomenon will have enough information to be useful, if not exact. The structure of the system is not depictable by a single image or even by a formal description, but it needs a multiplicity of views, a system of descriptions, a network of texts.

From this perspective, the atlas as a communication device *arranges* the elements of a speech, and “the practice of arranging embodies the idea of structured organization, planning and articulation of the elements that defines the communicative discourse” (Baule, 2007b). The arrangement, in this context, is not a simple list or enumeration, but a strategic placement focused on the achievement of a goal.

> The term ‘device’ – writes Agamben (2006) in his analysis of the use of the same term by Foucault (2001) – seems to refer to a set of practices and mechanisms (both linguistic and non linguistic, legal, technical and military) that are designed to cope with an urgency and to achieve a more or less immediate effect.

The strategic dimension of the atlas is therefore reflected in its design dimension: maps, diagrams, text and peritexts are arranged together in order to allow not only the description of a space, but also its use. Just like the map itself, the atlas is a communication tool with its own mechanisms, materials and supports, an instrument that enables users to act on space: it allows navigation, exploration, change of scale, comparison.

As an interface for space, the cartographic atlas anticipates the mechanisms of digital interfaces: browsing through the pages, following links, looking up its indexes, the user can explore complex contexts by moving thorough different views of a single subject. The world, at first displayed as a whole, is then described in its details by different maps designed with many different objectives. Physical, political, geological and economic maps of the same territory are put side to side on the same page to allow comparison. On one side diagrams, histograms, tables and explanations make visible the invisible, on the other side alphabetical indexes and tables of contents and figures allow the navigation of the volume, providing the opportunity to identify the geographic location of a city known only by its name.

Unlike a simple collection of maps, the atlas and holds together the different narrations of the same territory in the creation of a format for the description of space. Through the careful design and layout of its elements, of the consultation mechanisms, of the graphic and symbolic characters, the heterogeneity of its components becomes a browsable and navigable system, a polyphonic narration, a mosaic made of different tiles that give shape to a single picture.

The Knowledge Atlas

This concept of atlas as a model for the representation of complex contexts, as already foreseen by D'Alembert (D'Alembert, 1751) and later recovered in the '900 by other actors in the field of knowledge (Rayward, 1994), has been the subject of an experimentation in the context of design research. The *Knowledge Atlas* is a prototype of a software platform for the management of research systems (i.e. resources, actors and relationships that interact in the creation of new knowledge), designed to support research of common tasks such as survey, mapping and analysis.

The software, built on web-based technology, is a social web application that allows researchers and students to build their own bio-bibliographic database by adding five main types of resources (authors, texts, projects, conferences and research groups) related to the research field that's being investigated. Each resource in the system can be then described collectively by the users (as in a wiki) in its essential features (such as date, description, location ...) and individually, by each user, through the definition of tags, comments, and through the establishment of relationships between entities (e.g. relating a text to its author, a person to a research group).

The aim of this management structure, expanding beyond classic bibliographic management, is to adapt to contemporary forms of cultural production: to collect not only explicit knowledge, but also implicit knowledge embodied in people, in communities and in objects. Traditional bibliographic models are therefore hybridized with a model for the mapping of social, cultural and scientific contexts. Using this management structure for research ecosystems, all the resources inserted into the database are shared at different levels between the users. The resources are not limited to their individual use, but instead they represent the nodes of a big network that ties together users, resources, and keywords. On the other hand, the wealth of information available in the network that links resources, users and descriptions makes it impossible to create a single image able to express its complexity.

In order to address this issue, the cartographic metaphor has been applied to the design of an interface to research spaces, with the aim to create not so much a single totalizing view of the observed area, as a series of maps designed to describe the relationships between its components, the pathways develop between them, and the transdisciplinary themes that emerge.

The complexity of the information gathered by the system is represented through a series of partial maps, held together by an atlas, a representation system that acts as container of points of view. Building on a cartographic rhetoric of knowledge spaces, information and data entered by the users are selected, filtered, prepared, screened and symbolized in order to create specific images of the research designed to present specific view of the space.

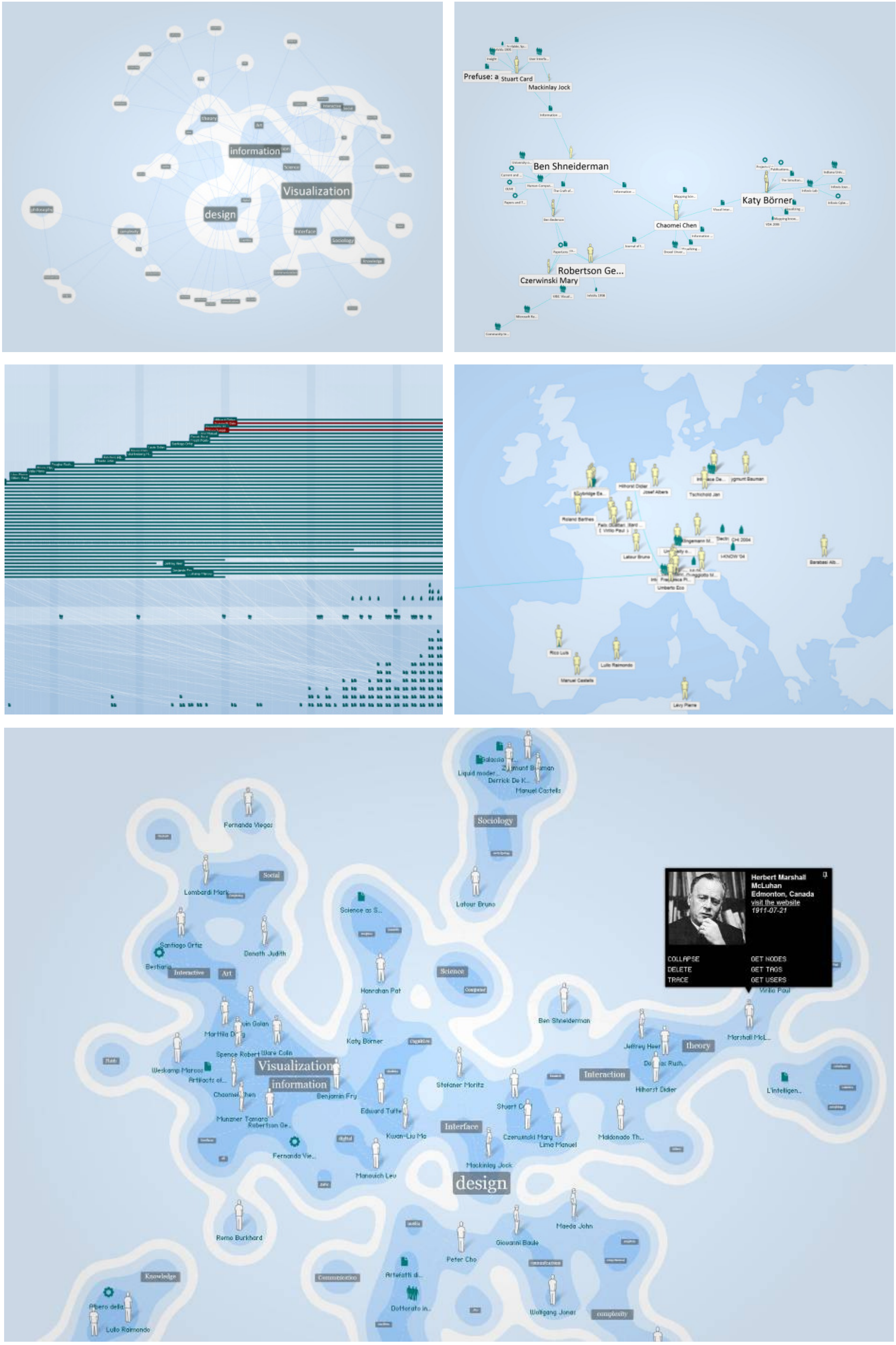

Figure 1 – Sections of the Knowledge Atlas.
Each map displays different aspects of the same complex space.

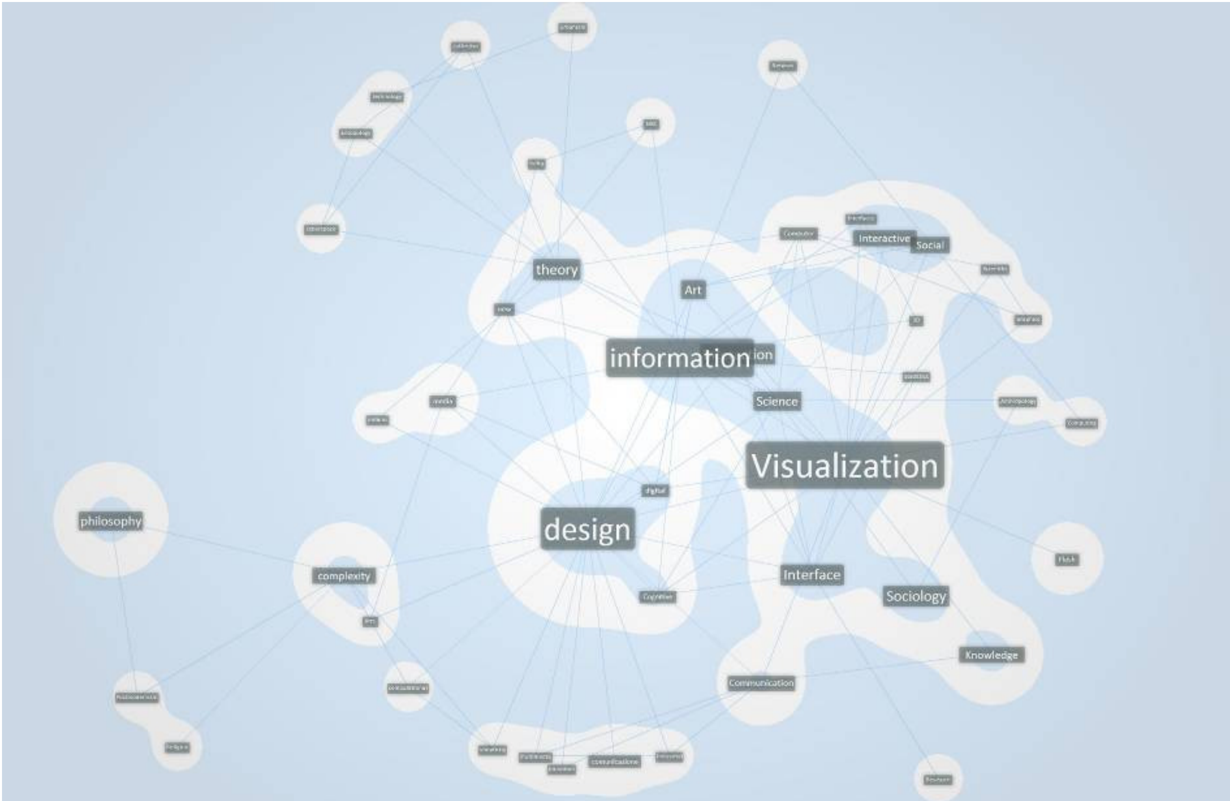

Figure 2 – *Thematic map*. Example typology characterized by focus on themes, subject clusters and implicit domain relationships.

As in traditional cartography, by combining the tools made available by the representation system, the user/designer can manage the rhetorical operations that lead to a potentially unlimited amount of maps. The most successful and most useful combinations eventually will be coded in relatively stable typologies that (with some variability) will be defined by their properties, their role and their use. Despite these typological forms, in the context of *knowledge cartography,* are not as stable as the typologies culturally defined by traditional maps (political, geological, physical maps are defined by strict rules governing their modalities of representation), the *Knowledge Atlas* attempts to propose some typological forms that seem to emerge from the international research on research representation. The atlas format becomes therefore container of *co-authorship maps* that show the relationship between authors, *geo-relational maps* that display the spatial distribution of research-related resources, *events timelines* aimed at describing the sequence of events, *thematic maps* designed to show the subject clusters of research, *relational maps* of the scientific community, etc. (Figure 2)

The connection that links maps and views, which in the paper version of the atlas is served by print-based mechanisms such as indexes, geographic reference systems (grids) and tables, in the digital version of the atlas is expanded to become a set of techniques for the navigation and exploration of space. The static shape of traditional maps is replaced by a map able to change borders, to increase level of magnification, to show or hide details. Areas of particular interest can be enlarged in order to show smaller details by exploiting the mechanisms of scale, or they can be reduced in order to obtain a general overview of the territory heavily focused on the global look of the 'landscape'. Similarly, just as easily it becomes possible not only to switch between visualization models at any time, but also to share with the final user the fundamental operations of cartographic rhetoric. Operations such as those of comparison, navigation and change of viewpoint, find new potentials in the digital tools: the user isn't bounded to a navigation bounded by the cartographer's maps, but he himself is able to create his own maps, aimed at communicating the most interesting, useful or clarifying aspects. The power of maps, historically at the service of power (king, government, church, military) is shared – in some part – with the user.

The Atlas format, once transferred into the digital contexts of software applications, finds its hidden nature: it becomes a meta-interface aimed at providing tools for the representation of complex contexts, a device for the creation and connection of different interfaces. It is not so much artifact as ‘graphic machine’, a system able to articulate set of individual artifacts as expressions of a systemic logic (Baule 2007a). The maps, their typologies and their sequence is generated from time to time according to the user’s needs and directions. Building on the potentials of digital systems, the atlas becomes a potentially unlimited network that collects and links a wide range of maps and pictures that can be modified by users to create narrations, reveal patterns, explore unknown territories or communicate the size and extent of their knowledge space.

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Understanding Team Design Communication through the Designer's eye: a Descriptive-Analytic Approach

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Abstract

The present study is an example of an empirical design research project based on design teams. Our main goal is to describe, understand and analyze the communication processes which take place inside a design team working on a design project for a short period of time. This paper presents the main observations and results of two case studies based on two design fields: Architecture and Graphic design. The paper's contribution lies on the methodology used, combining qualitative and quantitative methods of analysis, and involving the designers' point of view at various steps of the research process. In this way, we consider the value of this study twofold: first, it served as a 'vehicle of communication' between the research team and the design team and second, the structured methodology followed taking into consideration recognized methods, such as Linkography, and adapting them to the communication focus of this study.

Keywords

Design methodology, Team design, Communication, Case studies, Content, Structure, Linkography

The evolution of Team Design research can be marked by two main landmarks, which changed the view of how to focus on design processes: the Delft protocols workshop in 1994 (Cross, Christiaans & Dorst, 1994) and the DTRS7 common dataset analysis (McDonnell & Lloyd, 2009). In the two corresponding collections of papers written by diverse authors focusing on a big range of methodologies, a common tendency can be seen: the more complex the design process gets, the more effort is required by the Design research community to describe and analyze this complexity.

A major aspect of design complexity lies on the fact that design is nowadays mostly carried out by teams, including also others than the designers (e.g., the users) and consisting of people with different backgrounds and disciplines. This has generates an heterogeneity in the communication processes emerging during the meetings in which everyone involved in a specific design project has to be present but is not necessarily active and, even worse, not necessarily 'effective' for the production of the final product. As effectiveness we understand the relation of individual contributions at a cognitive-communicative level with the final team design result.

In order to judge this effectiveness, which additionally forms the basis of the team's best communication practices, an external eye, rather than the designers', is needed. At the same time, the designers' eye on the research processes is the other half of the judgment as they are the ones who know the specific characteristics of their work better than anyone else and the requirements they have to confront also outside the design meetings. For this reason we consider their involvement in the methodology presented below as an essential aspect of the research design process.

Method

Research questions

Having as main goal to describe the effective communication processes taking place in a team of designers, in a brief, as the projects considered were also brief, and communicable way, we posed the following research questions:

1) Are there moments in the team design interaction that can be characterized as more effective than others?
2) Which aspects of communication are relevant to this effectiveness?
3) Are there significant correlations between them?

Participants

The data used for this study is taken from two teams of professional designers at work on real design projects. Both projects had a short overall duration and were completed with the achievement of their goals, i.e., the creation of specific design objects.

In the first case, a team of 6 architects designed a Cultural Center for an international contest. This project ran for 4 months and generated a full submission for the contest, in the form of plans and model pictures. Overall, this project included 6 team design sessions for a total of nearly 10.5 hours. In the second case, a team of 2 graphic designers and their client designed a multiple-content book, authored by the client. The project ran for 3 months, and generated as final output a book on a famous film director. This project included 6 team design sessions for a total of nearly 8.5 hours. For the remainder of this paper the cases will be referred to as case A (for Architecture) and case B (for Book).

Data collection

According to Nardi (2006), in order to best describe an activity taking place in a specific context the following methodological implications have to be taken into consideration:

- A research timeframe long enough to understand actors' objects, which in Activity Theory also represent the goals-objectives (Leontev, 1979);
- A broad data collection, that allows paying attention to broad patterns of activity;
- The use of a varied set of data collection and analysis techniques;
- A commitment to understanding things from the actors' points of view.

Following the above principles, our method of analysis can be summarized in four steps, which are presented and discussed in more detail in the following paragraphs:

1. Following the participants during the whole duration of the project, understanding its context and specific features from the point of view of the professional life of the designers. In particular, we audio- and video recorded all team meetings for later analysis.
2. Focusing on the activity of participants both as individual contributions (moves) and team processes and interactions, namely by coding the recorded protocol in *cognitive-communicative acts* and then segmenting the coded protocol in *design episodes.*
3. Analyzing design episodes according to a number of parameters, blending different design analysis methodologies.
4. Discussing the content, structure and significance of these episodes with the designers themselves, in order to reach a level of consensus on their own communication processes.

STEP 1: Starting from the beginning

Following the principles stated above, to the purposes of this research study, we contacted designers which were about to start new projects with a duration compatible with the time constraints of our research. We then engaged the participants in a conversation about the project, asking them to present the project and identify its specific features from two points of view: the project itself (e.g., the peculiar kind of content for the book in Case B), or its position in the professional career of the involved designers (e.g., the fact that it was the first submission to an international contest for the team of Case A). Collecting such information was important for defining the framework of the design projects, along with the frame of mind of involved designers. This was indeed central for being later able to interpret their feedback on the analysis and to identify the relevant design features of the output.

We then video-recorded all design meetings. While large part of the activities carried out within design projects are individual activities, when a team is involved, design meetings represent project milestones: it is there when individual contributions come together and are shared and blended, when tasks are assigned, when ideas must find effective expression and representation in order to become shared and actually contribute to the project.

STEP 2: Segmenting episodes and coding acts

Following the nature of the projects, video recordings were organized in *design sessions*. Our main unit of analysis was the *episode*, intended as a significant temporal segment of a design session. Other scholars in Design Research have also chosen design episodes as the main units of analysis (in Cross, Christiaans & Dorst, 1996; McDonnell & Lloyd, 2009). In short, the granularity of episodes and the criteria for their definition (i.e., for segmentation) remain under-studied issues both in Conversational Analysis and in Design Research.

Our definition of episode is very similar to Wheatley's (1995) *topic type*, which refers to "a unit of talk that shares some of the attributes of Levinson's *activity types* and discourse *topics*" (in Firth, 1995, p. 379). The equivalent of our design episodes in discourse analysis would be what Sinclair and Coulthard (1992) call *transactions*. However, in our study we did not follow strictly these authors' indications for two reasons: (a) because of the lack of analysis of the transactions' main components, i.e. *exchanges and sequences*; and (b) because of the so-called "anarchy" in the design discourse, due to an "opportunistic movement between topics" (McDonnell, 2009, p.252).

Given this situation, we defined two criteria for the distinction between episodes: (a) topic-shift and (b) goal-shift. This means that each time that an explicit introduction of a new topic happens, or a new goal emerges during the interaction, a new episode begins.

Each video-recorded session was therefore transformed into communication protocols, which were composed of design episodes, each composed by several moves. *Moves* refer to each participant's contributions in the interaction and correspond to the smaller unit of analysis after acts (Sinclair & Coulthard, 1992). As these authors declare "a move boundary signals a change in the speaker who is composing/creating the discourse, and therefore a move boundary is a potential change in the direction of the discourse" (p. 23). In Design Research, Goldschmidt's (1992) description is one of the most representative: "The meaning of a 'move' in designing is akin to its meaning in chess: a design move is a step, an act, an operation, which transforms the design situation relative to the state in which it was prior to that move" (p. 72). As for episodes, for the granularity of the moves we again consider two main criteria of change of state: topic-shift and goal-shift. The difference here is that for moves, topics refer to individual representations and goals to person-derived goals.

Each move was then tagged with a *theme* and a *keyword*. This protocol, and not a full transcript, was used for coding and analysis.

Finally, each move was coded according to a framework of cognitive-communicative acts, to which the moves correspond in a design interaction. Each act is described by an action (e.g., *present*) and an object (e.g., *data*). The framework included the categories presented in Table 1. An example of a coded episode can be seen in Figure 1.

			Object			
			Data	*Solution*	*Plan*	*Goal*
Action	*Present*	make explicit, generate	P(d)	P(s)	P(p)	P(g)
	Analyze	clarify, explain	A(d)	A(s)	A(p)	A(g)
	Evaluate	assess, justify	E(d)	E(s)	E(p)	E(g)
	Decide	give final agreement on	-	D(s)	D(p)	-

Table 1 Coding framework for cognitive-communicative acts

Line	time	theme	keyword	P1	P2	P3	P4	P5	P6
128	32.35	performance hall	sphere-like shape			P(s)			
129	33.00	work-progress	functionality	P(p)					
130	33.30	performance hall	sphere-like shape				E(s)		
131	33.41	sphere-like shape	internal structure			A(s)?			
132	33.43	sphere-like shape	internal structure				A(s)		
133	33.47	sphere-like shape	internal structure			A(s)?			
134	33.57	sphere-like shape	internal structure				A(s)		
135	34.05	space organization	internal structure			A(s)?			
136	34.32	work-progress					P(p)		
137	34.35	space organization	boxes-surroundings			E(p)			
138	34.40	space organization	direction			A(p)			
139	35.04	space organization	internal-external			P(p)?			
140	35.20	space organization	direction	A(p)					
141	35.45	space organization	ticket	E(p)					
142	35.50	space organization	ticket				A(d)		
143	35.54	space organization	ticket			A(p)?			
144	35.57	space organization	ticket				P(d)		
145	36.00	space organization	ticket	P(p)					
146	36.10	ticket	funcionality			E(p)			
147	36.15	space organization	multiple accesses			P(s)			
148	36.26	space organization	multiple accesses			A(s)			
149	36.35	multiple accesses	underpass					A(s)	
150	36.38	multiple accesses	roads			A(s)			
151	36.47	multiple accesses	lights	P(s)					
152	36.50	multiple accesses	lights			A(s)			
153	37.05	structure	space organization	P(p)					
154	37.12	structure	space organization			E(p)			
155	37.34	structure	sphere-like shape	P(s)					
156	37.48	sphere-like shape	costs			E(s)			
157	38.05	sphere-like shape	costs	E(s)					
158	38.15	sphere-like shape	costs			E(s)			
159	38.20	sphere-like shape	costs	E(s)					
160	38.23	sphere-like shape	costs			E(s)			

Figure 1 A coded episode from Case A

STEP 3: Episode analysis

The main focus of this paper is on communication episodes as main unit of analysis. This was operationalized as a threefold analysis, which included their *content*, *structure* and *relevance*.

Content. As we already implied above, content refers to two main entities, distinguished for the purposes of this study: the *theme* and the *keyword*. The *theme* refers to the context or to the common ground of the discourse (Hajicova, Hall Partee & Sgall, 1998), whereas the notion of *keyword* was created to refer to Akin's (1986) *thing* or *relationship* to which a move is focused on. The theme is related to the topic in the following way (Katz, 1980): "The notion of a discourse topic is that of the common theme of the previous sentences in the discourse, the topic carried form sentence to sentence as the subject of their predication" (p. 26). Perfetti & Goldman (1974) add: "By thematisation we mean the discourse process by which a referent comes to be developed as the central subject of the discourse" (p. 71). In conclusion and according to our use of the notions *topic* and *theme,* topic refers to a more general conversational object, usually composed of many themes, which in their turn consist of at least one referent – what we call *keyword* for reasons of simplification- which has become part of the common ground of the speakers.

Structure. As far as the structure of an episode is concerned, we were mainly interested in:

1) *Time duration*: absolute and in relation to the whole session.
2) *Number of active participants*: absolute number and in relation to the total number of team members present during the session.
3) Identification of *the person(s) who initiates and finalizes* the episode (related to roles).
4) *Number and type of cognitive acts* belonging to the episode.
5) *Number of links* among identical keywords inside an episode; this measure is an adaptation of the method of linkography which is already applied on team design protocols (e.g., Goldschmidt & Weil, 1998). Our adaptation consists in considering only inter-episode links, taking therefore into consideration that the topic currently under discussion, which is usually the same during one episode, promotes the use of certain keywords and prevents others.
6) the *type of links* belonging to an episode. We mainly distinguish between two types of links: neutral and relevant links. Relevant links in this study are those which link between relevant keywords, i.e. keywords directly referring to aspects of the final design object.

Relevance. To the purposes of this research study, we defined relevance as the relationship between episodes and the final design product. Conceptually, an episode is relevant to the design project if it provided ideas, features or decisions that were eventually positively reflected in the final product. In order to determine relevance, after the design projects were concluded, we had a special session with the lead designers, and asked them to select relevant features of the final design product from the list of keywords from our protocols (see below). This served as a benchmark for the analysis. Relevance can refer either to content or to structure. In the case of content, we consider the *relevance of keywords* in relation to the final product; in the case of structure, we consider *relevance of links* in relation to the number of linked relevant keywords inside an episode. Formulas are presented in Figure 2.

$$\frac{\text{\# relevant keywords in episode}}{\text{\# keywords in episode}}$$

Formula for relevance of keywords (content)

$$\frac{\text{\# links to/from relevant keywords in episode}}{\text{\# links in episode}}$$

Formula for relevance of links (structure)

Figure 2 Formulas of "relevance" used in the study

STEP 4: Feeding back to the designers

The participant designers were involved in the research process mainly in two ways: deciding on the relevance of the keywords and discussing the choice of some episodes as more relevant than the others.

Deciding on the relevance of the keywords

After having tagged each one of the protocol's moves with a keyword, we came up with a list of all the keywords referred during the six sessions of each project and their occurrence in the whole protocol. In the following table we show the keywords with the highest occurrence of both analyzed projects.

CASE A: Architects		**CASE B: Graphic designers**	
space	access	images	cover
shape	building	contents	texts
dimensions	texture	dimensions	pages
performance hall	patterns	structure	translations
wrapping	internal-external	corrections	order
piece of city	stone	history	poetries
volume	«souk»	report cards	family images
empty space	continuity	authors	PDF
underground	route	index	costs
facade	square	position	titles
quality	symbols	scripts	form
surface	external	material	color
internal	green	father	notes
costs	requisites	format	tetralogy
materials	structure	images	interviews

Table 2 Some of the keywords emerged

The second step consisted of a grounded analysis (Glaser & Strauss, 1967) based on the produced list of keywords and their corresponding theme, according to the already coded protocol. This kind of qualitative analysis permits both to define categories as emerging from the data and to classify contents into these categories and not according to pre-defined and frequently biased taxonomies. Finally three big categories emerged for both projects, named: Problems, Solutions and Constraints-Requirements. In Case A, another small category was added called 'Examples'. Solutions were further categorized as belonging to one of the problems.

In the third step, the responsible of each design team was asked to help the research team in defining the integration of the keywords emerged into the final product. This co-decision turned out to be necessary, especially in the case of Architects as their final product was a projected model and not a physical building. During our discussions we mainly defined the use or non-use of each solution proposed, which of the requirements-constraints were related to which solutions and finally, only in Case A, which of the examples emerged during the discussions served as base for which implemented solution. Having done all that, we were able to determine the relevance of the problems, solutions, examples and requirements-constraints discussed throughout the projects.

Feedback to and from the designers

Once the most significant episodes were selected, a Focus Group session was organized with the design teams. The structure of these sessions followed the basic steps of an ordinary Focus Group meeting (Morgan & Krueger, 1998); however, the content of discussion was formed on the basis of Video Interaction Analysis methods (Jordan & Henderson, 1995).

More precisely, we showed the team the video clips of the episodes we selected and we discussed their content and structure, the other two measures of our analysis. Some representative issues of discussion brought up during the Focus Group sessions are:

- What is happening in this episode?
- How would you evaluate the team's communication in this episode?
- Is this episode relevant to the final solution? If so, how?

One of our goals was also to give and get feedback on the types and identification of the 14 cognitive-communicative acts we selected as codes for the protocol construction. We consider that the predominance and sequence of these acts gives a first image of the team communication dynamics constructed around a complex cognitive object, such as the design object. Moreover, the categories selected are understandable and communicable also to non-experts. However, we could not be sure about the adequacy of our selection until we tried out a test of inter-rater reliability having as raters one of the authors and 5 members of team A. The results were satisfying (K=0,65) considering also the difficulty of agreement in such types of coding schemes (Goldschmidt & Weil, 1998), and the lack of clear explanations for each category. The improvement of the coding scheme is one of our future goals.

Results

From the analysis described in the previous section, a respectable amount of data regarding team communication processes emerged. However, their treatment and statistic analysis was adapted to this study's goal and more precisely to give answers to the following main questions:

- Which are the characteristics of the episode with the highest structure and content relevance?
- Is there a significant correlation between these characteristics?

First of all, we needed to know which of the 206 episodes in total (of both cases) were more relevant in terms of content and structure. In order to do that, we selected all cases which appeared having very high structure and content relevance at the same time. Our analysis turned out with 7 out of 85 most relevant episodes for Case A and 12 out of 121 for Case B. These episodes where the ones which formed the base of discussion with the two teams during the focus group meetings.

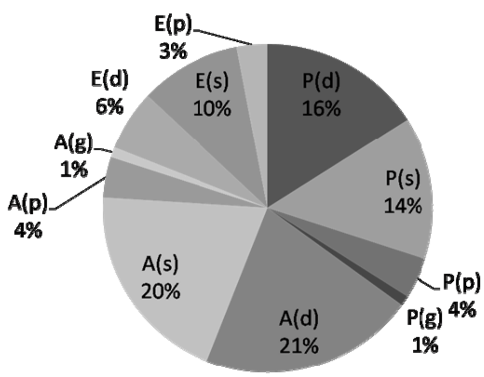
Secondly, we were interested in describing these highly relevant episodes using the measures discussed previously. Table 3 shows some general characteristics we considered representative of the team communication process such as the session in which the episode appears in, the number of active participants, the time proportion that the episode occupies in the whole session etc.

Case	session	active participants	duration in session	first speaker	second speaker	last speaker	total acts	predominant act
A	2	4 of 5	12.7%	3	2	3	33	A(s), P(s)
A	3	4 of 6	4.8%	1	2	2	26	A(s)
A	3	5 of 7	6.4%	1	2	2	31	P(d)

A	3	3 of 6	7.4%	1	4	3	27	E(s)
A	4	4 of 6	7.7%	3	1	3	25	P(s)
A	4	4 of 6	8.2%	1	3	1	30	E(s)
A	6	4 of 5	9.9%	1	4	1	25	P(s)
B	1	2 of 3	8.4%	1	2	1	22	A(d)
B	1	3 of 3	2.4%	1	2	2	16	E(p), P(p)
B	1	2 of 3	4.1%	1	2	1	19	E(d)
B	2	3 of 3	13.0%	1	2	2	13	E(p), A(p), A(d)
B	3	2 of 2	5.0%	1	2	2	10	-
B	3	2 of 2	4.8%	1	2	2	19	P(s)
B	4	2 of 3	7.4%	2	1	1	25	P(s)
B	5	2 of 3	3.3%	1	2	1	14	A(d), P(s)
B	5	2 of 3	8.4%	1	2	1	32	E(s),P(s)
B	6	2 of 2	2.3%	1	2	1	22	P(s)
B	6	2 of 2	4.2%	1	2	1	16	P(s)
B	6	2 of 2	2.5%	1	2	2	10	-

Table 3 Some descriptive characteristics of the most relevant episodes

These descriptives were used as a “vehicle of communication” between us and the designers at the time we wanted to make them reflect on their communication processes. We also considered necessary to give them a more detailed image of their use of cognitive-communicative acts during these highly relevant instances of the project. Figure 3 shows the distribution of the appearing acts in both cases always inside the 19 episodes’ time.



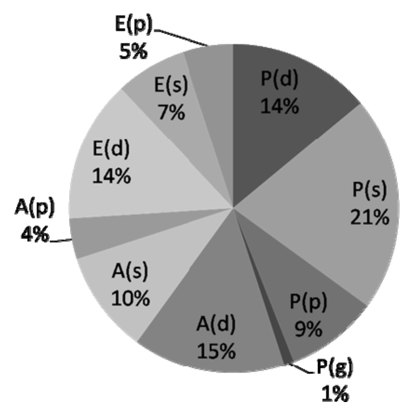


Figure 3 The distribution of the appearing acts during the most relevant episodes in Case A and Case B

Significance of correlations was also examined in order to check the reliability of the methods used. Table 4 shows some of the significant correlations emerged between the variables used.

	Duration in session	Active participants	First speaker	Total acts	Total links	Content relevance	Structure relevance
Duration in session	-						
Active participants	.035	-					
First speaker	.139*	-.091	-				
Total acts	**.851****	.119	**.154***	-			
Total links	**.310****	**.425****	-.131	**.458****	-		
Content relevance	-.103	**.377****	**-.223****	-.067	**.368****	-	
Structure relevance	-.027	**.310****	**-.135**	.014	**.303****	**.791****	-

Table 4 Pearson correlations for the sample N= 206 (* p > 0.05, ** p> 0.01)

Discussion

First of all, some interesting comparisons between the two cases emerge regarding their relevant episodes. The distribution of the relevant episodes among the sessions doesn't seem to follow any general rules. We can assume that it depends on the very specific characteristics of the project and the team. In Case A, for example, session 5 was dedicated to the application of solutions already discussed and this could explain why relevant episodes do not emerge. In Case B, the first and last sessions seem to be the most relevant: the first session was dedicated to the explanation of the project from the client to the designers and the final solutions were mostly presented in the last 2 sessions, after the complexity of the material was more or less resolved.

It is interesting that in all relevant episodes half or more of the participants are active. However, our small sample does not allow considering this observation as a pre-condition. Also, the type of participation has to be controlled before getting to generalizations.

The length of duration of these episodes, compared to the total duration of the corresponding session, does not seem to be significant as it is also confirmed by Table 4.

As far as the identity of the first, second and last speaker is concerned, it is interesting to notice that in all cases the second speaker is different than the first. Given that in our study 'speaker' corresponds to a person who makes a move, it is possible that a sequence is composed of more than one moves of the same speaker. Another interesting observation is that the last speaker almost always, in 17 out of 19 cases, corresponds to one of the two initiators of the episode.

No reliable observation can be made about the influence of the number of total acts, as this measure is significantly subject to the episode's duration as we can see on Table 4.

Nonetheless, the type of cognitive-communicative acts inside the episode seem to have some comparable characteristics between the two cases: a) in each episode distribution, 'solution' is the main action's object in both cases, and b) in all episode distribution, the action of 'analysis' is most predominant one and together with the action of 'evaluation' overpass the action of 'present'. This is interesting if we consider that in Case A the most frequent act is ‘present’ rather than ‘analyze’ and in Case B the most predominant object is ‘data’ instead of ‘solution’.

The most significant correlations, marked in bold in Table 4, turn out to be:

- Between Content Relevance and Structure Relevance: the more relevance there is between the content of the discussion and the final design product, the more this content is linked with other episodes before and/or after the episode under analysis.
- Between Total links and both Relevances: this is a confirmation that the method of Linkography is a representative measure of both the content and the structure of a design process.
- Between Total links and Active participants: the more participants are active in the episode, the more links in the structure of the process are created.

Conclusions

The present study’s goal was to construct and apply a method of description and analysis of the team design processes sufficient and adequate enough to respond to two requirements: (a) to shed light onto the communication processes of two diverse teams designing a specific design object in a short-time period and (b) to describe and analyze this process in a meaningful way for the designers involved.

Taking into consideration that this paper forms only a part of an ongoing research on team design processes, we should mention that the present focus is limited to some macro-observations without getting into further detail which we consider to be necessary in order to be more precise in our results and communications to the designers. In addition, this paper’s contribution should be seen considering the notable lack of precise and efficient methods in both fields of Small Team Communication and Team Design Research. Regarding the limited literature and confrontation, especially in the latter field, we conclude with mentioning our contributions and implications for further work.

Regarding the method used, it can be broadly considered as an extension of the Linkography method (Goldschmidt, 1992; Goldschmidt & Weil, 1998). Our innovation lies on the following facts: a) we didn’t transcribe the whole discourse; instead, we coded the whole communication that took place for both studies creating in this way an extended protocol to work on, b) our coding relies entirely on natural setting communications – no thinking aloud protocols were used and c) the links were constructed between keywords to which the moves were referred; these keywords sometimes were uttered exactly the same by the designers and some other times we had to infer them from the context. In this way, we gave a pragmatic dimension to the concepts used and, as a result, their connection with the final characteristics of the design object made more sense.

Moreover, the combination of the method described above with other methods deriving from the Cognitive Ergonomics field, regarding the use of the coding scheme, and from the Communication field, regarding the granulation of the episodes and their discursive structure, resulted in the production of various observations, with a high significance in a great number of them. Finally, the introduction of the measure of ‘relevance’ and its double definition as ‘content relevance’ and ‘structure relevance’ was proven efficient at the time of selecting a small number of episodes as more representative of the team design process. A constraint of this research device is the need for active involvement of the participant designers and their collaboration during the entire research timeline.

Future work includes adding more cases from other design fields, further controlling the reliability of the coding and segmenting methods and analyzing the most relevant episodes also from dialectic and argumentative points of view so that a more detailed view of the micro-communication processes can be given. Participant roles is another issue not thoroughly considered by this paper and which needs further characterization regarding not only the behavioral aspects but also the epistemic dimensions (as in Baker et al., 2009).

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Seeing what they are saying:

Diagrams for socio-technical controversies

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Abstract

The opening of enormous databases and the possibility offered by new tools to access the heterogeneous flows of data and information emerging from the Internet could be seen as an innovative mode also to observe and represent social complex systems. The *cartography of controversies*, the applied version of the Actor-Network Theory (ANT), is one of the examples of this new way of exploring and understanding these new information and knowledge domains. The cartography of controversies also aims at overcoming some of the limits of the traditional description of social issues by exploiting the potentialities of the *information visualization* and of the *information design*. In this framework visual models and diagrammatic devices are assumed as useful tools to describe the different position assumed by the actors of controversy. A distinctive feature of these, heterogeneous and non-isotopic, spaces is the absence of *unique metrics* to deal with them. The absence of reference points requires endowing with technical and conceptual tools for understanding and grasping the dynamics and the processes, which characterize them. Diagrams are here considered as operating devices able to describe and unveil the nested and latent connections of a system.

A real case has been choose to develop and test the capability of diagrammatic models to observe and describe controversies and to show the point of view of the actors involved in it: the remote control of dangerous materials transportation in road.

The research is strongly related to the development of the *Turtle Project*: a series of visual tools and diagrammatic devices able to explore controversies. It could be defined as an observation environment of the discursive knowledge flowing through the Internet, offering the possibility to make profit both from quantitative and qualitative research methods.

Some results about the chosen controversy are discussed as well as the limit of the tools.

Keywords

Social Complexity, diagrams, controversies, Actor-Network Theory, cartography of controversy, content analysis, discourse analysis.

New domains to visualize

It seems that the traditional modes of accessing, observing and representing social complexity are changing thanks to the opening of enormous databases and new tools to access heterogeneous flows of information (Latour, 2007).This hypothesis, supported also by Lev Manovich (2001, 2006), redefines a new emerging cultural form to capture, explain and discuss the complexity of reality, but it should be reshaped and extended. A more accurate analysis should be carried on two aspects strictly related to design discipline and more specifically to communication design practice. Communication design tools could be used as strategic devices able to read and narrate the dynamics that shape the current space of information and knowledge (Bonsiepe, 2000). On one side, theoretical remarks should concern the access to data, which, gathered from different fields of study, produce a new relationship between qualitative and quantitative methods; on the other side, empirical experimentations should be deployed on the modes through which these spaces are synthesized and translated into narrative devices[1]. These two aspects, only apparently

[1]The key concepts about the capabilities of visual tools refer to some theories born in the cognitive sciences with Johnson-Laird and particularly on the effectiveness of images, graphs, maps and more generally the class of diagrams, not only in mnemonic tasks (Yates, 1974), but also in those of complex reasoning and orientation between

sequential, can be merged into a new dimension that overcomes epistemological borders: beside a strongly codified knowledge are associated new relational and dynamic ones. This new domain requires also new modes of observation and representation. Indeed, it is emerging an area study labeled as *knowledge visualization* (Okada, Shum, & Sherborne, 2008; Shum & Okada, 2008), quite similar to the *information visualization* and to the *information design*, that aims to depict spatially knowledge domains (Shiffrin & Börner, 2004).

From visualization to controversies

The *cartography of controversies*[2], developed by Bruno Latour as an applied version of the Actor-Network Theory (ANT) (Latour, 1999, 2005), is one of the examples of this new way of exploring and understanding these new information and knowledge domains. The ANT approach tries to comprehend social and knowledge issues as complex network made up by relationship between heterogeneous actors, objects and discourses.

One of the most innovative elements of cartography of controversies is how the description of the analyzed complex social system is performed. The limits of a pure analytical approach, based on textual forms, are also shown by the increasing achievement of system theories and of complexity science. Alongside to text and discourse, visual models should be a mode of representation that does not divides or analyzes the elements separately but studies them in an interconnected and indivisible manner. *Images* thus could assume a role of primary importance: able to describe elements as a whole without dividing them, it becomes an irreplaceable instrument for depicting qualities of systems otherwise difficult to interpret. The aim is to explore, to integrate and depict the enormous informative richness produced by the actors through communication devices able to assemble information and practices even apparently unrelated, in a single *optically coherent space* (Venturini, 2008). The cartography of controversies aims at overcoming some of the limits of the traditional textual narrative description by exploiting the potentialities of the *information visualization* and of the *information design* to observe social phenomena.

Smooth spaces and points of view

Under certain aspects ANT shares with Complexity theories, and particularly with social complexity, not only the interest in complex networks[3]. Indeed, some features of the complex systems[4] show resemblances with the controversies, as the dynamicity due to a high number of agents and actors and the non-compressibility due to non-linear interactions. Furthermore, the very same definition of controversy makes reference to open dimensions, with a priori non-definable boundaries. They are indefinable as the Complex systems are, bringing to an impossible exhaustive, stable and complete knowledge[5]. The possibility of understanding these systems depends also on the production of *dialogical* models able to compare different data, information and knowledge. The dialogical models configure themselves as a representation of *smooth spaces* (Deleuze & Guattari, 2006*)* animated by different tensions which do not appear as unique and compact realities, but composed by fragments and heterogeneous pieces (Marzocca, 1994). A distinctive feature of these, heterogeneous and non-isotopic, spaces is the absence of *unique metrics* to deal with them. The absence of reference points requires endowing with technical and

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a high number of data and information (Berthoz, 2006).

[2]The *cartography of controversies* can be defined as a set of techniques for observing and describing, as well as to explore and visualize social issues, especially but not exclusively, *socio-technical systems*. The word controversy refers as a neutral term, to a shared uncertainty or to *«a debate surrounding a technique or scientific fact that has not yet been determined»*. Its aim is to open the *black boxes* of techno-scientific truth and observe empirically how they are constructed through a widened and non-linear process of negotiation. At a conceptual level all the controversies, even though each one is essentially unique, have some common characteristics (Law, 2004):

- A high number and high diversity of actors and agents involved;
- A high dynamics of relations between actors and agents;
- A marked non-reducibility and compressibility;
- A dialectic but conflicting form.

[3]In the *latourian* cartography every social event is described as a heterogeneous network of connections where actors are constantly working to bind or dissolve their mutual links.

[4]See also (Cilliers, 1998).

[5]Even if it is assume to be able to obtain all the data about a Complex system it would be impossible use them, coming to a situation of *information overload*. See in this regard (Ricci, Ciuccarelli, & Valsecchi, 2008; Scagnetti, Ricci, Baule, & Ciuccarelli, 2007).

conceptual tools for understanding and grasping the dynamics and the processes, which characterize them. Also according to the cartography of controversies, each approach to the knowledge spaces can exist only from subjective and partial point of views. The only objectivity accepted by the social epistemology is a second order objectivity, which is the attempt of understanding a system as a unique object through the highest number of possible point of views, even those in opposition. This position, often accused of radical relativism, is interested more in the *"truth of the relationships"* rather than in *"the relativity of the truth*[6]*"*. In this way the Latourian relativism is the opposite of the point of view absolutism, i.e. the evident willingness of not comparing or of not linking one of the vision of the world with the possible others, of not establishing a dialogue with them. It is a *dialogue* able to disclose a deeper knowledge of the analyzed controversy.

The bridging artefacts of communication design

The capability of the communication design of building languages and tools, first of all visual ones, should be oriented also to the construction of bridging artifacts, in order to connect different point of views, social contingencies and manifold interests, structural features of a Complex social system. One of the raising challenges is the representation of smooth and complex spaces (Scagnetti et al., 2007), which are also spaces of knowledge and controversies. Visual models could help in describing, in a tangible manner, the different position assumed by the actors of a complex system and their point of view, developing mutable explanations of the reasoning processes as well as the data cognition processes paths, which underpin their assertions. It is a very process of translating the actors' mental models (Laird, 1988; Norman, 1996; Preece et al., 1994) into a shareable form. It is a focus, which moves from identifying the possible controversies solutions to assisting the actors of the social transformation in underlining the social, economic and organizational dynamics through the constructions of artifacts:

- *open* to the possibility of recombining data and heterogeneous information;
- *inclusive* in the possibility of telling plausible visions regarding the system perception, offering an optically correct device, maintaining and preserving the multiple interpretations, produced by a space of controversies.

Diagrammatic devices

The challenge is that of showing the multiplicity of viewpoints and stressing the different narration typologies which underpin them. Besides, it has to point out where the different interpretations overlap and where they diverge. At the same time it has to be shown how the information characterizes the very nature of the system. It is, then, necessary a notation system, which explains the controversies dynamics. Diagrammatic modes of visualization (Scagnetti et al., 2007; Ricci et al., 2008; Ricci, 2009) seem to be particularly adapted to achieve the above mentioned goals. In this context diagram are considered as operating devices able to describe and unveil also the nested and latent connections of a system. When design is addressing complexity, diagrams could become generative tools that can be used to generate *metadata* relevant to the design process. Diagrams effectiveness lays in the ability to act as go-between with explicative functions of the different correlated quantities (Abrams & Hall, 2006; van Berkel & Bos, 1998; Corbellini, 2007), as a sort of *graphic short-cut* for the representation of complex phenomena. Indeed diagrams and maps are media between what is known about a system and what the system is; they could display not only quantitative data but also ideas, concepts, frames, schemes, viewpoints, perspectives and values of the system observer. The aim is not that of representing fixed positions in space and time, but rather of rendering in a visual language the actors' mutable tensions and the strengths fields produced during a controversy.

In this research field have been conceived, first conceptually and then in an empirical form[7], two diagrammatic tools to manage the three main dimension of a social complex system: time, actors

[6] See also (Deleuze, 1990).

[7] This research is related to a wider field in the framework of the DensityDesign Lab. The aim of this line of research is to verify the power of communication artifacts in helping decision making processes and their ability to facilitate dialogue within participatory design actions. For more information see densitydesign.org

and interactions. Each of them has the objective of transforming and formatting in a common form data and knowledge produced by each actor belonging to the system. The proposed approach discussed in this paper is different from others in which the main effort is to develop formal model and algorithms for computer simulations, and where visual codes are strongly codified. Here, the objective is to set up a visual language mixing up digital information to depict, through the observer interactions, how agreement areas and disagree ones are generated. The real goal is to build narrative models (Bruner, 2005) preserving the informative richness but bearing in mind that every analysis reduce and compress.

Choosing a real controversy

This research has seen, since the very beginning, a profitable collaboration with the Mobility and Transportation Laboratory (LMT) of the Politecnico di Milano, in order to test on a real case both the theoretical concepts and the diagrammatic tools of this work.

From a series of interviews and collective discussions with the LTM research group, it has been found the most interesting case to be tested: the remote control of dangerous materials transportation in road. The selected social-technical system is constituted by many actors, very different each other and facing a deep transformation. On one side the legislative modifications are causing a deep transformation of the entire industry; on the other the whole transportation industry has changed is dynamics, which are still facing a redefinition process. This industry is characterized by a hyper-fragmentation of the transporters, which are action as single firms. Another featuring phenomenon is the evolution of the shipment management technique, producing enormous data to be analyzed. If on side this could be interpreted as a raising efficiency but on the other as privacy and independence loss of the myriad of involved transporters. This is causing a lot of frictions both on the experimentations of the info-mobility technologies and to the implementation of clear and sustainable laws. The research effort is also to set-up tools useful for a profitable discussion among transporters, legislative and technological actors.

Setting up the research method and strategy

Once the observation field has been defined, an approach to generate the dataset and a method to elaborate them in order to observe the controversy has been chosen. Many are the difficulties linked to the direct observation of a controversy (Venturini, 2009) and in general to observe all the social complex system since expanding themselves in space and time. The observation of social and technical system is like a constant collection of materials produced by the actions of the several actors, present in different time and places. It is an integration work, which finds in the digital dynamics of the Internet an affinity almost elective (R. Rogers, 2002, 2004, 2009). Differently from many digital research methods, which by the automation of some mathematical algorithms build networks and rebuild connections, among the different actors of a controversy, in this research the aim is to try developing and testing semi-automated tools focused on the semantic content and structure of information. During a controversy every actors constantly leave some traces, which could be seen a potential heterogeneous database: made up by the interview transcriptions, official reports, statistical data, operating and normative procedures, and industry analyses and media news. All these traces share, regarding the research hypothesis, the shape in which they are generated. They belong to a social structure, reflecting also the point of view of each actor. They are part of different discourses by which each actor tries to further and enhance its position within the network and in the controversy developing path. Among the various qualitative research methodologies, through the use of discourse analysis[8], it is possible to try to

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[8]The text, language and discourse are seen within the methodologies of *discourse analysis* as *objects* able to provide representations on how things are, how they were, and how they could be or should be. Discourse creates three types of interdependent social and cultural meanings that define a mental model. In our field of research:

- It creates representations of activities and events – it is the discourse "semantic function" through which we define the concepts, ranks them, they are enumerated and assigned attributes ;
- It constructs the viewpoint of each actor and social relations – it is "the pragmatic function" building social and emotional ties to some issues brought forward by other stakeholders, whether real or not, and to other points of view;
- It creates the relationship with the environment – it is the function that organizes the contents of the texts and discourses, that create the sense and narrative structures, it also related to other forms texts such as the data

understand, unveil and construct how the positions in the networks are related to this traces and discourses. The discourse analysis, in fact, examines how the social word is constituted by the meaning of discursive practices: it interprets them.

This work, from a technological point of view posits itself above information and discursive flows, related to a controversy developed in the Internet. With adequate tools, such as crawlers and ad hoc research engines the traces of a controversy emerge and they can be observed. The data gathering finds in the Internet not only a precious *box*, which contains the elements to reassemble the network and the dynamics of a controversy. Stemming from the previous statements, the *Turtle Project* has been conceived. It is made up by a series of tools and devices able to explore controversies and could be defined as an observation environment of the discursive knowledge flowing through the Internet.

Turtle is able to grasp significant discursive data exploiting the potentialities implicit in RSS feed system. For this project an RSS is a constant source of information related to specific actor. Each RSS feed is associated to an actor, vice versa each actor could be related to a more than one RSS feed. *Turtle* is periodically monitoring the feed list for each actor, and it finds relevant news and traces for the analyzed controversy thanks to a keyword matrix. In order to build an extensive list of RSS feeds related to each actor, some tools have been borrowed from the Digital Methods Initiative. They are complementary to the *Turtle* project: in particular the *Lippmannian Device* also knew as Google Scraper, which has been used to attain a series of valid URLs, from which extracts the RSS in relation to the dangerous goods transportations. This process has been carried on in the following way:

1. The first two hundred results of a traditional Google research with the query “Trasporti” have been selected;
2. The multiple hosts, the links from Wikipedia, images and videos have been deleted;
3. The remaining results have been processed by the *Lippmannian Device*, with the query “merci pericolose”*;*
4. With another tools have been extracted the RSS;
5. A weighted list of one hundred and sixteen results related to the controversy has been build;
6. The list has been enlarged by adding the most important Italian journalistic headlines;
7. Exploring this website list, have been generated twelve clusters of actors.

At this time *Turtle* is able to automatically perceive the information produced in real time by the actors. Since an RSS can produce information not strictly related to the observed controversy, a semantic correspondence between the information content and a list of keyword related to the dangerous goods transportation is performed. Furthermore, if an information is considered relevant, from it are extracted the most important words. To sum up, to each actor are associated some RSS feed from which are extracted the relevant information. The main contents come by the latter. Furthermore, performing a Content Analysis process *Turtle* is also able to give some quantitative insights about the observed controversy[9].

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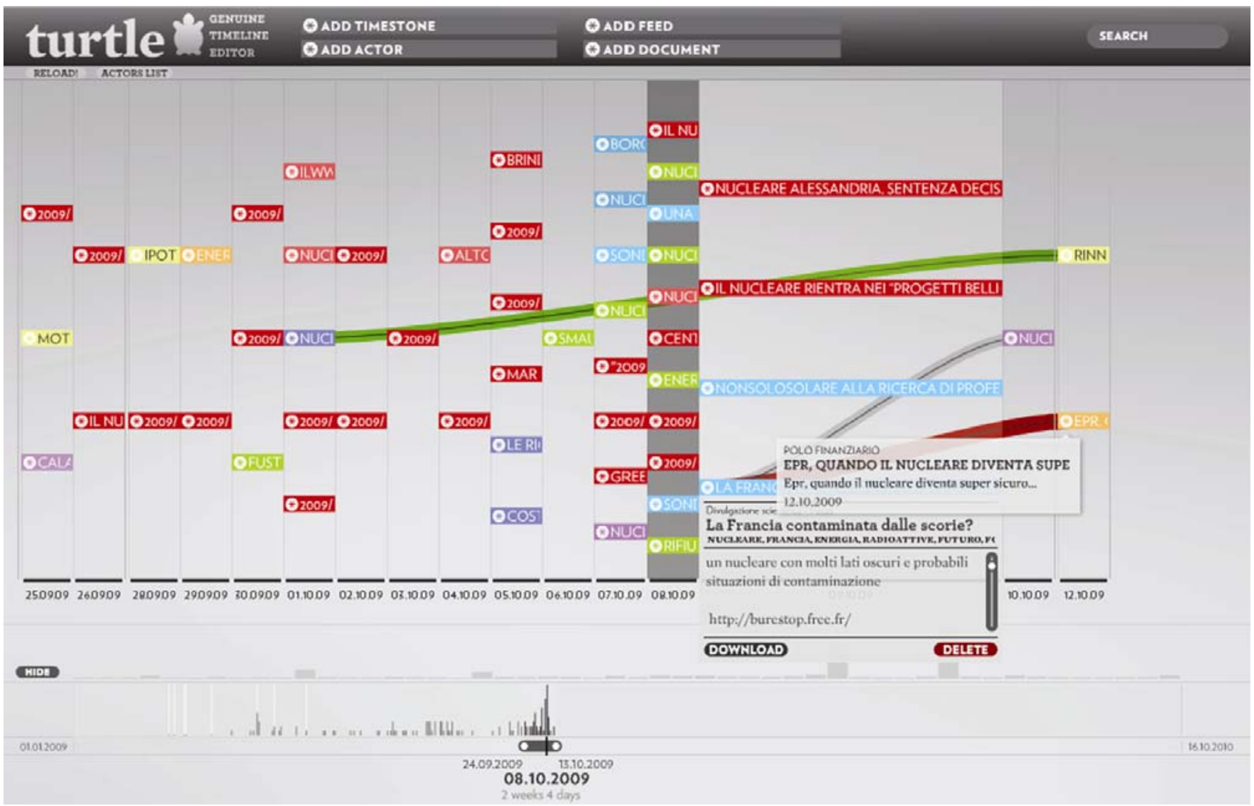
or images.

The concept is often vague, or used with different meanings depending on context. A useful description is given by Marike Finlay (1987): *«[...]discourse analysis is the study of the way in which an object or idea [...] is taken up by various institutions and epistemological positions, and of the way in which those institutions and positions treat it. [it] studies the way in which objects or ideas are spoken about [...]».*

[9]Content analysis is a method used to transform non-numeric and symbolic information for the purposes of statistical analysis. It follows explicit rules of coding and allows classifying large amounts of data. Because of its relative conceptual simplicity can be used to support other, more detailed textual information and discursive fragments. Are distinguished two main approaches in the use of this class of research tools (Shapiro, 1997) the instrumental analysis and the representational analysis: *«At issue in this distinction is whether it is the source's or the researcher's perspective that is used to interpret the texts under analysis. When a researcher understands texts representationally, they are used to identify their sources' intended meanings. When a researcher understands texts instrumentally, they are interpreted in terms of the researcher's theory»* (Smelser & Baltes, 2001).

Observe and visualize

After having described the technical and conceptual features of the research, it has to be pointed out that the *Turtle* characteristics are not exclusive linked to the RSS feed aggregator. Indeed, *Turtle* offers some useful tools to explore a controversy. To the traditional and digital filing documental functions are added explorative and narrative functionalities of visualization. From a graphic interface point of view *Turtle* is made by two explorative tools: *Turtle Timeline* useful to analyze data and observe the controversy, depicting the results of the automatic Internet information gathering; *Turtle dynamics* synthesizes information showing the position of the various actors, their relations and the most important content of their discourses. The potentialities of the visual models have been tested in the empirical study in a real controversy on a twofold floor: firstly, *Turtle* should clarify the specific contribution to the overall discursive structure of each single discursive fragment; secondly, it should underline the latent structure by synthesizing every single discursive fragment. Even if it *Turtle* seems to act in an automatized manner, each action is controlled by the controversy observer.



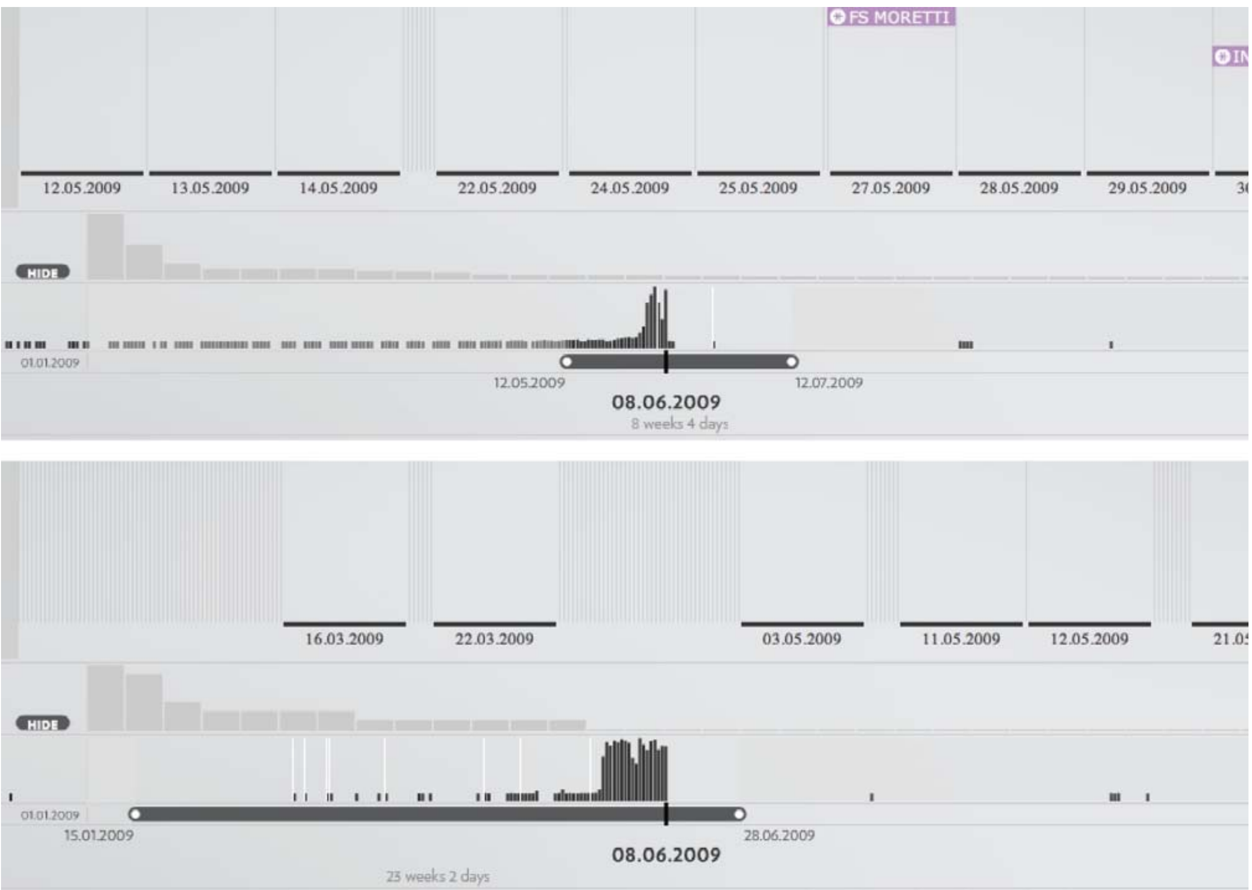
Turtle Timeline: Creating the relationship between discoursive fragments

For example, illustrating the interface characteristics and its features in visualizing information, it is possible to start from the actors identification procedure, which is a step by step process and it is able to guarantee a great flexibility. To each actor it is possible to associate a color, different shades indicate different groups of actors (e.g. the observer can choose the purple for the governmental headlines; blue for right news headlines; green for environmental associations). Different color graduation can indicate different actors, which tend to share their idea. To each actor the observer can associate some metadata. The specific aim of this software is to visualize the discursive fragments and stress their relationships, also with respect to time. The observer can link two or more fragments assigning to their relationships in terms of similitude or contrast. Three are the possible links: a generic one, depicted as a grey line; the second, an agreement link, assigned by the observer when he considers the content of two fragments as converging; the third one, a disagreement one when the observer states that the content of two fragments are in conflict or show two different opinions or point of views. Furthermore, the observer can assign a weight to the last two links, indicating the strength of the concordance and discordance.

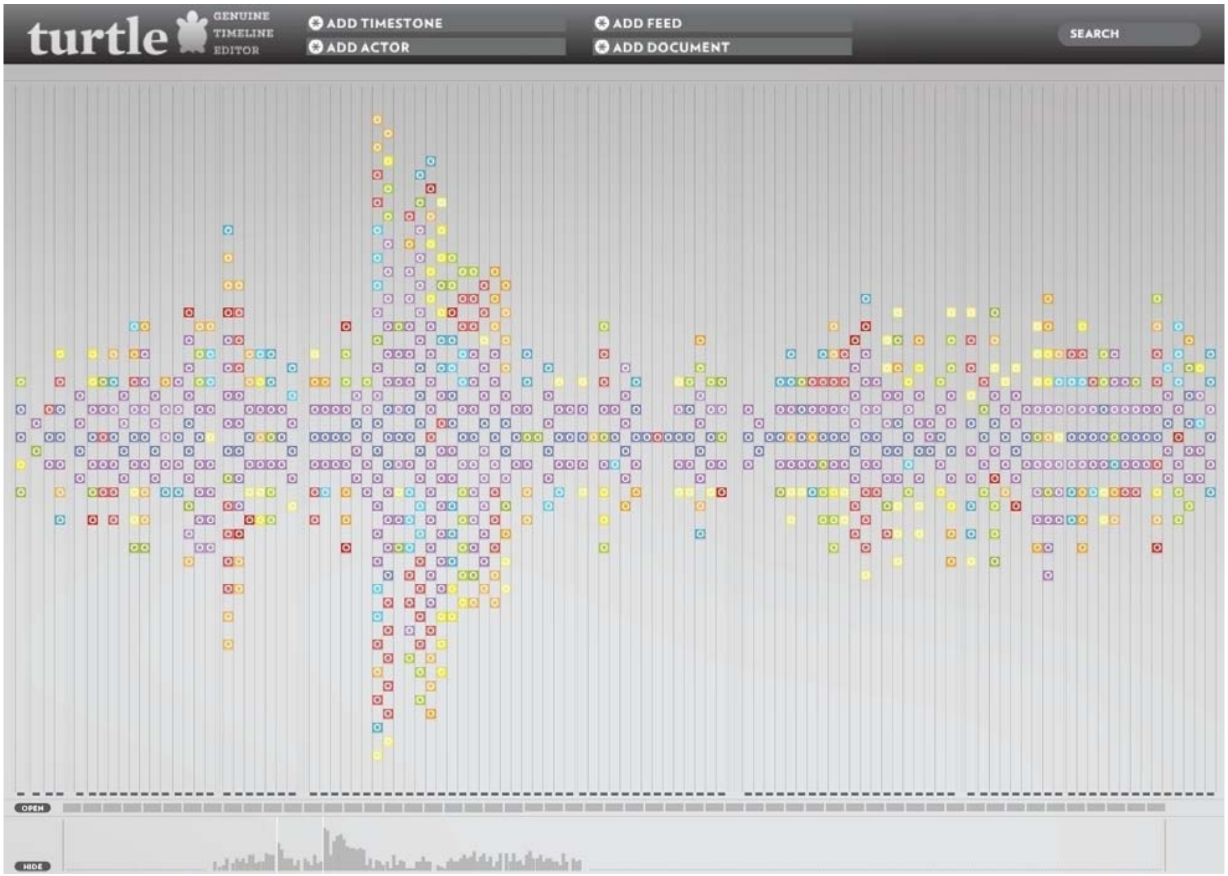
Turtle dynamics is the complementary device of *Turtle Timeline*. It gathers the fragments actor by actor and the relationships among them, proposed by the observer to visualize a synthesis of the controversy. It shows cluster of actors for a specific momentum as a graph; letting emerge the relationships among clusters of actors. The latter are visualized as circles, with a directly proportional to number of fragments produced by them. Each position on the graph is a function of the relationship built by the observer in *Turtle Timeline*. The distance among the circles decreases as the agreement links between actors increases. On the contrary the distance increases if two actors have lots of fragments in opposition.

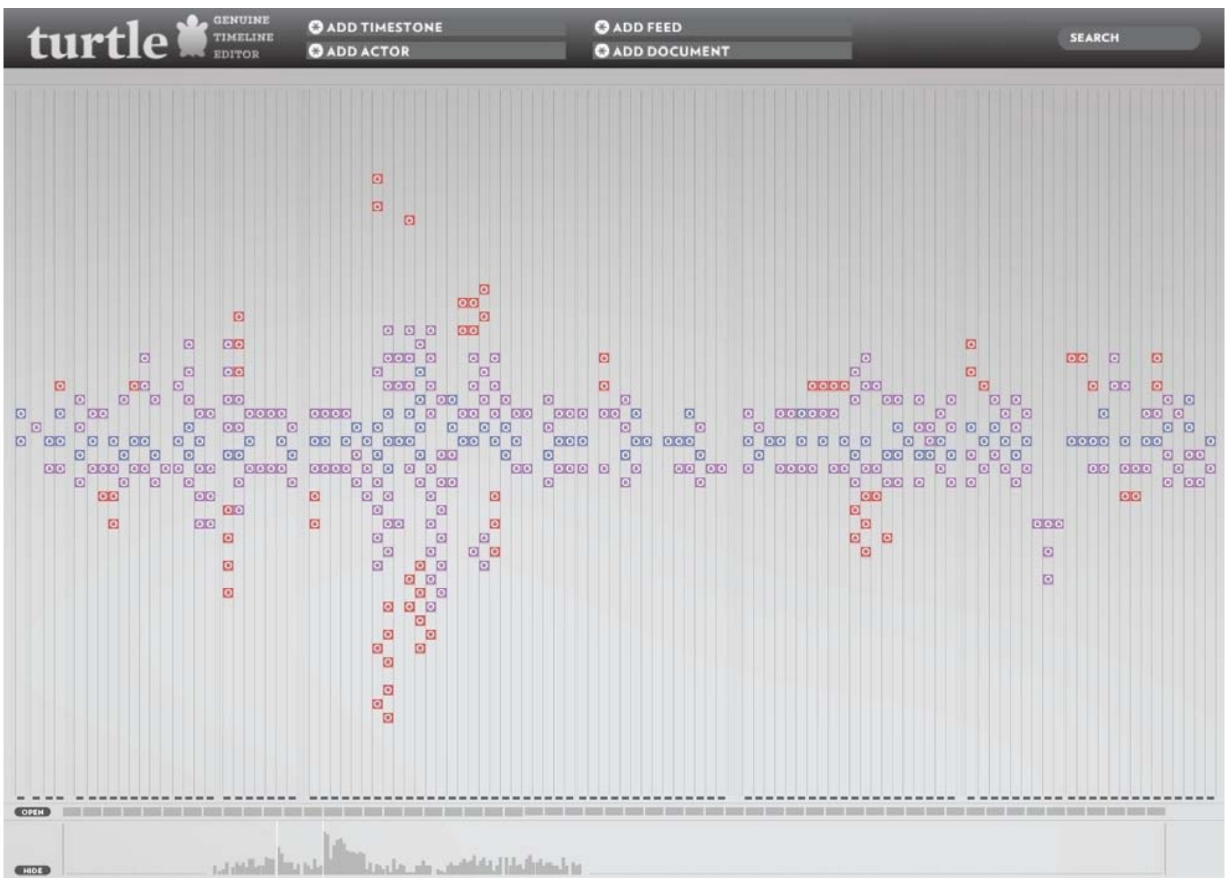
Some results about the controversy

In observing the controversy about the dangerous goods transportations *Turtle* has made it possible to enlighten some interesting dynamics. First of all, the dynamicity of the considered case has emerged thanks to its content analysis capability and from a comparative analysis with another controversy, i.e. the nuclear energy implementation in Italy. By observing the dimension of the flow through the time, it has been possible how the external events can affect the controversy. In this sense, the comparative analysis shows the *discursive flow volatility*: the increase or decrease of the discursive production in relationship with an external event. For instance, considering the last European poll, the two controversies showed a different behavior. The dangerous goods transportation one, as the elections were approaching, saw a rapid raise of the flow, which has been constant through all the poll period for plummeting at the end. On the contrary, the nuclear controversy the flow rose even before of the elections, and then stayed stable in the long run.



Turtle Timeline: Above the "dangerous good" information flow. Below the "nuclear" information flow. The considered period is related to the 2009 European poll

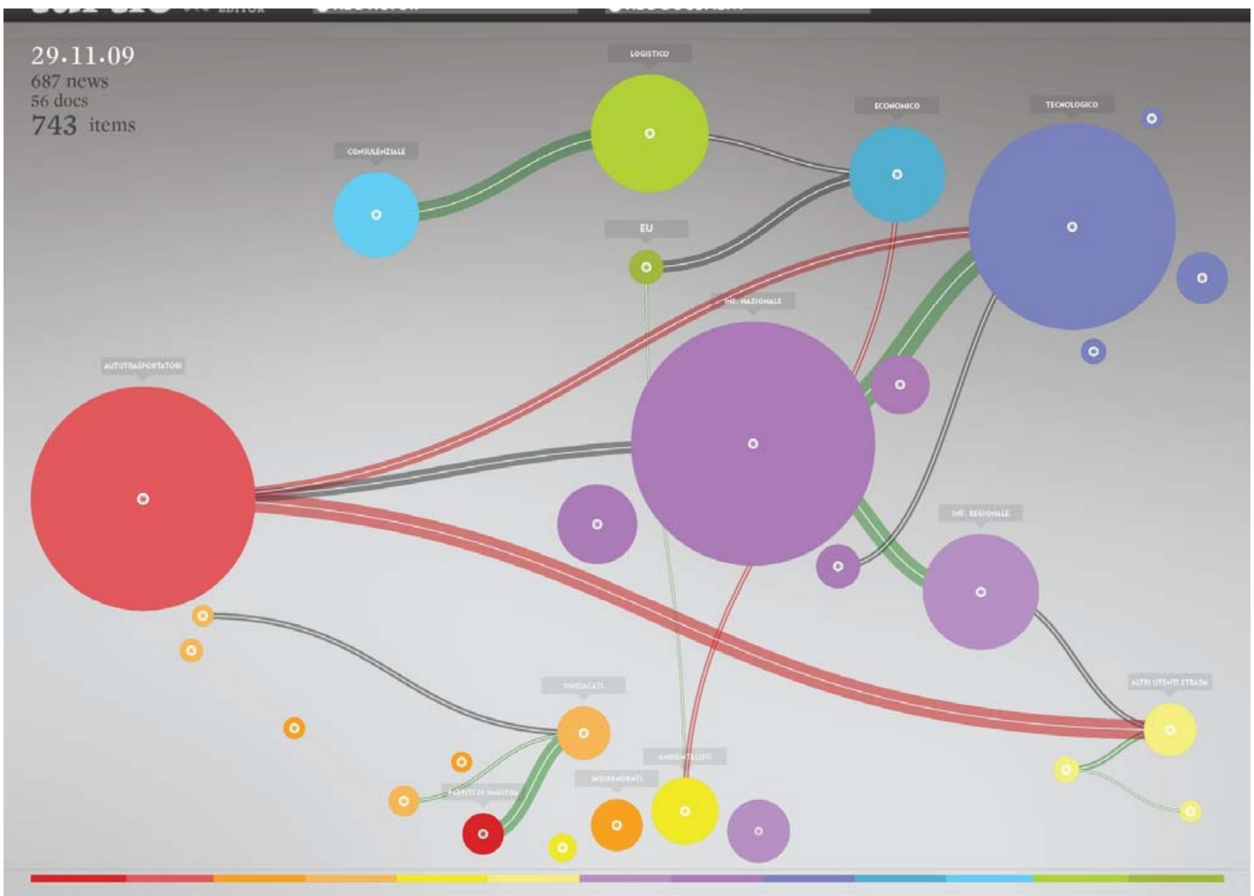




Turtle Timeline: Above the diagram after six months of observation. Below the diagram where the *discourse axis* is enlighten

Other observations have been performed in relation with events more germane to the specific controversy of the dangerous goods. On 29 June 2009, in Italy a tragic event took place in Viareggio, where a train transporting dangerous goods was involved into an accident. Although it was referring to a differing transportation system, this event led to a significant increase of the discursive flow, strictly related to the remote control of the transportation of dangerous materials in road. After this event, the flow remained stable. *Turtle* shows its capability of revealing the interdependence of controversies with other systems. By observing the lay out of the fragments into the interface, other patters emerged, both communicative and relational ones. *Turtle Timeline*, in fact, positions on the median area the fragments belonging to the actors, which in the observation time frame has the highest ratio between the number of fragments vs. number of days, so to identify the more active actors in the controversy, which constitute the *discussion axis*. In our case, it is represented by the technological actors cluster.

The most important qualitative and discursive results can be abducted by observing the diagram produced with *Turtle dynamics*. It shows in the upper part, really near among them, clusters concerned with the economic aspects of the controversy: the technological cluster, the logistic and the economic information one. Within this area, of great interest is the consultancy cluster, which represents those actors involved in the trucks and drivers certification. It is at the end of a chain starting from to the EU cluster, producing the laws and directive for the entire transportation industry. In other words it is evident a link between directives and their economic impact, the logistic and the bureaucratic issue, all of them are polarized by the technological aspect of the controversy. A weak link joins the EU cluster with the environmental one, even if the link is an agreement one.



Turtle Dynamics: the graph after six months of observation.

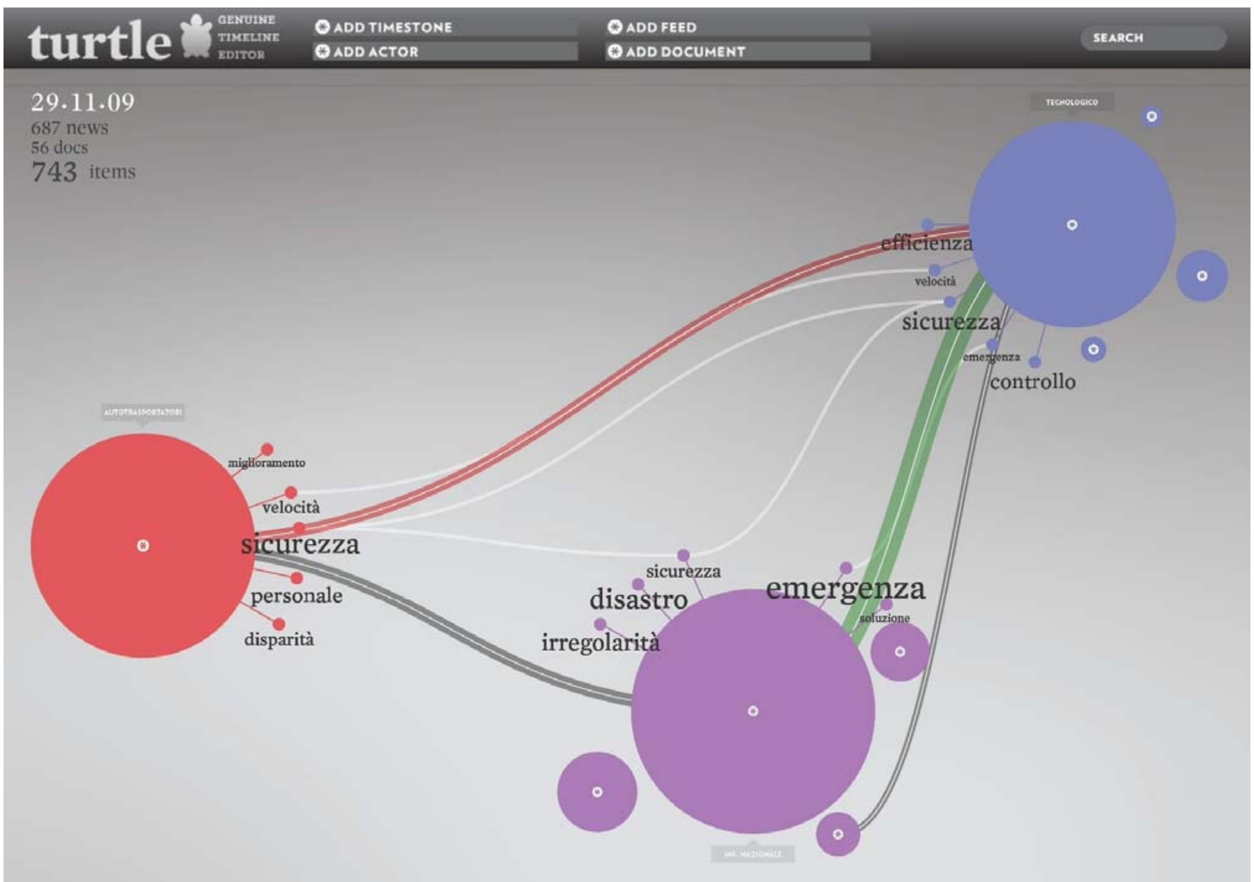
On the contrary, the environmental cluster has a disagreement weak link, with the economic cluster. In the middle of the graph, the national news headline cluster has a huge weight, strongly linked to the tech one. The regional news headline cluster, closed to the national one, has a generic link with the cluster pertaining to the car and motorcycle drivers. This relationship could mean that there is a mutual influence between the regional news sources and personal blogs and forums, which constitute the vast majority of the car and motorcycle drivers cluster.

The latter are clearly and strongly in opposition to truck drivers, which occupy the left part of the diagram. They are in opposition with the tech cluster as well.

At the diagram bottom are situated the labor unions cluster and the left party cluster.

This diagram lay out reflects some hypotheses emerged from the first and quick analysis of the controversy as well as the interview session with the researchers of the LMT. Expanding the *Turtle dynamics* diagram and letting appear the key issues concerning the three main clusters, even though they are in contrast, it is possible to point out where their point of views converge. Recalling the remote control of dangerous materials transportation in roads, jointly with the privacy issue, the diagram shows the tech cluster interest in safety, efficiency and dangerous goods transportation control. The national news headline is concerning with the need of finding solutions to prevent emergencies and accidents. Even the truck driver cluster is supporting the safety issue, but it is concerned also with the improvement of their working conditions. Safety is by far the major linking strength, even if it could be declined in various facets from the economic to the social one.

Taking into account what it can be observed through the diagram and triggering a *designerly* way of thinking, the clash between the need for a greater safety, achieved through the control and the tracing of the truck drivers, and the need for independence and privacy can be balanced considering the other drivers interests. The role of the remote control devices should be considered twofold: on one side it is perceived as invasive by the truck driver, on the other they can be used to increase their working condition. An issue, the latter, which is one their main concern.



Turtle Dinamics: The three main actors, and their issue relationship.

Some limits about the tools

The research results presents obviously some limits, which basically reflect all the three levels on which the empirical tests have been carried out: the technical one, the definition of observation area and the visualization one. Here will be discussed only the first, which has shown the more significant impact on the results achieved. The main limit has been represented by the *noise* of the information flow. It is an issue related to the automatic part of the gathering data process but it requires some reflections about the research methods. The researcher has to constantly monitor the results of the filtering process in order to overcome this limit. If one side it can be enhance by optimizing the algorithms, on the other it implies not to fully rely on the automatic procedure; therefore, it implies the need for exploiting the researcher cognitive capabilities to reassemble the puzzling fragments of a controversy.

Multiple perspectives

In developing the research, from a more abstract point of view three steps in *formatting* information and discursive fragments have been carried out:

1. From the textual fragment to a visual object. It has been sought the qualitative and quantitative data salience in order to convert them into nodes and elements referable to an optical space;
2. From the phenomenon implicit structure to an explicit and visual one. Analyzing one by one the visual objects, it has been tried to highlight their mutual significance as well as their overall sense, visually showing their relationships.
3. From a unique perspective to a multiple one. The possibility of not univocally linking the different fragments opens to more than one possibility. Moreover, it brings to further reconfigurations and multiple interpretations of the same phenomenon.

The possibility of another observer to build its own links would bring him to configure a different network and a diverse interpretation of the observed phenomenon.

The diagrams, presented in this paper, have not to be considered as devices able to provide the reader with definitive answers, but instead as tools to be used in drafting better questions to be asked to the system. Their novelty relies more on their capability of *formatting* data, rather than their visual aspects. On the wake of Bonsiepe (2000), it could be stated that diagrams are like *finding engines*, rather than searching engines. Rephrasing, they are able to provide entry points to better examine the faced issues. Diagrams are interfaces providing patterns where he observer is responsible of the assembly operations and of the meaning making operations. At the same time the reader is responsible for the sense making activity of the diagram. The logical path linking the observer-writer with the reader is featured by three questions: what do I see? What does mean what I see? What it might mean with respect to my issue?

In such a context *to see* acquires a key importance: it highlights the structural features, it describes distributions, directions, dynamics helping the observer in understanding a complex discursive space. In this researcher these possibilities are pursued differently from a pure algorithmic approach. The most important actions, as for instance that of building links among fragments, result from active actions of the observer. The observer is called to read and interpret every single information and data acquired about the controversy, producing a personal and non-linear discursive order. Through these actions, he increases his consciousness with respect to what it observes. This chance of arranging, linking and manipulating objects and discursive elements has not to be disconnected from the ethical stances. It is to be accepted the responsibility of the modeling operations and be aware of their imperfection. The overall process, in fact, identifies only what it is relevant to one observer. In this way diagrams incorporate also its point of view. This, which could mean a great limit, in the light of the Complexity, in which there is never an absolute point of view, could mean taking advantage the multiple interpretations and models, which can be built for the very same phenomenon. Every attempt to homogenize observations and, thus, interpretations would imply *violence* to the complexity in which we are immersed.

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Donato Ricci is a researcher and senior designer at DensityDesignLab (www.densitydesign.org), where he carries out scientific researches, design project and teaching activities in the field of visual languages for complex decision making processes. In 2005 he graduated in Communication and Industrial Design at Politecnico di Milano. In 2010 he obtained a PhD degree cum laude in Industrial Design and Multimedia Communication at Politecnico di Milano with the dissertation Seeing what they are saying: Diagrams for social complexity and controversies. During the doctoral research he developed Turtle, an advanced prototype of a web-based platform for the visual exploration of socio-technical controversies.

His works have been featured in several conferences and exhibition (the MediaLAB Prado – Visualizar08, the SIGGRAPH09 Conference, the VirginiaTech Educate09 Conference, the MIT Humanities + Digital Conference) and publication and showcases (Data Flow 2, Visual Complexity.com).

Empreintes lumineuses nocturnes : Codes et représentations simplifiées appliquées au design de l'éclairage architectural et urbain

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Résumé :

Cette recherche présente une méthode simple pour mesurer, analyser, représenter et comprendre la complexité des systèmes de lumière urbaine dans les grands espaces. Elle démontre les avantages d'un code simplifié de repérage et de représentation des ambiances lumineuses, appelé ici« empreinte lumineuse nocturne », pour l'intégrer dans l'analyse et la création des paysages, architectures et places publiques vécues la nuit. La recherche propose un outil d'analyse de la lumière urbaine à partir d'une technique photographique basée sur l'idée de mouvement afin de créer ces « empreintes lumineuses nocturnes». Celles-ci permettent de vérifier les conditions critiques des éclairages existants et d'améliorer les propositions de design étudiées.

Mots clés

ambiances lumineuses, photographie numérique, méthode d'analyse de la lumière, design urbain

Problématique

La ville nocturne se vit en mouvement, introduisant à plusieurs égards les notions de complexité dans l'appréhension visuelle des grands espaces. Cela est vrai dans les villes nordiques où le climat froid, présent plus particulièrement où la période nocturne hivernale occupe une grande partie du temps, génère des comportements favorisant la mobilité physique des usagers pour optimiser leur confort physiologique. Il existe donc, dans tout projet de design d'éclairage architectural et urbain, une complexité inhérente à la caractérisation des ambiances lumineuses observées dans le continuum de la perception visuelle. Narboni définit ces ambiances lumineuses comme le « résultat d'une interaction entre une ou des lumières, un individu, un espace et un usage. L'ambiance lumineuse provient d'un éclairage naturel ou artificiel et influence momentanément ou durablement la perception du lieu éclairé. » (Narboni, 2006, p.14)

Si les types de sources lumineuses sont nombreux et que la conception d'ambiances nocturnes occupe une place de plus en plus importante, les problèmes causés par la lumière sont de plus en plus complexes et difficiles à intégrer dans le processus de design, notamment en regard de la pollution lumineuse et du calibrage des contrastes. C'est dans ce contexte qu'il apparaît nécessaire d'adapter les méthodes existantes pour analyser les ambiances lumineuses de manière globale et dynamique.

Par ailleurs, l'espace urbain n'est pas perçu par les utilisateurs à travers des champs visuels statiques, mais plutôt dans son ensemble (Lou, 1996, p.29). Les places publiques sont vécues et perçues par le public selon des champs visuels qui diffèrent d'une expérience à l'autre et d'une personne à l'autre.

Si la photographie numérique est un support pour enregistrer les modèles lumineux dans l'espace (Demers, 1998), il n'existe pourtant pas de méthode photographique permettant de mesurer ou d'analyser la lumière d'un lieu dans son ensemble mis à part l'utilisation d'un objectif de type « fish-eye ». Les méthodes existantes analysent des points de vue particuliers, la capture des ambiances lumineuses se faisant à travers des photographies cadrant un point fixe du lieu ou de l'élément architectural à étudier. En d'autres mots, l'analyse de la lumière urbaine par la photo numérique reste encore limitée au « champ visuel » tel que définit par Lou, en raison, notamment, des limites de l'appareil photo.

Dans ce contexte, la méthode du balayage photographique se présente comme une méthode alternative d'analyse de la lumière afin d'optimiser son intensité pour améliorer le confort des citoyens, l'ambiance et la santé collective. Ce projet vise donc la création et le développement d'un outil d'analyse des ambiances lumineuses et la représentation visuelle des paysages nocturnes des places publiques. Cette recherche poursuit et approfondit l'analyse de la lumière présente dans les paysages nocturnes urbains à partir de la photographie en mouvement grâce à un procédé technique novateur, qui permet d'enregistrer et de capter la lumière des espaces dans leur ensemble par le biais de photographies panoramiques à 360°. L'outil développé porte le nom d'empreinte lumineuse nocturne.

La méthode du balayage photographique

L'empreinte lumineuse nocturne se présente à la fois comme une expérience, un outil d'analyse et une source de réflexion sur l'éclairage urbain. L'outil permet la mise en relation de données à la fois sensibles et quantifiables à partir de relevés photographiques de la lumière. Cette mise en relation tient compte de l'échelle et de la dimension des lieux, d'un parcours, d'une place publique, etc. Cette réflexion de recherche transpose photographiquement le ressenti en mouvement d'une ambiance lumineuse urbaine et permet une prise de conscience de l'importance d'harmoniser la lumière dans son ensemble.

Cette recherche introduit la photographie comme support d'information et instrument de recherche indispensable dans l'analyse des ambiances lumineuses urbaines. Les outils informatiques appliqués à la technologie photographique numérique permettent de créer le code simplifié de lecture et d'analyse de la ville nocturne. L'objectif de la recherche était d'évaluer le potentiel qualitatif et quantitatif d'une image balayant 360° d'un espace public à partir d'un point précis, pour en caractériser les ambiances lumineuses. Le balayage réunit sur un même plan vertical toutes les sources lumineuses et surfaces éclairées de l'espace qui entourent le photographe et sa caméra.

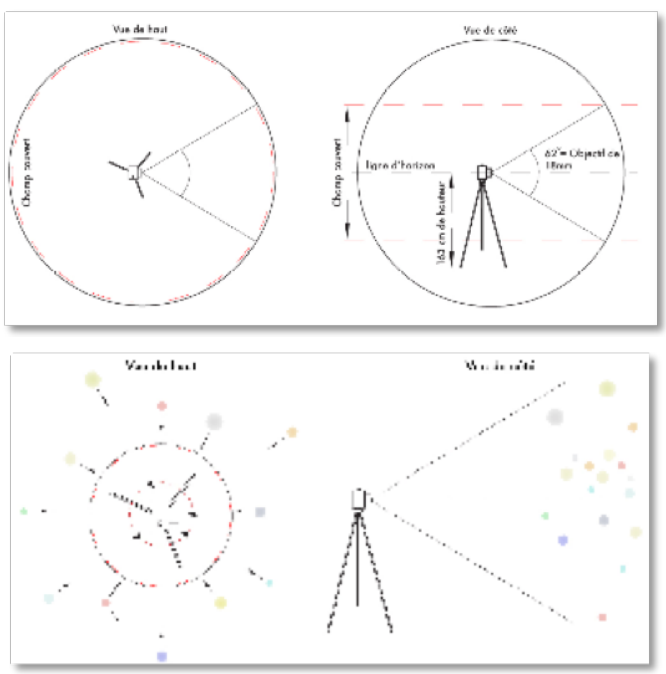


Figure 1 : Champ couvert par le balayage photographique

La méthode consiste en la capture de photographies reconstituant le spectre lumineux d'un lieu dont le mouvement en rotation du balayage photographique estompe l'environnement architectural pour ne percevoir qu'un ordre superposé des tonalités lumineuses d'une atmosphère. Cette méthode permet d'éviter que les formes architecturales n'interfèrent sur l'image et ne présente ainsi que les sources et les surfaces lumineuses du lieu étudié. Une bande significative d'un pixel de large, c'est à dire une bande où sont imprimées toutes les sources lumineuses, est sélectionnée sur toute la hauteur de l'image (figure 2). Cette bande est extraite au centre de l'image, afin de minimiser l'effet de la distorsion concave de la lentille et de conserver la hauteur réelle des sources lumineuses dans la photo. L'échantillon ainsi obtenu consiste en une tranche qui est étirée sur le sens de la largeur pour visualiser l'*empreinte lumineuse*. Cette empreinte, échantillon du balayage photographique, est transformée et analysée en se basant sur la méthode digitale développée par Demers [2007] pour quantifier les brillances et le contraste afin d'établir une classification des ambiances lumineuses nocturnes. L'ambiance nocturne du lieu ainsi fixée sur support photographique est prête à être réinterprétée. Les couleurs, les contrastes chromatiques et d'intensité ainsi que les brillances sont désormais lisibles et donc analysables.

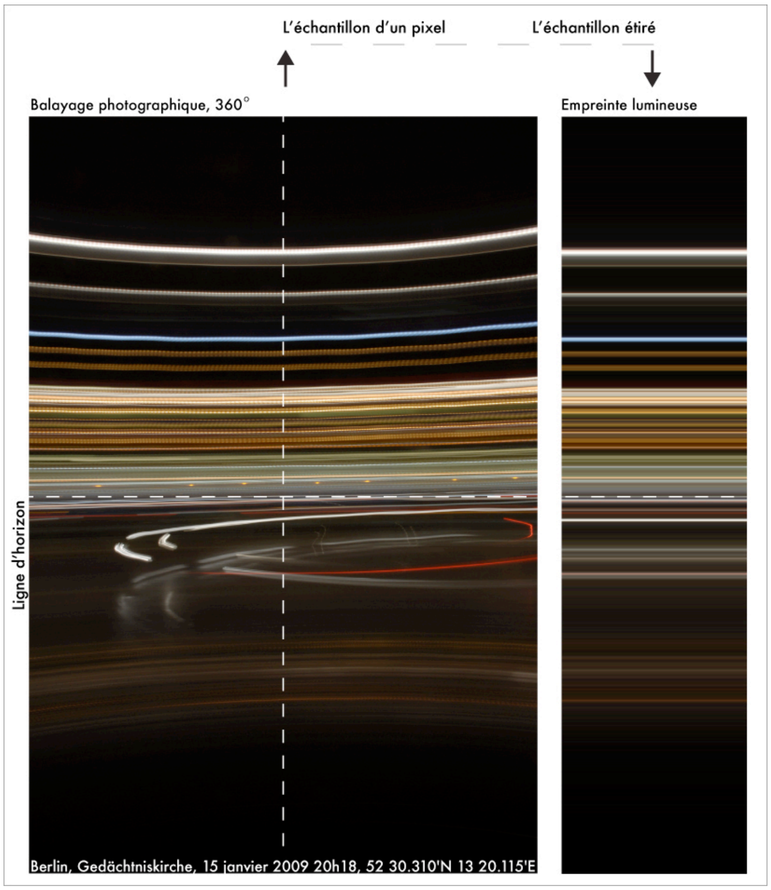


Figure 2 : Du balayage photographique à l'empreinte lumineuse - Un portrait abstrait lumineux condensé au pied de la Gedächtniskirche. Le résultat (balayage photographique) devient graphique quand la colonne d'un pixel est étirée.

L'analyse développée ici se base plus particulièrement sur les notions de contraste et de brillance, de couleur et d'angles de prise de vue. Le contraste est une valeur essentielle de l'image. Il permet de quantifier les données, de comparer différentes zones entre elles et de façon plus globale, différentes images entre elles. Une analyse du contraste par la méthode photographique offre une base critique pour l'étude des éléments urbains existants. Demers explique que le contraste d'intensité peut facilement être mesuré à l'aide de la photographie permettant une analyse quantitative de la lumière. Il existe deux types de contraste : le contraste d'intensité qui est quantifiable, puisque visible et le contraste chromatique, qui tient de la couleur, une mesure subjective et difficilement mesurable. La perception de la lumière dépend toujours du rapport existant entre les intensités lumineuses de diverse sources ou objets dans le champ de vision. Plus la différence de contraste est élevée plus la perception d'un objet par rapport à un autre se distingue. L'étude du rapport entre les éléments éclairés et non éclairés est une étape importante avant de procéder à la mise en lumière. (Demers, Potvin, 1997)

La recherche présente une méthode simple pour mesurer, analyser et représenter la complexité des systèmes de lumière urbaine à partir d'une approche originale de capture photographique et d'analyse numérique transposant des impressions visuelles en empreintes lumineuses. La méthode sert à mesurer l'intensité et le degré d'importance de la lumière et des couleurs dans les paysages urbains et permet d'appliquer plus efficacement les principes de design d'éclairage architectural et urbain. L'empreinte lumineuse réduit l'environnement aux éléments de base de la composition spatiale : les points, les lignes, les surfaces. Pour répondre aux particularités des compositions lumineuses urbaines, la notion de couleur s'ajoute à la réflexion spatiale. L'ensemble des points lumineux est ramené sur un seul plan, générant l'empreinte nocturne d'un point identitaire d'un parcours. L'absence de point de fuite des empreintes lumineuses (figures 4 et 5) procure une impression abstraite du mouvement de l'œil dans le champ de vision. L'approche du balayage photographique considère une ambiance comme une configuration ou un agencement de lignes lumineuses sur une échelle verticale correspondant à l'espace visé. L'organisation des lignes, des couleurs, ainsi que leur épaisseur créent une combinaison spécifique, propre à chaque lieu. Les empreintes lumineuses permettent donc de qualifier et d'interpréter de manière organisée les impressions ressenties des lieux. L'appréhension globale d'un parcours à l'aide de ce procédé peut servir à observer la progression des tonalités ressenties lors d'une promenade urbaine, puis à fixer les critères de design appropriés à une intervention dans le lieu visé. Dans l'ensemble, les empreintes lumineuses permettent donc d'établir une relation physique et abstraite entre l'espace, la lumière et le mouvement, essentielle à la perception visuelle de l'environnement et des ambiances.

Méthode & démarche expérimentale

Afin de confirmer la faisabilité et le potentiel de l'empreinte lumineuse nocturne comme outil d'analyse, nous avons procédé à des expérimentations sur le terrain. La méthode a été appliquée à deux projets d'éclairage urbain: Les champs Élysées, à Paris et Unter den Linden, à Berlin.

À Berlin, le projet d'éclairage urbain, qui s'étale sur un parcours d'environ 1,5 kilomètres sur l'avenue Unter Den Linden a été conçu par la firme *Kardoff Ingenieure lightdesign*. Il a été qualifié d'exemplaire par Christa van Santen, designer d'éclairage et professeure. Ce parcours a été choisi pour son importance comme axe dans la ville. Il a été comparé à l'avenue des Champs Élysées, son équivalent parisien, entrée monumentale de la ville lumière. La collecte des échantillons a été effectuée, en soirée, en janvier 2009. En vue de développer ce projet, 13 points de mesure ont été pris à Berlin et 11 points de mesure à Paris ont été choisis.

La prochaine section décrit avec précision la procédure suivie pour obtenir des empreintes lumineuses nocturnes pour les lieux sélectionnés.

1 Choix des emplacements

La première étape consiste à définir des points de vue représentatifs du lieu à étudier. Ceux-ci doivent permettre de saisir les espaces dans une cohérence photographique pour former un ensemble compréhensible et représentatif. Ainsi, la disposition de la caméra dans l'espace au moment de la mesure doit prendre en considération l'utilisateur habituel de l'environnement étudié. Le projet tient compte du champ de vision à l'échelle de celui du piéton. L'intention est de se rapprocher, avec l'outil photographique, des caractéristiques de l'œil humain afin d'établir le rapport entre l'observateur et la lumière.

Afin de prendre en photo une ambiance lumineuse, le chercheur, observateur/photographe doit sélectionner son emplacement avec soin, en fonction de ce qu'il souhaite étudier dans une scène L'avantage avec l'empreinte lumineuse, c'est qu'elle ne tient pas compte des points de vue des sujets dans une place publique, mais plutôt de la position spatiale dans l'espace. Il est à noter que le choix de l'emplacement reste subjectif. Les distances, donc les données, peuvent ainsi varier en fonction du point de vue du chercheur. Afin de standardiser les analyses, les lieux d'étude, s'il s'agit d'une étude comparative, doivent posséder certaines similitudes. Par exemple, pour les besoins de cette recherche, nous avons sélectionné des trajectoires qui occupent pour deux villes différentes une fonction similaire.

À Berlin, les lieux de mesure ont été choisis en fonction de critères spécifiques : ils devaient faire partie des quartiers centraux, avoir un usage multiple, présenter une concentration importante d'activités nocturnes et la lumière devait y jouer un rôle important dans la définition des ambiances. La position choisie permet, dans la mesure du possible, d'avoir une vue d'ensemble du lieu. À Berlin, la trajectoire Unter Den Linden est étudiée, à l'exception des empreintes 3, 4 et 5. À Paris, c'est l'axe des Champs-Élysées qui est la trajectoire empruntée, d'où l'importance de la séquence lumineuse.

1.1 La localisation de la mesure

Lors des prises de mesures, il est important de réaliser des photographies montrant les lieux afin d'en saisir l'esprit et de consigner certaines caractéristiques sur un support visuel. Ces photographies (figure 3) sont riches en informations qualitatives pour compléter une analyse complète des ambiances lumineuses. Une photographie montrant le contexte des lieux constitue une première source d'information et de repérage. L'image photographique est un outil indispensable pour l'analyse et l'observation de la lumière. Pour chaque empreinte saisie à Paris et Berlin, deux photographies de référence ont été prises pour situer et décrire visuellement les lieux où les points de mesures ont été pris.

Le plan de localisation des images (figure 3) précise le lieu exact des prises de mesure par balayage photographique. En plus des plans, des photos permettent de situer et de suivre l'évolution des conditions lumineuses sur un parcours donné. Il est effectivement possible de mesurer de façon globale la progression lumineuse des couleurs et des tonalités d'un parcours. Par exemple, le parcours emprunté à Paris permet d'observer que la séquence (illustrées par les empreintes) va du peu contrasté et peu brillant (cour carrée du Louvre), au très contrasté et très brillant, sur les Champs Élysées. D'un élément et monument urbain qui sommeille la nuit (musée) à l'activité urbaine grouillante (commerces), il y a là une gradation intéressante des ambiances sur ce parcours.

Figure 3 : Les points de localisation des prises de mesure à Berlin et Paris.

2 La technique du balayage photographique

2.1 Équipement

L'équipement nécessaire pour réaliser le balayage photographique est constitué d'un appareil photo reflex numérique réglé en mode manuel, d'un trépied, d'une rotule. Plusieurs variables techniques au moment de la prise de vue sont susceptibles d'influencer les résultats. Il s'agit, notamment, de l'ouverture focale, du temps d'exposition et de l'ISO, c'est-à-dire le degré de sensibilité du capteur de l'appareil photo.

2.2 Réglages de l’appareil numérique

Les mesures à Berlin et à Paris ont été enregistrées avec la plus petite ouverture (f/22), un temps d’exposition de 10 secondes et l’ISO à 100.

Plus l’ouverture de l’objectif est petite (f/22), plus les détails des éléments sources et des surfaces lumineuses sont précis. Parce que le temps d’exposition est relativement élevé (10 secondes) pour compléter une rotation, l’ISO choisie est 100. Avec l’ISO à 100, l’image possède l’avantage d’être plus nette et plus précise, avec moins de bruit visuel. Finalement, une rotation de 10 secondes est une durée qui offre un bon rapport entre qualité des résultats et facilité de réalisation.

2.3 Prise de mesure

Une fois toutes les variables techniques déterminées et l’appareil photographique fixé au trépied, c’est le moment de la capture d’images. Cette dernière consiste en une rotation de l’appareil grâce au trépied sur 360^{o}. Pour ce faire, il faut s’assurer que l’horizon est cadré au milieu du viseur afin de situer et repérer les lumières dans l’environnement avec plus de facilité. Lors de notre expérimentation, toutes les sources lumineuses du lieu ont été, dans la mesure du possible, captées par l’appareil. Par contre, ce n’est pas toujours possible en raison des champs visuels restreints de l’objectif. C’est le cas lorsque le point de mesure est situé au pied d’une source lumineuse ou d’un immeuble en hauteur et que l’objectif n’est pas en mesure de cadrer tout l’ensemble lumineux constituant l’espace public. Il est possible de limiter la portée de cette contrainte en utilisant un objectif grand angulaire.

L’idéal est de commencer et de terminer le balayage photographique à l’endroit le moins éclairé des surfaces ou de l’horizon de l’espace mesuré. Cela permet d’avoir une marge d’erreur dans l’angle de rotation et dans le temps. En effet, lors de la réalisation du balayage photographique, une marge d’erreur est à considérer lors de la réalisation de ce processus manuel. Il serait possible d’y remédier en élaborant un système motorisé.

Le photographe doit poursuivre la rotation pendant toute la durée du déclenchement de l’appareil, afin de créer un panorama de 360^{o}. La constance dans la rotation garantit une mesure exacte. C’est pourtant la considération technique la moins précise et la plus difficile à atteindre. C’est par essais et erreurs que cette synchronisation est atteinte par le chercheur photographe.

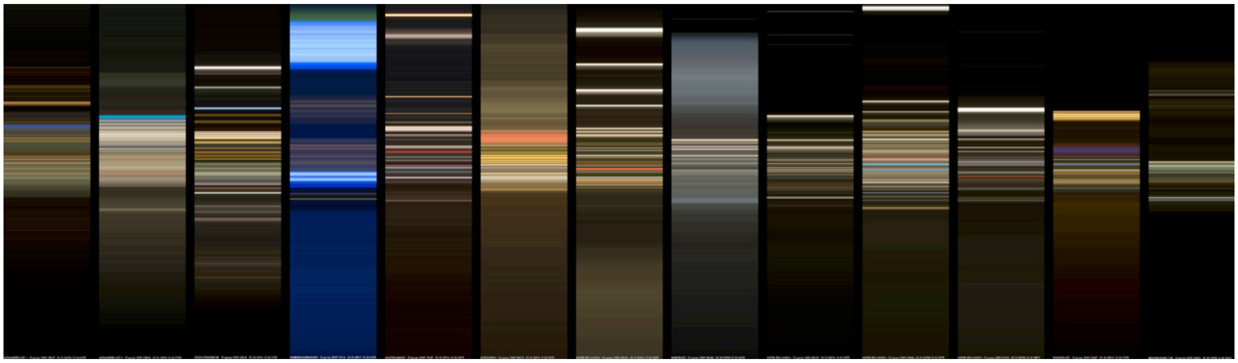
3 Traitement informatique des images

Une fois que le balayage photographique est réalisé, l’image est ensuite traitée à l’aide du logiciel *Adobe Photoshop*. Avec l’outil « rectangle de sélection » réglé à un pixel de large, on sélectionne une bande significative sur toute la hauteur de l’image (figure 2). Cette bande est extraite au centre de l’image, afin de minimiser l’effet de la distorsion concave de la lentille et de conserver la hauteur réelle des sources lumineuses dans la photo. Cette bande très étroite est ensuite étirée horizontalement pour créer une bande de 10 cm de large, qui permet visualiser ce que nous appelons une empreinte lumineuse nocturne. Cet étirement n’influence pas la résolution du document.

Les empreintes lumineuses nocturnes obtenues dans le cadre de cette collecte de données peuvent ensuite être comparées et analysées. Elles constituent chacune une unité qui se prête à la recherche. Elles se présentent de la façon suivante pour les lieux que nous avons étudiés.

Les empreintes lumineuses nocturnes

L’empreinte lumineuse réduit l’environnement aux éléments de base : les points, les lignes, les surfaces et les couleurs. Chaque ligne correspond à une source de lumière ou à une lumière réfléchie. Ici, le point de fuite n’existe plus, les impressions obtenues sont des images en deux dimensions. L’ensemble des points lumineux est ramené sur un seul plan. L’absence de point de fuite dans les images donne une impression abstraite du mouvement. Les résultats présentés ici portent sur les empreintes lumineuses de Berlin et Paris.



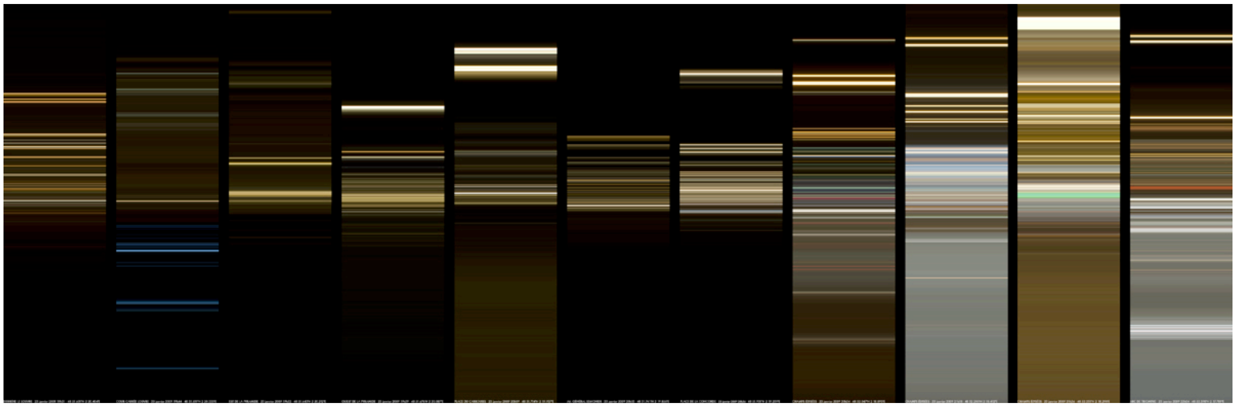


Figure 4 et 5 : L'ensemble des empreintes lumineuses prises à Berlin (haut) et Paris (bas).

Toutes les sources lumineuses perçues sur les empreintes lumineuses sont artificielles, à l'exception de la lune, dont l'intensité varie dans le temps. Les sources lumineuses proviennent des espaces publics (lampadaires, enseignes lumineuses, feux de circulation, etc.), mais aussi des immeubles résidentiels et commerciaux. Les sources proviennent de toutes les directions et hauteurs. Une étude qualitative des empreintes lumineuses nous permet de constater que lorsque des zones noires les dominent, cela signifie dans la majorité des cas que la mise en lumière de l'élément architectural et l'ambiance lumineuse du lieu reposent sur un contraste important.

Autre élément intéressant : la lumière indirecte affecte beaucoup moins l'empreinte et offre un éclairage plus doux et homogène dans l'espace.

Particularités de la lumière visibles sur une image balayée

La plupart des sources lumineuses dans l'espace public sont fixes, certaines sources sont mobiles (ex. véhicules routiers où les lignes sont surtout situées sous la ligne d'horizon, sauf si la topographie du sol est importante), alors que d'autres sources clignotent (ex. panneaux lumineux, enseignes publicitaires, etc…). Les distances, couleurs et intensités sont variables.

Dans la plupart des cas, la lumière blanche est émise par un lampadaire plus ou moins rapproché. (Exemple : images à Berlin 3, 7, 9, 10 et 11) La dimension des sources lumineuses varie en fonction de la distance d'observation, de la position relative de l'objet illuminé en rapport avec son milieu physique et des divers points d'observation, de leur dimension et de leur intensité. (DEMERS, POTVIN, 1997, p15) Il est impossible de connaître les distances à partir de l'empreinte lumineuse seule. Par contre, plus la concentration de lumière est forte et située au centre de l'empreinte et plus les sources lumineuses au loin sont visibles et nombreuses.

Application de la méthode

Étude de la variation du contraste en fonction de la brillance

La méthode Demers (1997) pour l'analyse des ambiances lumineuses nocturnes, qui s'appuie sur la brillance et le contraste des empreintes lumineuses nocturnes, permet une classification des empreintes lumineuses par catégories pour fins de comparaison. Les valeurs des contrastes et brillances des empreintes lumineuses sont classées dans le tableau suivant (figure 6). Les treize valeurs enregistrées à Berlin sont situées entre 8,62 et 44,91 pour la brillance et 19,7 et 45,01 pour les contrastes. On constate sur le graphique que plus le contraste augmente, plus la brillance a tendance à augmenter.

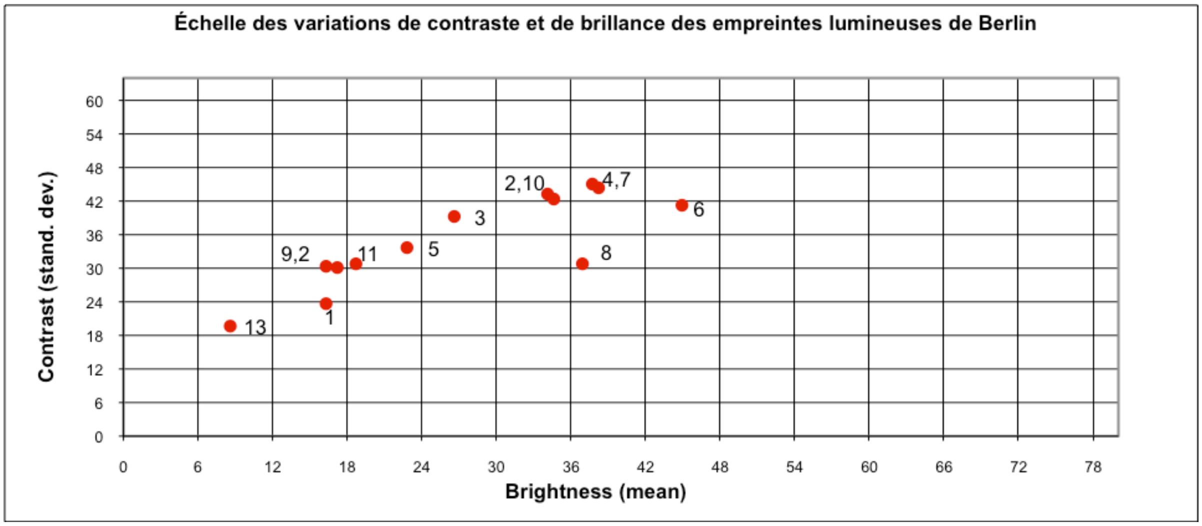


Figure 6 : Échelle des variations de contraste et de brillance des empreintes lumineuses de Berlin.

Les empreintes lumineuses nocturnes des deux symboles historiques allemands que sont la Porte de Brandenburg (13) et la Tour de Berlin (1) ont une brillance et un contraste faibles. Les images les plus contrastées et lumineuses sont les 4, 6 et 7, c'est-à-dire le musée Hamburg Hauptbahnhof, Altes Museum et la gare Centrale de Berlin. Les images 4 et 6 sont enregistrées devant les musées Hamburg Hauptbahnhof et Altes Museum.

Analyse des contrastes et des brillances

Le tableau suivant démontre que la brillance et le contraste d'intensité entre les différentes sources sont beaucoup plus élevés à Alexanderplatz qu'à la Cour Carrée du Louvre, ce qui n'est pas évident sur les photos panoramiques. L'avantage de l'empreinte lumineuse par rapport à une analyse faite sur une photographie statique tient donc à ce qu'elle permet de visualiser l'importance relative d'une source lumineuse par rapport à une autre. Par exemple, dans l'exemple d'Alexanderplatz (figure 8), l'entrée de métro (ligne bleue), qui n'est en définitive qu'un point de lumière dans l'espace, apparaît comme une signalétique forte, si on la compare aux autres sources de lumière de la place. En effet, lorsque ramenée sur un plan simple grâce à l'empreinte lumineuse, cette source s'avère importante.

Empreinte lumineuse	Brillance	Contraste	Ouverture	Temps d'exposition
Cour Carrée du Louvre	7,06	10,81	f/22	10 s.
Alexanderplatz	34,57	42,45	f/22	10 s.

Figure 7 : Comparaison des contraste et brillance entre les empreintes lumineuses et les panoramas.

La comparaison des panoramas et des empreintes lumineuses permet de déterminer la nature de chaque source présente sur l'empreinte (figure 8). Puisqu'il permet un repérage facile, le panorama demeure indispensable à l'analyse qualitative de la lumière. Le panorama et l'empreinte lumineuse se complètent. L'ouverture au moment de la prise de vue n'est pas la même pour le panorama que pour l'empreinte et varie d'un lieu à l'autre, tandis que l'empreinte lumineuse est constante à ce niveau.

Figure 8 : Panoramas et empreintes lumineuses – Cour Carrée du Louvre à Paris et Alexanderplatz.

La Cour Carrée du Louvre est un lieu fermé où toutes les couleurs, les contrastes et les tons forment un ensemble lumineux homogène et cohérent. L'empreinte démontre que la luminosité des façades est faible comparativement à l'empreinte lumineuse nocturne prise à Alexanderplatz. Pratiquement aucune source directe de lumière n'est visible à partir du centre de la place, sauf pour celles situées dans l'eau de la fontaine bleutée. Le point central de cet ensemble équilibré et homogène est marqué par la fontaine bleue, sur un plateau sombre. Les zones bleues dans la portion basse de l'empreinte sont les réflexions de la lumière dans la fontaine située au centre du lieu. Une caractéristique de cette place est l'absence de lampadaires. L'éclairage des bâtiments provient de luminaires montés sur la façade du Louvre. Les sources lumineuses sont discrètes. C'est pourquoi cette empreinte lumineuse est la moins brillante et la moins contrastée du graphique. Parce que l'intensité lumineuse est relativement faible et que la lumière est surtout réfléchie sur les murs de la cour Carrée du Louvre, une ouverture de l'objectif à f :13 permet de mieux lire les couleurs et les tonalités propres à l'ambiance par l'empreinte lumineuse.

À Alexanderplatz (figure 8), l'espace s'ouvre sur une variété de sources lumineuses beaucoup plus importante. La diversité des couleurs provient des commerces et des lampadaires tout autour de la place. L'espace central d'Alexanderplatz n'est pas éclairé, seule la ceinture commerciale illumine ce grand espace sombre. Alors que le brouillard épaissit la lumière dans l'air, le sol mouillé réfléchit la lumière des lampadaires. Le pourtour de la place publique au niveau des étages supérieurs des immeubles discret, sauf pour la tour « Park Inn » qui projette une auréole dans le brouillard nocturne. C'est pourquoi cette empreinte se caractérise par une concentration très forte de lumière juste au-dessus de l'horizon.

Les empreintes lumineuses nocturnes de Unter den Linden, à Berlin, révèlent une variété impressionnante de couleurs. Les commerces, les musées, les édifices, les infrastructures lumineuses jouent pour beaucoup sur ces variations. Sur les Champs-Élysées à Paris (figure 8), on constate une certaine homogénéité de la couleur de la lumière. Un blanc doré chaud illumine l'avenue. Les analyses démontrent également que la lumière s'intensifie du musée du Louvre à l'Arc de Triomphe.

Ambiances lumineuses

Lorsque la méthode est appliquée l'ensemble d'un parcours, la séquence des empreintes lumineuses obtenue on obtient le portrait d'une impression lumineuse d'un parcours et de ce qui est vu par les usagers. Les empreintes lumineuses permettent donc de qualifier et d'interpréter de manière organisée les impressions ressenties des lieux et des parcours. L'appréhension globale d'un parcours à l'aide de ce procédé peut servir à observer la progression des tonalités ressenties lors d'une promenade urbaine. Les figures 4 et 5 présentent l'ensemble des empreintes lumineuses prises à Berlin et Paris. Les lieux où on été prises les mesures sont indiqués sur les empreintes lumineuses. Des photographies des lieux prises à partir des points de mesure sont également présentées sur la figure 3.

Étude de la localisation des concentrations de lumière

À Berlin, les concentrations moyennes de lumière se situent surtout entre l'horizon et 10° au-dessus. La figure suivante présente la localisation du niveau de concentration de la lumière pour la moyenne des empreintes lumineuses, généralement situé entre 2° sous l'horizon et environ 10° au-dessus.

Le graphique suivant présente la distribution moyenne des brillances sur une échelle verticale des tons de gris des treize empreintes lumineuses prises à Berlin. L'analyse démontre que la brillance est à son plus élevé au niveau des yeux, c'est-à-dire environ 150 cm de hauteur (entre les valeurs de 1350 et 1950 px). Dans la partie supérieure de l'empreinte (0 et 1350 px), les valeurs sont plutôt fluctuantes, allant de faibles à moyennes, alors que pour la partie inférieure de l'empreinte (1950 et 3872 px), la brillance diminue de façon graduelle (20 à 10).

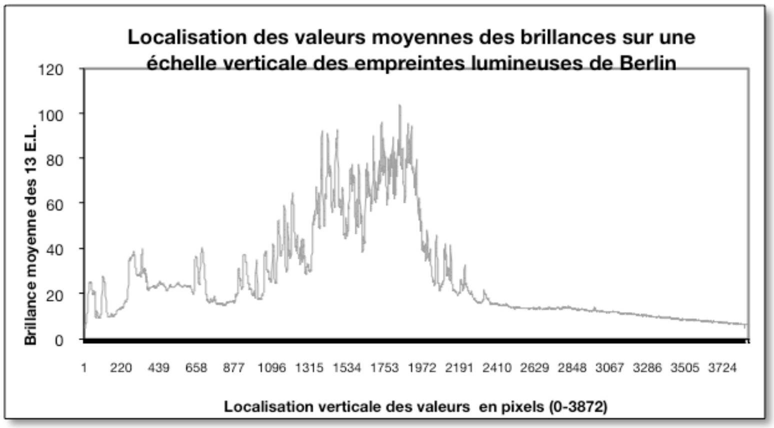


Figure 9 : Distribution moyenne des brillances sur l'ensemble des empreintes lumineuses.

Visualisation moyenne des couleurs

Le logiciel *Adobe Illustrator* CS3 et sa fonction « gradient mesh », permettent de créer des dégradés de couleurs à partir des empreintes lumineuses. Cette analyse sert à comparer les moyennes de couleurs obtenues sur l'échelle verticale d'une empreinte lumineuse. Les couleurs se fondent ainsi les unes dans les autres, ce qui donne une impression plus forte de celles-ci, en faisant abstraction des lignes. Cela simplifie la comparaison des couleurs pour l'ensemble des empreintes lumineuses.

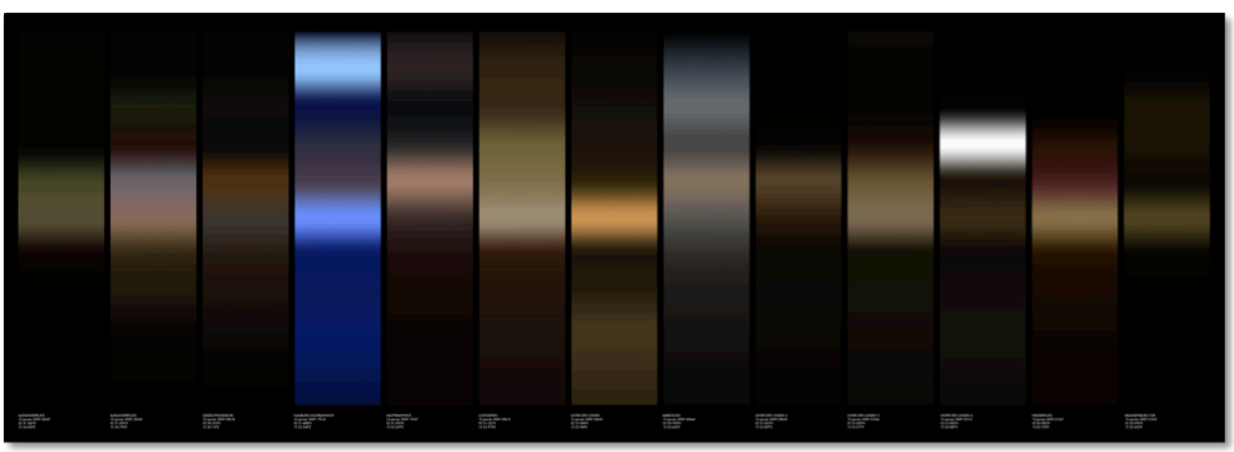


Figure 10 : Les 13 empreintes lumineuses couleurs de Berlin transformées en 10 gradients vectorisés.

En brouillant le paysage nocturne horizontalement, l'ordre vertical des couleurs et des tonalités prédomine sur les détails et les lignes. L'ensemble des couleurs devient par conséquent un matériel de travail et de réflexion.

Synthèse

La mise en application de la méthode sur des échantillons pris à Berlin et à Paris a prouvé que l'outil développé permet notamment d'étudier et d'analyser les ambiances lumineuses pour les aspects suivants:

- Transposer photographiquement des ambiances lumineuses urbaines dans leur ensemble.
- Extraire des informations qualitatives et quantitatives pertinentes sur l'ensemble d'un lieu.
- Étudier la couleur des sources lumineuses des espaces publics et obtenir des moyennes de couleur.
- Analyser les contrastes, la brillance et de les couleurs des sources lumineuses dans un environnement en entier.
- Évaluer l'homogénéité ou l'hétérogénéité d'un parcours lumineux.
- Comparer l'identité lumineuse entre plusieurs lieux.

L'étude a mis en évidence l'intérêt de développer la recherche sur la lumière urbaine. Il serait intéressant, par exemple, d'effectuer une analyse en fonction du zonage ou de l'échelle spatiale, des préoccupations de ses habitants, des spécificités des sites. D'autres expérimentations avec l'outil pourraient aussi être effectuées en vue de mesurer l'intensité lumineuse d'un environnement ou encore ses excès de lumière. Une adaptation du procédé du balayage photographique permettrait éventuellement de déterminer une corrélation entre le niveau de brillance et le niveau de pollution lumineuse dégagé par une source de lumière à partir de points précis dans l'espace.

Limites de la méthode

Il convient de dire qu'il existe une multitude d'approches pour cerner la lumière dans l'espace et qu'il n'existe pas une démarche exacte. L'empreinte lumineuse, même si elle est soumise à certaines contraintes, permet tout de même la précision dans certaines mesures.

Lors de l'analyse d'une empreinte lumineuse, plusieurs facteurs peuvent influencer la démarche expérimentale et l'interprétation des données. Cette synthétisation de la lumière comporte des limites. D'abord, elle ne s'applique qu'à des endroits bien précis dans l'espace. Le mouvement horizontal ne tient pas compte de toutes les forces lumineuses verticales qu'on peut retrouver dans le paysage. La superposition des couleurs par rotation affecte les rendus. L'imprécision des mesures d'un appareil à un autre ou d'un objectif à un autre peut aussi affecter les données.

Conclusion

Cette recherche exploratoire a élargi les possibilités offertes par les outils photographiques et informatiques pour l'analyse des espaces publics urbains. Elle tentait spécifiquement de développer le balayage photographique de la lumière, un processus d'analyse, de réflexion et d'exploration qui permet de réfléchir sur l'aménagement des paysages urbains nocturnes et la représentation des sources lumineuses pour un lieu dans son ensemble.

Le développement de cette méthode, où le lieu est appréhendé non seulement à 360^{o}, mais aussi en mouvement, souligne comment l'image photographique peut aider les différents acteurs du milieu à saisir l'impression ressentie par les utilisateurs des lieux publics. Les expériences et les analyses effectuées pour l'élaboration de cet outil suggèrent en effet que les ambiances lumineuses créées par la lumière artificielle peuvent être condensée sur une empreinte lumineuse. Le balayage photographique peut aider à mesurer certaines qualités lumineuses des espaces urbains. Dans l'ensemble, les empreintes lumineuses permettent donc d'établir une relation physique et abstraite entre l'espace, la lumière et le mouvement, essentielle à la représentation visuelle de l'environnement et des ambiances.

Les empreintes suscitent l'inspiration et peuvent se concrétiser en projets d'éclairage urbain. En effet, cette technique permet d'obtenir une composition propre et unique à chaque lieu et dans le temps. La lumière urbaine est une composition collective. Commerçants, citoyens et aménagistes participent à la créer. L'exploration présentée ici devrait ainsi permettre d'optimiser son utilisation par tous les acteurs du milieu.

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Analyzing the Appearance and Wording of Assessments: Understanding their Impact on Students' Perception and Understanding, and Instructors' Processes

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Abstract

In the context of a design studio, the study presented in this paper investigates the effects that appearance and wording of assessment forms have on design students' perception and learning. The project is motivated by hypotheses formed by a prior study, which revealed visual and textual components of assessment forms as possible influences on students' perception and learning. Thus, the goal of this project is to investigate their impact on students and offer the study findings to educators to help them better understand and construct effective assessment tools.

This paper argues that the appearance and wording of assessments convey meaning and must align with the activities and discussions that are common in design courses. This argument is supported by research that emphasizes the seamless integration of all steps of the learning process (Biggs, 2003) and the importance of students' learning preferences in developing lesson plans (Gardner, 1993). The paper explains the construction of four assessment forms. It also describes the post-evaluation self-reflections that students wrote and the questionnaire they completed at the end of the course. These project components were conducted to learn what students retained and how they perceived the assessment forms. In addition, the instructors provided their perceptions and time allocated to using each tool.

The outcomes of the study revealed that the digital assessments were more efficient to complete than the handwritten form. Students noted little difference in their satisfaction between the digital and handwritten forms when the wording stayed consistent. However, they did prefer comments that were personal and related to each specific project. The students retained more information from assessments that included a clear visual hierarchy and eliminated ambiguous titles. These findings informed the proposal of visual and textual considerations that should be taken into account when creating assessment forms for use in design classrooms.

Keywords

Visual design, rubrics, assessment, evaluation, pedagogy, education, learning, feedback

Throughout the past decade a large segment of professional design practice has gone from focusing solely on the creation of artifacts to also emphasizing the importance of collaboration within and among disciplines, applying a range of design processes, and engaging in projects actively throughout their duration (Poggenpohl, 2004). At the same time, government agencies are requiring the documentation of measureable outcomes (Middle States Commission on Higher Education, 2003). These changes require educators to not only rethink the ways they teach but also the ways they assess students' performance. Many educators are adjusting project plans and course activities to align with professional practice. (Heller, 1998). In contrast, based on the review of assessment tools used by design educators over the past several years, little has changed in the ways instructors evaluate students' performance. As a result, there is a misalignment between how design courses are taught and how students' performance is assessed, which in turn, negatively impacts the learning process. (Biggs, 2003). Assessments in design courses often focus on a review of an artifact instead of the learning process, which encourages students to work passively with the intent to please their instructors instead of striving to solve complex problems independently (Davies & Reid, 2000; Long, 2004). Research indicates that students devote much time and attention to the assessments that they receive and that these tools significantly impact students' learning (Brew, 1999). Hence, improving assessment processes to align with course activities is crucial to enhancing design students' learning.

Based on the survey of assessment tools conducted for this study, many design educators who have altered their evaluation process now utilize rubrics. In their book, *Introduction to Rubrics*, Stevens and Levi (2005) define the term. They state,

> At its most basic, a rubric is a scoring tool that lays out specific expectations for an assignment. Rubrics divide an assignment into its component parts and provide a detailed description of what constitutes acceptable or unacceptable levels of performance for each of those parts. Rubrics can also be used for grading a large variety of assignments and tasks: research papers, book critiques, discussion participation, laboratory reports, portfolios, group work, oral presentations, and more. (p. 3)

In addition to including a matrix of evaluative criteria and performance attributes, the structure of rubrics also stress the importance of aligning assessments to project objectives, and methods for translating performance ratings into grades (Stevens & Levi, 2005). It is logical for educators to explore the use of rubrics in the context of design courses based on learning science research that proves their success in assessing students' performance and applying them across disciplines (Goodrich, 2000). Although rubrics provide methods that are intended to help instructors develop and use assessments, discussions with design educators and students reveal a reluctance to adopt the suggested evaluation changes. A study that researched the actual and perceived effectiveness of rubrics in a design studio showed that students appreciate the clarity provided in rubrics but prefer less-informative feedback that poses questions and is personal, which matches the activity in design classrooms (Rohrbach, 2008). The outcomes of this study lead to the hypothesis that the form of assessments should draw on the teaching characteristics of design courses.

In his book, Frames of Mind, Howard Gardner explains that people learn best when information is communicated to them in ways that match their learning preferences (Gardner, 1993). Based on several years of teaching experience, information that is communicated to design students through one-to-one conversations and visualizations, such as sketches, appears to resonate with them more than densely written text and quantitative tests, which confirms Gardner's notion. Research that describes the use of rubrics explains the importance of clear wording in communicating evaluative criteria and performance attributes to students (Goodrich, 1996). Unfortunately, although this is informative, such efforts often lead to a document that is text-heavy and impersonal in its structure, which misaligns with the learning preferences of many design students. Hence, it is logical for them to prefer to receive feedback as handwritten comments as opposed to pre-formatted text because it appears more personal, matching their expectations, despite the fact that it often provides them with less information regarding their performance and ways to improve in the future. Thus, studies, which focus on improving design students' perceptions of assessments while maintaining the clarity and robustness of information provided via rubrics, must be investigated.

Another critical component of assessing the performance of design students is the appearance of evaluations. Visual perception and cognition are critical learning components for people who often have a heightened sense of visual acuity, such as design students (Kosslyn & Koenig, 1992). They spend a great deal of time analyzing design artifacts and constructing compositions. Hence, it is logical for design students to read the appearance of their assessments and gather meaning from them. Unfortunately, research that focuses on the impact of visuals on perception and understanding in the context of assessments has not been found. Thus, studying the effects of visual form on students' perception and learning is warranted.

This paper argues the need for assessment tools to reflect design students' learning preferences and expectations, and align with course activities not just in their content but also their form and delivery. This premise is based on research that stresses the importance of weaving together all the stages of learning (Biggs, 2003), from the onset of a project to the receipt of assessments (Wiggins & McTighe, 1998), and the value of visual perception to learning and understanding (Kosslyn & Koenig, 1992), especially for design students, who often prefer to learn visually. The study uses rubrics, which have been proven to provide design students with informative feedback (Rohrbach, 2008), as a basis for exploration, with each assessment form including slight modifications in wording and appearance. The outcomes generated in this project illuminate the impact that the visual tendencies of design students and the unique structure of design courses can have on the effectiveness of assessment tools.

The construction of four assessments forms that are based on rubrics but vary in wording and visual appearance is illustrated and described in this paper. The use of each form in relation to specific projects is explained and the findings gleaned from a questionnaire, a series of self-reflections, and documentation by instructors are also included in this paper. Study limitations and principles that inform the wording and appearance of assessments forms that are derived from the study outcomes conclude the paper along with projected next steps in the study of evaluation methods in the context of design education.

Background and Context

I received a fellowship in the summer of 2007 that enabled me to work with teaching experts and four professors positioned in other disciplines to investigate the development, delivery, and assessment of projects in the seminar courses that I teach. Although the assessment portion of the fellowship focused on evaluating students' writing by using rubrics, I began to question the application of rubrics in assessing design projects and the perception of rubrics by design educators and students. Therefore, I conducted a study that investigated these issues within the context of a design studio with 48 first-year design students and the two educators of the course. The results of the study showed that students perceived attributes of rubrics more positively than other forms of assessment but still preferred handwritten comments. Thus, there appeared a disconnection between assessments that aided learning and those that students preferred, which warranted further investigation.

Research Goals

The initial investigation I conducted shed light on the perceived successes and failures of a range of assessment tools. However, perhaps the most significant finding from this study was the difference between assessments that students preferred and those that they believed were most effective. Through an analysis of theses results I hypothesized that the disparity might be attributed to differences in wording and appearance, which inspired a second course of inquiry. Educators can assess the outcomes of design courses fairly and consistently using assessment tools, such as rubrics, that are proven successful in other disciplines (Ehmann, 2005). However, the individual attention that students receive in studio courses and their tendency to grasp information visually may warrant the delivery of evaluations in alternate forms to improve their learning, value, and understanding of assessments. Therefore, I developed a study that investigates the visual and textual forms of assessments.

The goal of the study presented in this paper was to gain insight into how the appearance and wording of rubric-based assessment forms affect design students' perception of the tools and support or negate learning in the context of a first-year studio course. Although studies exist that argue the success of rubrics across a range of disciplines based on systematic measuring of student learning (Fuchs and Fuchs, 1986), research that supports the notion that the appearance and wording of assessments affect students' learning and perception has not been discovered. Therefore, this project uses variations in assessment forms throughout a course, student self-reflection writings, a questionnaire completed by students in the class, and documentation provided by the course instructors, as research content. This paper then uses the analysis of the project outcomes to argue the importance of visual and textual attributes of assessment forms to students learning, understanding, and value of evaluations. The results of the project also inform the proposal of design considerations that educators may find beneficial when creating assessment forms for design students, and call attention to issues of assessing the outcomes of design courses that require further study. In pursuit of these goals, this project seeks to answer the following research questions:

- How does the appearance of information affect students' learning, understanding, and perceived value of assessments?
- How does the wording of assessments affect students' learning, understanding, and perceived value of assessments?
- How does the form of assessments affect the amount of time instructors allocate to the task and how they perceive the accuracy and consistency of their reviews?

Implementation

The study was performed during the 2008 fall semester in a required studio course for 45 first-year design students, which I taught with a colleague. Similarly to the first study, my colleague and I established a set of preferred outcomes for the course that would prepare students for their next stage in the curriculum. Our intention was to help students better understand the meaning of design, what designers do, and why they are needed. We sought to help them identify design opportunities, learn and employ strong design processes, evaluate work, and propose ideas for improvements. I constructed a course rubric that articulated these goals in written form for the students' repeated reference and guidance. The learning objectives were broken into four categories—process work, resolution, participation, and attitude—and four sets of performance attributes aligned to each criteria. We also explained the objectives to the students the first day of class and emphasized that through the design of two- and three-dimensional individual and group projects, they would strive to:

- develop appropriate ideas in response to project assignments
- build a process for working that enables consistent, incremental growth
- articulate their ideas well, both verbally and visually
- translate and communicate ideas into effective, well-crafted visual forms
- collaborate with their peers: share ideas and information
- understand and integrate feedback into their creative working process
- illustrate an understanding for how context shapes, and is shaped by design

Assessment Forms

In this study, the form that was proven the most effective learning tool in the prior assessment investigation—a rubric—was used consistently throughout the semester to evaluate project outcomes. The visual appearance of the information, the wording used to provided feedback, and the ways the forms were completed, varied. To limit the interference of the various project parameters on the study, students were divided into four groups, which would indicate the type of assessment form they received for each project (table 1). The first two assessments differed in visual appearance but did not vary in content or language structure. The assessments for the third and fourth projects functioned similarly. However, the division of groups changed to minimize the impact of the assessment instruments on the outcomes. It is important to note that the content and language structure of the first two assessment tools varied from those used for projects three and four.

	Assessment A	Assessment B	Assessment C	Assessment D
Student Group 1	Project 1	Project 2	Project 3	Project 4
Student Group 2	Project 1	Project 2	Project 4	Project 3
Student Group 3	Project 2	Project 1	Project 3	Project 4
Student Group 4	Project 2	Project 1	Project 4	Project 3

Table 1

The assessment form that I created for the first two projects consisted of the general rubric that was used as an overview for the entire course. It included the four sets of learning objectives—design process, resolution/final work, participation, and attitude—and four sets of performance attributes aligned to each objective. The text was written in paragraph form and cited general practices that applied to the course as a whole, as opposed to the individual project. As a part of our evaluation, my colleague and I checked a box next to a paragraph in each row that best described each student's performance. Each row included a space beneath it where project-specific comments could be listed. The feedback consisted of observations made during the corresponding project and suggestions geared toward helping students improve their performance in the future. Prior to our evaluating sessions, my colleague and I established a list of common comments that we would provide students. These aligned with the learning objectives that students received in the project briefs and were based on the work that we saw in development and our experiences with the students. I constructed digital versions of the assessment forms that enabled us to select several of the comments via drop-down menus (Fig. 1). The students received printed versions of these assessments where the comments appeared as typed sentences without the drop-down menu present. For the other project, students received a similar form. However, instead of typed comments, the same sentences were handwritten (Fig. 2). This enabled the comparison of handwritten to typed comments in a situation where the wording structure was identical.

The last two assessment forms that I developed consisted of a rubric that included performance attributes that were specific to the third and fourth projects. The content of each rubric matched the learning objectives listed in the briefs that the students received at the beginning of each project. The content structure of these forms differed from the first two in that their performance attributes weren't written as all-inclusive paragraphs. Instead, each comment was separated with a check box next to it but still resided in the columns and rows of the rubric. This enabled us to check one component of their process work, for example, as "excellent" and another as "good". The visual appearance of the assessments used in projects three and four differed, while the content structure and wording stayed consistent and students received printed versions of each assessment. One of the forms showed all of the text in black with comments relevant to the individual student checked (Fig. 3). On the other form, all of the text appeared as a 50% gray with the relevant comments shown in black and checked (Fig. 4). The goal of this part of the study was to investigate the effects of visual hierarchy on students' perception and understanding of the feedback they received.

This set of figures shows portions of each of the assessment tools that were used in the freshmen design studio throughout the duration of the course. Note that to enable the comparing of assessment tools, the segments shown here relate to the "design process" attribute in each project. However, students were also assessed based on their resolution/final work, participation, and attitude.

Process	☐ **excellent**	■ **good**	☐ **needs improvement**	☐ **unacceptable**
	breadth and depth of ideas generated and explored is extensive; evidence of steady progress shown through sketches, models, notes, etc. is clear and consistent; ideas are thoroughly evaluated and clearly used to inform steps taken in development and refinement stages	the required amount of ideas are generated and are moderately varied, some sporadic evidence of progress is shown through sketches, models, notes, etc.; ideas are evaluated and connected loosely to the development and refinement stages of projects	a few ideas are often generated; little evidence of progress is shown through sketches, models, notes, etc., ideas appear to be occassionally evaluated; loose connections of process work to the development and refinement of ideas is seldom visible	a single idea is typically generated; evidence of any progress is difficult to find; few sketches, models, notes, etc. have been made; evaluation of ideas isn't evident; connection of process work to the development and refinement of ideas is unclear
Photo composition	You generated a good quantity of quality sketches and notes.			
Type composition	You need to improve your use of sketches and notes as tools that aid your understanding and inform your next steps. You explored a good range of ideas. Keep it up.			

Fig. 1: Shown here is a portion of an assessment sheet that students received after conducting the first or second project in the course. It includes a general rubric that pertains to the entire course, which students received in the syllabus. It also provides students with project-specific feedback in the form of typed comments.

Process	□ excellent	■ good	□ needs improvement	□ unacceptable
	breadth and depth of ideas generated and explored is extensive; evidence of steady progress shown through sketches, models, notes, etc. is clear and consistent; ideas are thoroughly evaluated and clearly used to inform steps taken in development and refinement stages	the required amount of ideas are generated and are moderately varied, some sporadic evidence of progress is shown through sketches, models, notes, etc.; ideas are evaluated and connected loosely to the development and refinement stages of projects	a few ideas are often generated; little evidence of progress is shown through sketches, models, notes, etc., ideas appear to be occassionally evaluated; loose connections of process work to the development and refinement of ideas is seldom visible	a single idea is typically generated; evidence of any progress is difficult to find; few sketches, models, notes, etc. have been made; evaluation of ideas isn't evident; connection of process work to the development and refinement of ideas is unclear
Photo composition	You generated a good quantity of quality sketches + notes.			
Type composition	You need to improve your use of sketches + notes as tools that aid your understanding + inform your next steps. You explored a good range of ideas. Keep it up.			

Fig. 2: Shown here is a portion of an assessment sheet that students received after conducting the first or second project in the course. Similarly to Fig. 1, it includes a general rubric that pertains to the entire course, which students received in the syllabus. It also provides students with project-specific feedback in the form of handwritten comments.

Process	■ the quantity of quality sketches and models generated is extensive	□ the quantity of quality sketches and models generated meets requirements	□ the quantity of quality sketches and models generated is small	□ the quantity of quality sketches and models generated is limited to one or two
	□ an extensive range of ideas is explored	■ a moderate range of ideas is explored	□ a small range of ideas is explored	□ one or two ideas are explored
	□ ideas are thoroughly evaluated and clearly used to inform steps taken in development and refinement stages	■ ideas are evaluated and connected loosely to the development and refinement stages of projects	□ ideas appear to be occassionally evaluated and loose connections of process work to the development and refinement of ideas is seldom visible	□ evaluation of ideas isn't evident and the connection of process work to the development and refinement of ideas is unclear
	□ a working process that matches project specs is clearly evident	□ a working process that matches project specs is somewhat evident	■ a working process that matches project specs is diificult to find	□ a working process that matches project specs is not evident

Fig. 3: Shown here is a portion of an assessment sheet that students received after conducting the third or fourth project in the course. It consists of a project-specific rubric in which each comment is separated from the others but remains in the same column. Feedback that pertains to the individual student is noted by a black checkbox. All text is shown in black.

Process	■ the quantity of quality sketches and models generated is extensive	□ the quantity of quality sketches and models generated meets requirements	□ the quantity of quality sketches and models generated is small	□ the quantity of quality sketches and models generated is limited to one or two
	□ an extensive range of ideas is explored	■ a moderate range of ideas is explored	□ a small range of ideas is explored	□ one or two ideas are explored
	□ ideas are thoroughly evaluated and clearly used to inform steps taken in development and refinement stages	■ ideas are evaluated and connected loosely to the development and refinement stages of projects	□ ideas appear to be occassionally evaluated and loose connections of process work to the development and refinement of ideas is seldom visible	□ evaluation of ideas isn't evident and the connection of process work to the development and refinement of ideas is unclear
	□ a working process that matches project specs is clearly evident	□ a working process that matches project specs is somewhat evident	■ a working process that matches project specs is diificult to find	□ a working process that matches project specs is not evident

Fig. 4: Shown here is a portion of an assessment sheet that students received after conducting the third or fourth project in the course. Similarly to Fig. 3, it consists of a project-specific rubric in which each comment is separated from the others but remains in the same column. Feedback that pertains to the individual student is noted by a black checkbox and black text. Comments that don't pertain to the individual remain gray.

Self-Reflections

At the start of the class following the receipt of each assessment form, students were asked to take ten minutes to jot down all of the feedback they could remember receiving on the sheet and to explain their understanding of the information and how they planned to use it in the future. This step of the study was intended to ascertain students' retention and understanding of the assessments.

Questionnaires

On the last day of the course, students completed a survey that asked them questions about their perception of each assessment form. The task, which took approximately ten minutes, was conducted via the internet and the students' responses were logged anonymously. The questionnaire was divided into four parts—each corresponded to a different assessment form but asked the same questions in a consistent manner. Most of the questions were followed by a set of pre-written responses and an area for students to enter their own comments, all of which were accompanied by checkboxes that students either ranked in terms of importance or selected all that applied.

In the questionnaire, students were asked how thoroughly they thought they read each assessment, how well they believe they understood the content, and what attributes of the assessment they thought infringed on their understanding of the information. Students were asked to consider the importance of individual assessment attributes to them and then rank each component, such as grade listings, and individual comments, on a five-point scale. The students performed a similar task when asked what they gained from the feedback, such as direction on how to improve in the future, and an understanding of what they performed well in the corresponding project. Disregarding their actual project grades, students were asked how satisfied they were with each of the assessments they received. If they weren't completely satisfied, they were asked to identify reasons that attributed to their dissatisfaction. Lastly, at the end of each section of the questionnaire, which related to a particular assessment form, students noted the grade they received for the corresponding project. This process enabled the examination of students' perceptions of visual and textual information and how the forms of the assessments impacted their preferences.

Study outcomes

The results of the questionnaire verified some hypotheses, revealed a few surprises, and fuelled a subsequent study. For purposes of clarity, I will identify each of the assessments throughout this section as:

- A: the assessment that includes a general rubric and typed comments selected from dropdown menus;
- B: the assessment that included a general rubric and handwritten comments that were identical to those selected from dropdown menus;
- C: the assessment that included a project-specific rubric that was separated into individual points shown in black text; and
- D: the assessment that included a project-specific rubric that was separated into individual points shown in gray and black text.

In each set, the first few questions referenced students' reading and understanding of the assessments. The vast majority of students noted that they read each assessment thoroughly (Fig.5) and that they understood all of the information (Fig.6). It is important to point out that although the distinctions are slight, students read assessments A and C, which contained a full page of black printed text, less thoroughly than B and D, which included handwritten or gray and black text. Students also indicated a slightly higher understanding of C and D—the detailed rubrics—than A and B—the general rubric. The students' lack of knowledge of design terminology may have attributed to their high rankings of ambiguous and unfamiliar language as causes of their misunderstanding (Fig.7). It's important to note that students found the amount of text on A and C more problematic than B and D.

The next set of questions in each section related to students' value and use of the assessments (Figs. 8, 9). Here, slight differences among the assessments became apparent. Students valued their grades on C and D, which didn't include column labels such as "excellent" and "good", more than on A and B. The placement of checkboxes was less important in C, which lacked visual hierarchy. In addition, individual comments were valued more on A and B, which didn't reference project-specific criteria in the rubrics. When asked which assessment provided specific information well, students noted B, which included handwritten comments, as best supplying suggestions for improvements and D, which utilized gray and black text, as best indicating their performance on the relevant project. Students pointed out that C and D, which included project-specific rubrics, listed important attributes of the corresponding project better than A and B, which used a general rubric, and that the translation of feedback to a grade was most clear in D, which used visual hierarchy to delineate content. Interestingly, students' consistent use of the assessments did not appear to be affected by the differences in the types of feedback they received—A and B pointing out project performance and offering suggestions for improvements, and C and D simply noting project performance.

The last section of each set in the questionnaire dealt with students' satisfaction of the assessments. Although differences among the four forms were evident, the discrepancy between printed and handwritten feedback was slight in comparison to a similar study that was conducted in the fall of 2007 (Rohrbach, 2008). In the study described in this paper students noted that they were most satisfied with C and D consistently, followed by B then A (Fig. 10). Their preference may be attributed to the detail, clarity, and specificity of the project-based rubrics used in C and D. Students who claimed that they were not completely satisfied with the results of the assessments, largely attributed their dissatisfaction to a lack of information (Fig.11). Many of them expanded on their notation, stating that they wanted more time to discuss their work with their instructors. Lastly, there was no noticeable correlation between students' grades and their responses to the assessment questionnaire.

Although students' self-reflections that were collected as part of this study were written in prose, similarities arose among the set. Students' retention of information from assessments A and B were consistent, indicating that the form, whether it was printed or handwritten, had little impact on the content that students remembered and how they planned to use it. Students were consistently focused on the performance headings shown on assessments A and B, such as "excellent" and "good", and seldom connected the titles to concrete information about their performance. Hence, the headings were dropped from assessments C and D, which marked an increase in students' descriptions of their performance in their self-reflections. Students also appeared to remember more information from assessment D, which utilized visual hierarchy, than assessment C, which lacked visual hierarchy.

The instructors documented the amount of time spent completing the various assessment forms throughout the duration of the course. Instructors spent approximately seven hours completing the handwritten assessments and four hours completing the digital assessments. In review of the first two assessments my co-teacher and I noted that the forms diminished our time on the task and reduced our tendency to scrutinize specific attributes of students' projects that often cause inconsistencies among our assessments. However, the necessity to check one paragraph that cited several performance attributes prevented us from commending specific successes or noting particular areas for improvement. In contrast, the last two assessments, which separate each individual performance attribute, required us to examine details more than we had in the past. This characteristic is not necessarily problematic but forced us to assess students' performance in an unfamiliar manner.

This set of figures illustrates students' perceptions of the four assessment forms used in the freshmen design studio. The data was collected via a questionnaire that the students completed anonymously at the end of the course. Moving from left to right, each column correlates to a specific assessment form—A,B,C,D, as listed at the start of the study outcomes.

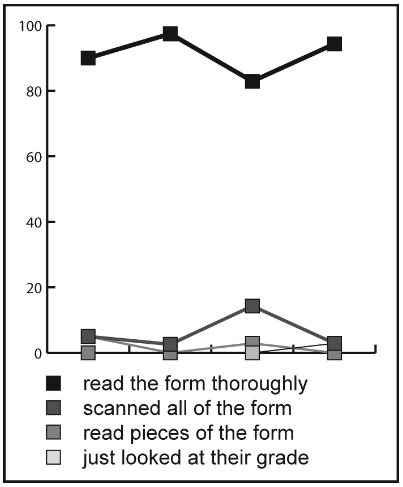

Fig. 5: Students' reading of forms

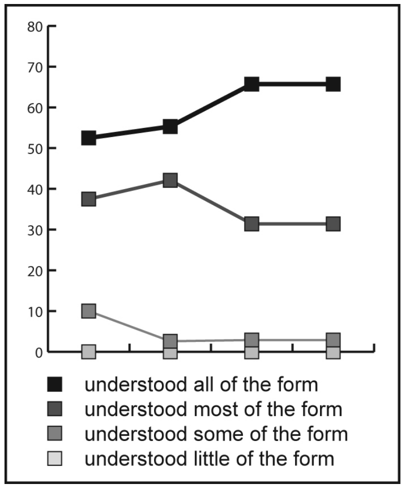

Fig. 6: Perceived understanding of the forms

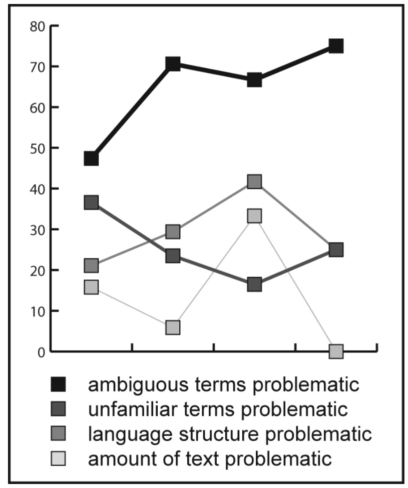

Fig. 7: Perceived causes for misunderstanding of the forms

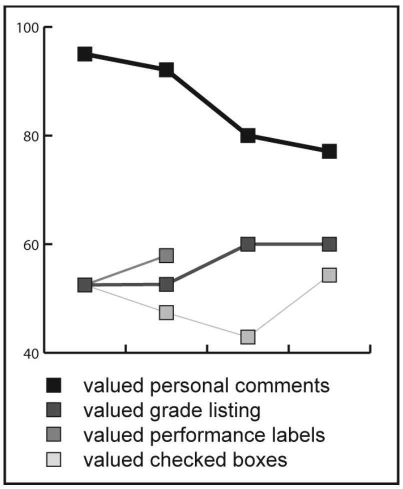

Fig. 8: Perceived value of the forms' components

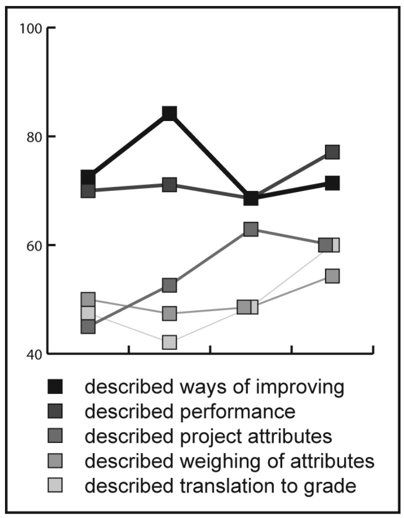

Fig. 9: Perceived value/use of the forms' content

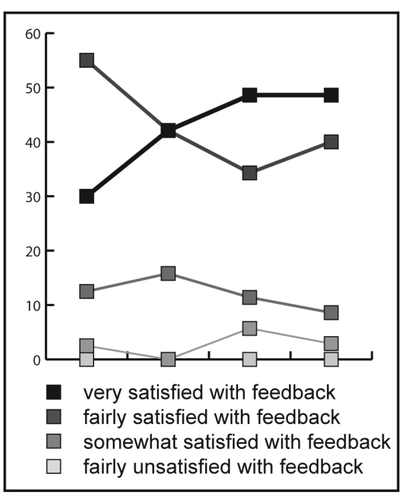

Fig. 10: Perceived satisfaction of the forms

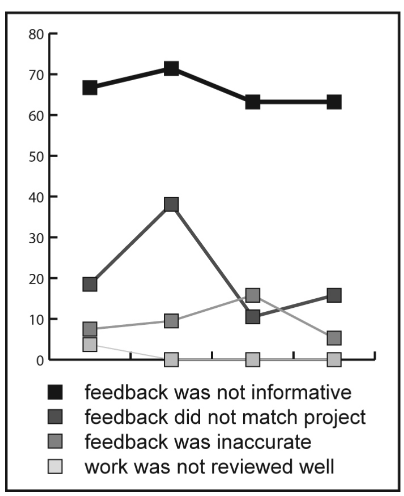

Fig. 11: Perceived causes for dissatisfaction of the forms

Study Limitations

Although the structure of this investigation, which is illustrated in Table 1, limits the interference of the project parameters throughout the course of a semester on the study, it is important to reiterate that the investigation was isolated to the context of a design studio that included first-year students. The narrow pool of participants enabled the in-depth study of assessment tools without having to account for vast differences in students' design skills, knowledge, and experiences. Nonetheless, this is an inherent limitation of the study because students' placement within a curriculum may have a bearing on their assessment needs and desires. Their diverse levels of maturity and learning experiences may warrant different approaches to assessment. Hence, the outcomes of this study are intended to serve as a basis for further investigation.

Conclusion

This study and its outcomes are intended to serve design educators by providing them with clear and substantiated information that facilitates their rethinking of the assessment process and guides their decision-making when conducting evaluations. It proposes methods for studying the visual appearance and wording of assessments and informs subsequent investigations in this area of research. As a result of this inquiry, I believe the design education community will gain a better understanding of the critical components of assessments and how they can use visual appearance, wording, and form structure to improve students' understanding of feedback and inform their subsequent learning.

Supply feedback aligned to students' educational experiences.

The outcomes of this study show that the majority of students understood all of the feedback that they received. However, students who noted a lack of understanding cited their unfamiliarity with the terminology, ambiguity of the feedback, and structure of the comments as causes. Thus, to improve all students' understanding of the assessments they receive, it's important for educators to consider the words they use when providing feedback, verifying that new terms are clearly defined and matched to each student's level in the curriculum. In addition, students noted that they believed the handwritten comments provided them with more direction on how they could improve their performance, despite the fact that the handwritten and typed comments were identical. Therefore, it is important for instructors to consider the wording and form of assessments to which students are accustomed, and introduce new instruments slowly, clearly explaining any changes in the evaluation metrics.

Provide comments that address a specific project and student.

Students' responses to the questionnaire and the information culled from their self-reflections indicate that they most preferred and understood project-specific feedback that was geared toward the individual. For example, more students noted that the detailed descriptions of their performance were highly important on assessments A and B, which presented them with a rubric that related to the entire course, than in assessments C and D, which used a project-specific rubric. This indicates that students sought personal and project-specific information that wasn't readily available in the rubrics. Students also noted that assessments C and D gave them a better understanding of the evaluative criteria and listed important attributes of the corresponding projects more effectively than assessments A and B, attributing the majority of their dissatisfaction with the assessments to a lack of information and stating that they wanted more direct feedback. Thus, educators must consider how broad, course-based statements negatively impact students' perception and understanding of the feedback they receive.

Remove vague titles of performance.

The review of self-reflections that took place after each assessment indicated that most students focused on the performance titles that had been marked by instructors on assessments A and B, such as "excellent" and "needs improvement". Students often cited their rating at the beginning of their self-reflections but failed to link them to concrete information that described their performance or offered suggestions for improvements. Thus, I think the vague performance titles provided students little useful information and instead caused them to stop reading the supporting information and look for connections among the content. Therefore, I believe instructors should be wary of titling performance levels and instead focus on the clear definition and delineation of one from another. I think this process will help students grasp project and course objectives and outcomes, and how they relate to each other, more effectively.

Situate individual comments within a larger context.

The questionnaire outcomes indicate that students were most satisfied with assessments C and D. Students' reasons are illuminated by the written responses that they provided in the questionnaire and also by the review of their self-reflections. Students noted relationships between their performance and attributes of those levels that were above and below their position in the rubrics. They noted that this helped them articulate their advances and inform further improvements. As a result, I believe situating each student's performance attributes within the larger context of the class helps them understand grading metrics and provides guidance for improving their performance.

Deliver feedback in a form that is efficient.

Provided that a consistent language is used to assess students' performance throughout a course, the differences in students' perception of handwritten and typed forms appear slight. The questionnaire responses indicate that students were minimally more satisfied with the handwritten assessments. In addition, the self-reflections showed that students retained the same amount and type of information despite differences in the visual form of the assessments. In contrast, the amount of time educators needed to assess students using the digital forms was significantly less than the handwritten forms. Thus, I believe it is important for instructors to explore alternative assessment tools with the intent of making them more efficient without sacrificing the quality of information they provide students.

Use hierarchy to improve perception and retention of content.

Perhaps most interesting are the results of this study that deal with the visual appearance of the assessment forms. Students indicated that they read assessments A and C, which included little visual hierarchy, less thoroughly than B and D. They also noted that the amount of text of A and C, which was identical to B and D, prevented them from understanding all of the feedback the received. Lastly, a comparison of self-reflections showed that students retained a great deal more information from D than C. In all cases, assessment D yielded the most positive results, which I believe is due to the form's clear and prominent hierarchical structure that draws attention to an individual's performance among attributes that reflect the class as a whole. Hence, I think instructors can improve students' perception and retention of assessment information by using visual hierarchy to reduce the overwhelming appearance of a text-heavy document and highlighting content that is pertinent to the individual student.

Use placement of text as a form of communication.

Based on the results culled from the questionnaire, the placement of assessment content can also provide students with valuable feedback. Students indicated that assessment D provided them with the most information about their performance and that they best understood how the feedback they received translated into a grade via this form. I believe these outcomes can be attributed to the visual pattern that results from highlighting comments that pertain to an individual within the context of the greater rubric. Hence, students can see that their grade is likely to be in the B range if most of the second column is highlighted. They quickly gain an understanding of their overall project performance and individual components that may not be in line with the others just by glancing at the assessment sheet. I think educators can use this information to help students form an overall, accurate perception of their performance on a project and also invite them to explore the feedback more thoroughly, linking it back to the first impression they made.

Next steps

This research project uncovers the affects that appearance and wording of assessments forms have on students' learning, understanding, and perception of the feedback. The study premise, research structure, and outcomes function collectively as a base, on which additional research on assessment in design education can be conducted. Although this project presents visual and textual principles for design educators to consider when constructing evaluation tools, the outcomes also reveal specific areas of assessment that warrant additional investigation. For example, the alterations to conventional rubrics in this study are slight. Therefore, another project may seek to extract the essential components of rubrics that must be retained in assessing design students' performance and further alter the appearance and wording to best suit students' expectations and the design studio context. In addition, since this project consists of instructors evaluating students' performance, which does not match the peer-to-peer and peer-to-educator interaction that is often present in design courses, another investigation may study the roles of design students' in the assessment process. However, these are but two directions that this research can follow. The key point is that it is important for educators to understand the critical role that assessments play in students' learning and understanding and that further studies are necessary to improve the evaluation instruments used in design pedagogy, making educational experiences enjoyable and effective.

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Stacie Rohrbach is an Associate Professor in the School of Design at Carnegie Mellon University in the United States. She teaches studio- and seminar-based communication design courses at all levels of the undergraduate and graduate curriculum. Rohrbach's research investigates how combining design processes and learning theories improves the teaching of complex and abstract content—specifically visual communication. She explores the design of educational tools and methods for university students within and outside of design, in classroom and online contexts. Rohrbach also applies her new knowledge to areas outside of visual communication, such as the biological sciences. The nature of her work allows her to explore the relationships between print and digital media and the communicative value of sound, motion, and visuals as educational tools.

Prior to her current academic appointment, Rohrbach worked professionally in both print and digital media. As an art director, designer, and researcher she developed identity systems, corporate standards manuals, interactive websites, promotional materials, and product packaging. She also taught design courses at Lehigh University as an Adjunct Lecturer. Rohrbach earned a B.F.A. in Graphic Design from Carnegie Mellon University and a Master of Graphic Design degree from North Carolina State University.

CAPTURING AND RETAINING KNOWLEDGE TO IMPROVE DESIGN GROUP PERFORMANCE

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Abstract

This paper explores the management and organizational context for capturing and retaining knowledge transferred through the design process.

It is widely acknowledged that our ability to successfully organise and transfer design knowledge is dependant upon the context in which it is situated. Cross (1992) has also highlighted the normally unsystematic way designers work and the limited extent to which the knowledge contained within the products they create is made explicit.

Essentially design knowledge transforms as it transfers (Ashton, 2007) and the knowledge-based resources of a design group are socially complex. Successful exploitation of these knowledge assets can secure competitive advantage (Alavi and Leidner, 2001) yet, a systematic literature review of leading design and educational management journals found limited empirical evidence that shed light on the influence of knowledge management on design group development.

The paper addresses this weakness in the literature and suggests that design consultancies utilise cross-disciplinary knowledge to solve problems which could not be resolved by linear disciplinary frameworks (Gibbons et al, 1994). Based on two in-depth case studies with interior design companies implementing new digital asset management systems over a two year period, the paper explores the findings in relation to design practice and policy, alongside implications for the contribution of the Creative Industries to the knowledge economy.

Introduction

The companies under investigation were supported through the Knowledge Transfer Partnership (KTP) scheme in the UK which draws upon academic expertise to improve organizational performance.

These schemes have been running for over 30 years and have helped businesses develop and embed new technologies, products and production processes. There has been considerable growth in KTPs as organizations have sought to exploit university expertise towards strengthening competitiveness, wealth creation, and social and economic performance.

Previous design related KTP research has focused on the long-term impact of strategies to innovate new products and services after a ten year period (Hands, *et al*., 2004) but the emphasis has often been on economic outcomes rather than design knowledge and its contribution to organizational development.

This research aims to develop a framework to identify the knowledge being captured and retained as designers' progress from one phase of the design process to the next. The intention is to shed light on the complex interaction of phenomena during the creative process which relates to both individual and design team knowledge.

Managing knowledge in the Design Group

It is widely accepted that knowledge is a key market asset for design groups (as described by Roworth-Stokes, 2007 and Harvey *et al.*, 2002). This is evident throughout the design process from research to concept development, from detail design to manufacture – in fact all the stages that underpin new product development. Design groups help their clients exploit design knowledge in a market for design services which is worth £4.8 billion in the UK alone (DCMS, 2001).

Gibbons *et al.* (1994) suggest that the production of knowledge is becoming increasingly focused toward the solution of specific problems through teams at the expense of the individual interests. It is argued that a new production of 'cross-disciplinary' knowledge is emerging – termed Mode 2 – which is distinct from the more traditionally based and linear disciplinary frameworks – Mode 1. Clark (1998) has proposed that this is a characteristic of 'entrepreneurial' organizations and it mirrors the way design groups manage knowledge for organizational advantage. Teams are brought together with multi-disciplinary expertise, with backgrounds in psychology, engineering and management to solve client problems.

Robertson and Hammersley (2000) found that consultancies wanted knowledge workers to develop their own knowledge – by sharing their own expertise and learning from others – in order to satisfy client demands and to be part of what was termed the 'cultural fit' of the organisation.

> *'Thus project team working was not hindered by consultants jealously guarding their personal knowledge and expertise...Valuable organisational knowledge and skills were thus retained within the firm over time…Expert consultants were selected on the basis of their cultural fit…Cultural fit implied a willingness and ability to share knowledge and…which allowed them to work with others from different specialisms and further develop and enhance their own intellectual capital.'*
> (Robertson and Hammersley, 2000, p.251)

Yet whilst there is a burgeoning literature on the contribution of the Creative Industries to the economy, there is a dearth of empirical research which has specifically focused on the ability of design groups to capture and retain knowledge within the design process. This paper will explain the practical interventions which address this gap in organisational performance and will then go on to explore the implications for policy and practice.

Methodology

Universities play a significant role in national innovation systems and are regularly cited in economic studies concerned with improving competitiveness through innovation and technology transfer. The term 'knowledge transfer' has recently broadened the concept of engagement between higher education and business in recognition of the need to harness both new and existing technologies that add value to the business and its customers through new products, services and enhanced organisational efficiency.

Building upon data sets already developed by the author in a research study exploring university knowledge transfer (Roworth-Stokes, 2007) two KTP projects were selected in the same sector to explore organisational processes which support knowledge capture, retention and exploitation. The projects both required the implementation of digital asset management systems (including web-design, digital archives and intranet development) within architecture and interior design practices. Academics supervised each project and oversaw the appointment of an Associate responsible for the implementation of the technological infrastructure over a two year period. This allowed for a close investigation of factors associated with knowledge management.

A summary of each case is provided below.

Case	Background	Context and purpose	Outcomes and benefits
A	Services: • Interior design • Architecture • Retail branding/ environmental graphics Clients: • HMV • Selfridges • City Councils	Context: • 20 staff • Turnover and profit declining Purpose: • Intranet facility with office manual • Purchase and implement digital asset management software • Create digital archive of previouse client work	Outcomes: • 15 staff • Turnover and profit stabilised • Database driven web-site • Digital Archive • Updated corporate identity, logo and business plan • Competitor analysis/new business database in other sectors Benefits: • Staff able to access digital archive of previous 10 years work • Prospective clients search website by client/service etc. • Designers can work remotely through secure Web site • Staff have an IT Service Desk supporting the intranet • Efficiencies in physical (utilisation of space) and human time in accessing client information
B	Services: • Interior design • Exhibitions • Architecture • Multimedia and graphic design Clients: • The Natural History Museum/ Maritime Museum • Lottery Fund projects	Context: • 13 staff • Turnover and profit decreasing Purpose: • Digital archive intranet • Archive database • Improved client presentation and on-line marketing • Efficiencies in project delivery	Outcomes: • 10 staff • Turnover reduced and profit increased • Archive Intranet (Website) • Archive Database Benefits: • Digital archive of previous 11 years of client artwork/admin • Prospective clients can get information on intranet • Designers use the Intranet for credential presentations • Efficiencies in physical (utilisation of space) and human time in accessing client information

Table 2. Description of case studies

The inquiry focused upon the interaction of cause and effect relationships during three stages of the project – origination, implementation and development. Building upon Eisenhardt's approach to deriving theory from case study research (Eisenhardt, 1989), documentary evidence, autobiographical interviews and semi-structured interviews where conducted with a range of staff.

Interviews with both the KTP employee and the Director of the design group were explored in depth, to identify the key events, milestones and the forces at play. A key feature of this approach was to establish as full as an account as possible in the respondent's own words with minimal intervention by the researcher. This technique, as described by Plummer (1983), was employed to give 'voice' to each individual view. As Plummer (ibid, p.57) argues: *'views, truths and conceptions of the real can never be wholly ripped away from the people who experience them'*.

The interview commenced by asking respondents to consider the circumstances which led to the initiation of the project before describing its implementation and outcomes, highlighting any critical incidents or factors along the way. This was followed by a series of structured questions around the themes of leadership, management, organisational development and developments in the design sector.

Careful wording of each question within the interview protocol was critically important to attaining as full and 'open' a response as possible – striking a balance between the need to guide the discussion around topics whilst not wanting to 'phase' respondents with 'management speak' they might not relate to. For example the theme of management sought to clarify perceptions towards resources and communication which led to the question: *'To what extent has the scheme improved the sharing of information and knowledge e.g. client work, contacts etc?'*

All quotations were fully transcribed and pseudonyms and codifications were used for all people and places to provide confidentiality and anonymity.

Findings

As recognised by Eisenhardt (1989) and Miles and Huberman (1984) there is a risk that there can become a divide between the actual data obtained and the conclusions derived. The huge amount of qualitative data accumulated can mean a lack of clarity within the filtration procedure and a lack of consistency in the process of condensation.

> *'Analyzing data is the heart of building theory from case studies, but it is the most difficult and least codified part of the process. Since published studies generally describe research sites and data collection methods, but give little space to discussion of analysis, a huge chasm often separates data from conclusion.'*
> (Eisenhardt, 1989, p.539)

A process of coding was undertaken to develop 'nodes' by highlighting each element of text that had meaning for the respondent. For example: *'once I had got the commitment of the staff I got going'* was coded as 'trust'. Here, Strauss and Corbin's (1990) well detailed method of building substantive and formal theory from qualitative data was employed, whereby open coding was used to label discrete events or phenomena, and categories identified to group concepts identified through phenomena pertaining to common themes.

In order to summarise the relationships identified and to make sense of the complex interaction of nodes and themes a visual approach to the display of data was sought. As described by Miles and Huberman (1994) the causal connection diagram was employed and is presented below. This incorporates a chronological 'timeline' on the left hand side of the diagram whilst the 'nodes' on the right signify connections between the incidents, happenings and events identified.

Miles and Huberman (1994, p.227) suggest *'such a chain helps analysts lay out explicitly what may be causing certain phenomena. Although the chain does represent a simplification, that very simplification carries with it the seeds of a fuller explanation'*.

For example, node 3 and 4 refer to the need to recruit a new Associate with the appropriate technical and educational background. This was referred to by those interviewed as 'A LOW PERIOD' due to the need to manage knowledge more effectively throughout the organisation.

In determining the significance of a cause and effect relationship the author draws upon Flanagan's (1954, p.327) definition, in that it *'must occur in a situation where the purpose or the intent of the act seems fairly clear to the observer and where its consequences are sufficiently definite to leave little doubt concerning its effects.'*

These broad patterns of causality form the basis for the discussion which follows.

PATTERNS OF CAUSALITY

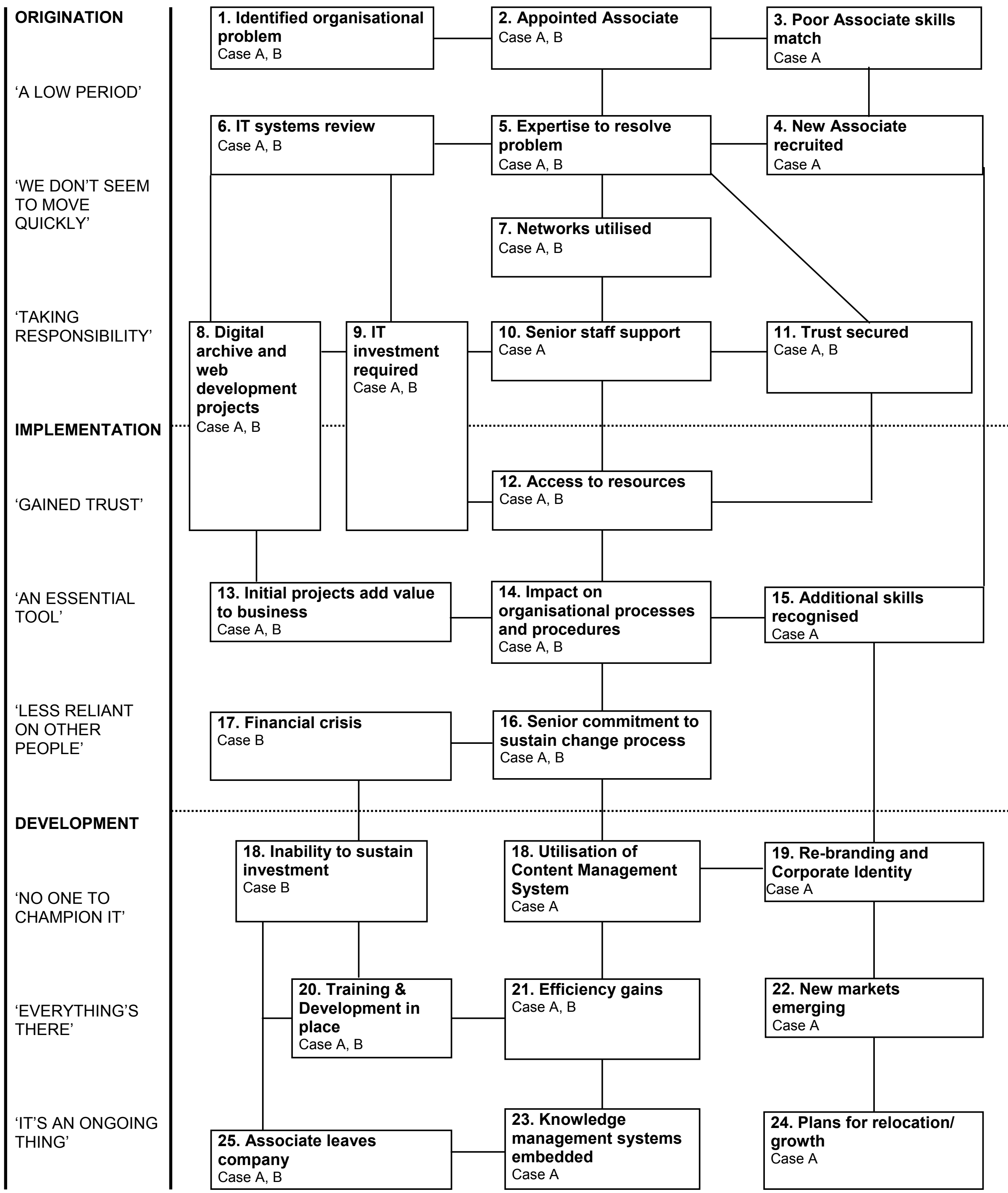

Figure 1. Cross case analysis of causal connections (modified from Roworth-Stokes, 2007)

ORIGINATION

'A LOW PERIOD'

At the point of origination both companies had identified similar organisational problems to improve efficiency (1) and increase competitiveness.

> *'the company had different digital assets which were difficult to find…over 10 years of data structures which were badly structured throughout the organisation…they were repeating a lot of information and designers couldn't find anything'*
> (Associate)

The need to improve digital asset management had the potential to improve communication and reduce duplication of client artwork between designers whilst enhancing awareness of design expertise through web based promotion and marketing.

Each associate (2, 3, 4) used their technical and educational background to conduct an audit of the organisations knowledge management systems.

> *'when I first arrived I was asked to look at the organisation and see what areas needed improvement…but there were various other problems such as the web-site needed upgrading and there wasn't any form of intranet.'*
> (Associate)

'WE DON'T SEEM TO MOVE QUICKLY'

As the Director of Case A pointed out, *'two years ago we could just about get by'* but the pressure to address this gap in performance had changed with a downturn in business following the millennium boom in regeneration work. A lack of in-house technical competence and expertise in web-design and intranet development had the potential to significantly reduce future success.

'TAKING RESPONSIBILITY'

The Associates, who were recent graduates, used their initiative to improve the level of awareness, trust and commitment towards the knowledge transfer project (7, 10, 11).

> *'I asked members of my family and friends to seek their advice, it was a challenge and whilst I had learnt the theory it felt like I had been thrown in at the deep end really…but once I had got the commitment of the staff I got going'*
> (Associate)

IMPLEMENTATION

'GAINED TRUST'

Commitment of resources to delivery the project (8, 9) begins to yield recognition by senior staff of the benefits of the new systems.

> *'the second year was a discovery, you suddenly understood what was going on, the work that had been put in…so I was as much a student as the Associate in that process'*
> (Director)

'AN ESSENTIAL TOOL'

Once the primary objectives had been achieved (15), attention turned to the need to fully embed the new technology within the culture of the organisation (13, 14). Concept and detail design work is recorded alongside client data as the design process unfolds. The web-site and the digital management system also facilitate access to files remotely through the internet, creating new working methods for the designers.

> *'We have a common international language of design…the systems have to be consistent and we are all scribbling away using the same tools…but we can now work together no matter where it is'*
> (Director)

'LESS RELIANT ON OTHER PEOPLE'

As knowledge assets are captured as part of the creative process there is less reliance on the Associates (16) to manage the process. However Case B highlights the fragility of the design services sector and when the company is affected by an economic downturn (17) staff resource are diverted towards new business development (18).

> *'involvement in the archive intranet was far greater than in the creation of the archive database, because the archive intranet was a greater priority to the practice in terms of generating new business'*
> (Supervisor)

DEVELOPMENT

'NO ONE TO CHAMPION IT'

The Associate in Case B completes the training and development of staff and is able to leave 6 months earlier than originally planned (20, 25).

> *'There has been a lot of internal efficiency, we have a few people leave and new people come in and they have been able to adapt quickly to the new structure'*
> (Associate)

Case A continues to invest time and resources into the partnership and there is a shared ownership over the knowledge management systems created (23).

> *'The Office Manager has learnt quite a bit…and her role has changed…she got through to the heart of the matter and set up the electronic document filing systems because she could see what we were trying to get at'*
> (Director)

'EVERYTHINGS THERE'

Benefits of the new asset management systems become apparent in both companies. The use of the intranet and the digital archives provide a platform to capture and retain creative and non-creative outcomes. Staff are able to use their time more effectively (21) and the Directors stress the importance of these systems in organizational development:

> *'There is less collective leadership and more autonomy…everyone knows what they are supposed to be doing and people have such access to information'*

> *'In a business sense it makes us much more effective…you are definitely more efficient'*

Case A utilises the enhanced understanding of its collective knowledge to revise its mission and purpose (15). The project becomes a catalyst for the company to align its business more closely with architecture, which also becomes a key feature of its brand and new corporate identity (19).

'IT'S AN ONGOING THING'

At the end of the project implementation (25) the emphasis has moved to the sustainability of processes and procedures which capture and retain knowledge. Investment in information management becomes an asset and driver for development rather than a risk to be managed. New market opportunities became evident through larger contracts (22) and the companies realise the potential for growth.

> *'we are now mature enough to accept bigger jobs…you can do a ten million pound job the same as you can do a hundred million pound job in roughly the same time with a few more staff…we can handle it and we will get a much better and consistent turnover for it.'*
> (Director)

Analysis

Before we consider the policy implications it is useful to reflect upon the findings of the research within the context of the design process.

There are many models to describe the design process originating from Archer's (1965) seminal work on design methods. More recently research conducted in the UK by the Design Council has proposed a simple double diamond diagram to explain how one might manage design more effectively. The diagram is used below to describe four distinct areas which show the different modes of thinking that designers encounter when they embark upon a new design project.

It should be noted that the purpose of these headings is to allow reflection on the findings, and their underlying cause and effect relationships, to inform design practice rather than a direct comparison with the chronological headings contained within the timeline in Figure 1.

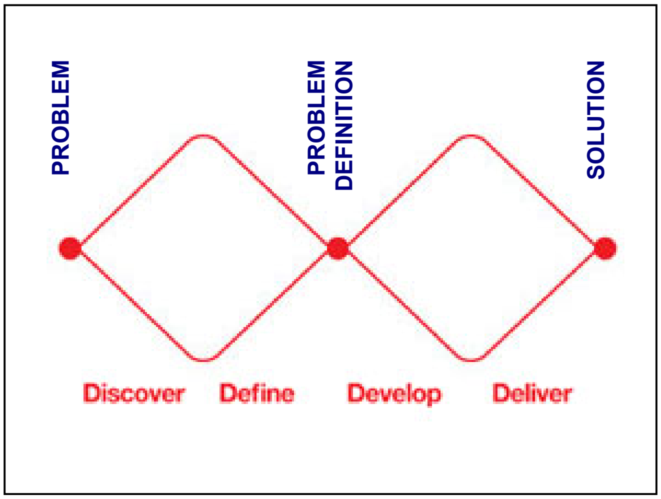

Figure 2: Design Council (2007)

The Design Council model offers an iterative process in which knowledge is captured and retained as designers progress from one phase to the next. The discover phase begins with an initial idea or problem identified from user need or demand before the second phase operationalises the design problem into a managed process. This is followed by the development phase based on the generation of concepts, ideas and potential solutions before the delivery stage when the product or service is tested, agreed, specified and launched in the marketplace.

In contrast the cases studies suggest that prior to the commencement of the digital asset management systems, knowledge appeared to being utilized in an unsystematic manner due to inherent problems with the operational structure and working practices.

The table below summarizes the model against the findings of the research and highlights the influence for each of the factors identified which are explored further in the commentary that follows.

Phase	Activities	Nature of influence
Discover	1. Market research 2. User research 3. Managing information 4. Design research groups	• 'Mood' and 'Theme' boards can be used in digitized format to express market context and consumer/audience profile • User research combined with visual content can enhance credentials presentations • Client details can be made easily accessible across the design group (even remotely) through customer relationship management systems • Understanding of new trends and market potential can be enhanced and retained even when individuals change within the team
Define	5. Business plan 6. Project development 7. Project management 8. Project sign-off	• Clarity over the knowledge assets of a design group can further organization purpose when seeking to grow the business • Concept develop can be informed by reference to previously archived work • Client access to project management information can support concurrent engineering/manufacturing processes • Enhanced information systems can reduce misunderstandings with clients and hence reduce lead times
Develop	9. Multi-disciplinary working 10. Visual management 11. Development methods 12. Testing	• Open and accessible working practices can facilitate multi-disciplinarily approaches to resolve design problems • Digital asset management systems can enhance remote working and efficiencies in preparing client artwork • Integrated IT systems which facilitate CAD/CAM file sharing with clients can improve efficiency • Prototyping and market testing can be used to effectively refine/redesign product proposals
Deliver	13. Final testing, approval and launch 14. Targets, evaluation and feedback loops	• Socially constructed knowledge (understandings, meanings or associations which underpin brand equity) can be retained or exploited for promotional purposes • Data can be used to evaluate the effectiveness of the design process and options or alternative design solutions can be captured to inform future product diversification

Table 2: Influence of interventions on design group knowledge

DISCOVER

The interviews demonstrated the importance of 'visualizing the brief' at the commencement of the design process. 'Mood' and 'Theme' boards are commonly used to communicate and clarify the market context, consumer/audience profile and style or finish being considered between client and design group. The analysis would suggest that the retention of these knowledge assets in digitization format can enhance communication throughout the project, providing clarity and purpose whilst ensuring common understandings or interpretations between designer and client which had been tacit, are retained even when individuals change within the team.

DEFINE

Case A highlights that clarity over the knowledge assets of a design group can further the strategic positioning of the organization in market terms when aiming to secure growth. In addition, both cases suggest that the efficiency of the design process can be enhanced by concurrent engineering/manufacturing processes whereby the design group integrates its own data with client production systems to reduce lead times.

DEVELOP

Increasingly the two design groups were moving towards open and accessible working practices to facilitate multi-disciplinarily approaches to resolve design problems. Specialist knowledge was drawn upon in the co-production of knowledge to resolve complex technical and operational problems. This included input from engineers, technologists, psychologists, sociologists and anthropologists amongst others as required.

Digital asset management systems were able to facilitate access and input to the design process, including remote working, in a cost effective way alongside file sharing for prototype development and market testing to refine/redesign product proposals.

DELIVERY

Case A suggests that the process of implementation of the digital asset management process had an effect on the design groups knowledge and understanding of itself within its sector. The recognition of a specific market proposition and subsequent rebranding exercise are evidence of socially constructed knowledge whereby the group collectiveness shares and operates within a common set of meanings and cultural processes underpinning the brand equity.

Equally both cases demonstrate that the management information systems offered further advantages in the evaluation of client work whilst the data captured throughout the design process could be used quickly to secure product diversification.

Conclusions

Business management factors are often characterised by strategies, processes and procedures to maximise market opportunity. Gibb and Davies (1990) suggest that this area relates to performance and the ability to operate at maximum efficiency levels.

Intrinsic to this area is the notion that business leaders are able to understand the market in which they operate and quite objectively undertake activities which improve competitive position. Hence, growth can be achieved by using appropriate business management tools such as business plans to set targets and overarching goals for the business. This pseudo-scientific approach to planning is often built upon the business development model identified by Ansoff (1965) by exploring development through market penetration; product development; market development and diversification.

The findings of this research would suggest that the business management of design groups can be enhanced by embedding sound ‘knowledge management’ in practice. In particular, technology which is geared towards the requirements of designers in capturing visual material and for sponsors to be able to utilise the knowledge derived from it (e.g. Ruggles, 1998; Bassi, 1997). However, Gumbley (1998) and Robertson and Hammersley (2000) have criticised the rather simplistic notion that technology is the means by which knowledge can be effectively produced and distributed due to the need for human and social aspects to be taken into consideration.

This study found that ad hoc management processes and procedures in the design groups combined with a lack of technical infrastructure to capture and retain knowledge reduced the potential to exploit a key market asset during the design process. The fluidity of the creative process and both individual and collaborative contributions towards innovative solutions can result in the retention of knowledge being overlooked. The objective to digitise outcomes led to a strategic change in working practices but this required an adaptive approach to the design process and new working practices. In summary, to translate ‘designerly ways of knowing’ (Cross, 1982) into tangible knowledge assets requires new ‘designerly ways of designing’.

Therefore, technical systems in themselves may only provide a means to facilitate effective knowledge production and dissemination. This research would suggest that a combination of trust in management and the intended purpose for the knowledge, as well as good social interaction (as suggested Robertson and Hammersley, 2000), may be necessary ingredients to its successful implementation.

In addition, the exploitation of knowledge is intrinsically linked to the ability to attract and retain design 'talent' or 'knowledge workers' as often cited in the knowledge management text. When asked to identify the major assets of the design group within the semi-structured interviews, the experienced research staff were invariable cited as the key resource of the organization.

The ability to capitalise on the knowledge of designers throughout the design process requires a balance to be struck between personal fulfillment (through high levels of autonomy and responsibility) and the need for regulation and control. Rotter for example (1966) suggests that 'locus of control' is higher for owner managers than the population average.

In this respect, this research supports the view of Robertson and Hammersley (2000) who found that knowledge workers (in management consultancy firms) are expected to act with a high degree of responsibility and autonomy which, if not forthcoming, may result in the departure of highly valued and talented staff.

From a policy perspective, if the contribution of the Creative Industries to the knowledge economy is to be sustained, leaders in design groups have to engender change in organizational culture towards knowledge management. Equally, universities have a role to play in supporting the design industry in the effective and sensitive implementation of management systems that can realise a positive influence on the growth of the business.

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Biography

Dr Seymour Roworth-Stokes is Pro Vice-Chancellor for Research and Development at the University for the Creative Arts in the United Kingdom and has responsibility for marketing and communications, research, knowledge transfer and cultural strategy. He is an industrial designer with many years experience as a design consultant for clients such as BT and BAA. He has published widely on design, teaching and learning strategies, and on art and design research management. His current research interests include design research methodologies employed with SMEs, creative entrepreneurship and the cultural economy, and managing design research teams. He is leading a major project on behalf of 13 universities in support of the Cultural Olympiad in the lead up to the 2012 Olympics and Paralympics.

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Misfits, Balance, Requirements, and Systems: thoughts on Alexander's Notes on the Synthesis of Form

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Abstract

The author examines the notion of misfit as presented by Christopher Alexander in his book *Notes on the Synthesis of Form*. We argue that from the point of view of our current understanding of design, the approach is flawed, but not flawed beyond use. In fact, the core concept of misfit, and how misfits can be addressed, remain as important to design today as when Alexander wrote about them. In this paper, a number of flaws are identified and explored. Subsequently, a new approach, which the author calls a *balanced systems approach*, is sketched. This approach preserves the intent and core of Alexander's work, while addressing the identified flaws. The main contribution of this paper is to indicate the shortcomings of Alexander's approach, but only for the sake of refining it and ensuring it remains relevant and useful.

Keywords

misfit; requirement; balance; system; Christopher Alexander; synthesis; function; form

In 1964, Christopher Alexander published *Notes on the Synthesis of Form* (Alexander, 1964), hereunder abbreviated as NSF. In that book, Alexander argued for a novel approach to design problems based on identifying and addressing misfits – mismatches between the capacities of and expectations on a form in a specific context. He also identified a change in the way design had been conducted that relates to changes in culture. His "unselfconscious" cultures designed primarily through a heritage of craft and artisanship where reflection and systematization were largely absent. These cultures have largely given way, in his view, to "selfconscious" cultures that reflect and systematize intensively. While he recognizes inherent design benefits from the move to selfconscious culture, he also advises that we have also given up certain advantages of the unselfconscious cultures. In particular, the responsiveness of unselfconscious design to externalities (the exigencies of the context and problem at hand) has given way to a more internalized and abstract perspective. He sees this as problematic because the internalizations are imperfect.

Alexander's relatively esoteric work on misfits and the nature of design problems as described in NSF has languished in comparison to his other work – e.g. the more pragmatic work on pattern languages, which has received broad attention in many disciplines.

The current author believes there is some benefit in revisiting NSF and considering its implications in the more sophisticated setting of contemporary design. We will argue in this paper that there are distinct benefits to Alexander's notion of misfits, and that the combination of (modified) misfits with systems thinking provides a valid framework in which to discuss modern design thinking and propose new potential avenues to improve how design is practised.

The paper is laid out as a series of observations about NSF and the notion of misfits. In each section, modifications are suggested that can address identified shortcomings in Alexander's original work. Finally, a new, balanced systems approach, is introduced. This approach appears to preserve the intent and core of Alexander's work, while addressing the identified shortcomings.

Set Theory in NSF

This is a fair amount of formal logic in NSF, in the form of set theory. The current author is well acquainted with set theory from his own research, and has identified three concerns with Alexander's work.

1. Alexander assumes the existence of the universal set; that is, the one set that contains every other possible set. However, the universal set is excluded from every standard set

theory, because its inclusion makes set theory invalid. An invalid theory is one that yields false positive results (i.e. the theory can prove true statements that are in fact false).

2. Godel proved that no formal system can be both complete and valid (Hofstadter, 1979). However, the current author has not found any evidence of a completeness proof of Alexander's logic. An incomplete theory is one in which there are some true statements that cannot be proved true within the theory. Thus, it appears that Alexander's work is neither valid nor complete.
3. Alexander's logic appears to be a many-sorted, first order logic. Every many-sorted logic has an equivalent one-sorted logic. One-sorted logics tend to be more stable and reliable, and more easily computed) than many-sorted logics. However, Alexander appears to have never translated his work to one-sorted form for the sake of establishing a completeness proof.

Of course, just because the appropriate proofs have not been provided does not invalidate all of his work – indeed, the current author believes NSF remains as relevant today as when it was originally written. However, there is no benefit in invoking set theory unless one seeks to establish a formal grounding for some undertaking. Therefore, this suggests that the formal aspects of Alexander's work should not be relied upon. In this article, the current author will not depend on these aspects of Alexander's work.

What is a Misfit ?

NSF provides no direct definition of *misfit*, but rather a number of characteristics scattered over several passages.

Alexander writes of "requirements or misfit variables" suggesting that there is some equivalence between the two terms. Indeed, although Alexander nearly always uses the term *misfit*, the text is best understood by reading *misfit variable*. The author suggests that the difference between misfit variables and requirements is that misfits simply describe a situation, whereas requirements constitute directives to the designer to address misfits to the extent described by constraints (either boundary constraints or minimization constraints).

Alexander also refers to a misfit (variable) as relating to an *ensemble*, which is the combination of a given form and the context in which it exists. This is very important because it connects a misfit variable to a particular situation; that is, *misfits are always situated*.

The importance of a misfit being a variable is easy to overlook. A variable has two elements: a named property, and a value for that property. If the variable's value is "bad," then it is a *mis*fit. The goal of designing, then, becomes the changing of the *values* of misfit variables so that they are no longer "bad," but the variables themselves must obviously remain.

This is reinforced by considering the partitioning and clustering tasks described in NSF. Networks of related misfits are mathematical graphs of nodes and links (a graph is a set of ordered pairs of nodes that represent the relationships between the elements of the node pairs). Nothing is said about the contents of the nodes or of the links.

Partitioning and clustering builds a hierarchy such that the top level of the hierarchy is the design problem as a whole. The network is one of misfits, or requirements, so the network is a model of the design problem.

The design problem is not something typically under the designers' control, although its model (as requirements/misfits) may change as the designers' understanding improves over time. Excluding changes arising from the imperfect knowledge and reasoning of human designers, the problem itself remains *fixed* (i.e. invariant). If the problem changes because of external influences on the existent ensemble (also not under the designers' control, but quite possible in the real world), then the original problem no longer exists and the designers must essentially begin again. For simplicity, we assume here that these kinds of changes do not occur.

If the problem is fixed, then the misfit network (the model of the problem) must also remain fixed.

The designers' goal, however, is to eliminate the misfits. If we eliminate the misfits, and the misfits are the network, then we must change the network. This contradicts the previous statement: we cannot change the network if it must remain fixed.

We can resolve the contradiction by realizing that the nodes in the network are variables and that misfits are just bad values of those variables. Thus, to eliminate a misfit, one must change the content of a node, not the node itself. In this way, we can remove misfits while keeping the network itself fixed.

There is another problem with the notion of misfits. As misfits represent only the "bad" aspects of ensembles, a network of misfits forms on a *partial* representation. If there are "good" aspects of ensembles, they will not be part of the misfit network. However, these good aspects will likely interrelate with the misfits, just as misfits interrelate with one another. Changing the values of misfit variables could adversely influence those good aspects, but the misfit network will not capture those influences.

This could be addressed by broadening the concept of misfits to include any property of an ensemble, not just those with bad values. The resulting network could then be described as representing *forces* at work in a situation that must be resolved, or *balanced*, by a design. In that case, one would end up with a network graph that describes how well *balanced* a form is with respect to a context, including both its good and bad aspects. The misfit network would be a sub-graph of the overall force graph. Conveniently, this viewpoint is quite consistent with Alexander's work on pattern languages (Alexander, Ishikawa, and Silverstein, 1977).

There is Always a Form

Misfits motivate designing, so misfit identification (and existence) must precede design. Over the years, some of the author's colleagues have argued that, because of the notion of starting from an existent form, Alexander's approach ignores the possibility of highly innovative design or invention. The argument hinges on the assertion that there is no form preceding the invention of a suitably innovative product.

However, the author believes that there is *always* a preceding form: it is the way that we do things "now," that we find inadequate, and that we address by innovation. Even for highly innovative forms, there is also a preceding form. In those cases, the preceding form is just substantively different from the innovative one.

For example, Jeff Hawkins led the invention of the original Palm Pilot personal digital assistant (PDA) by setting the device's main competitor as a leather-bound agenda (Rose, 2000). That is, the form that preceded the Palm Pilot was *not* a PDA but still shared aspects of functionality with it. There were a number of innovative technological elements in the Palm Pilot, such as the invention of the "graffiti" glyph language for stylus-based text input, and "instant on" technology. Palm developed these innovations for their product, without which the design team (led by Hawkins) believed the product would fail in the marketplace, to compete functionally with an agenda.

The forms before and after an innovative design do not have to share structure, but they *do* have to share some essential functional purpose. The Palm Pilot and the leather-bound agenda serve the same purpose, in context, even if the PDA expands on that purpose and opens the possibility of other functions.

Thus, while *form* is what one has at hand, one must really focus on the *function* that the form serves. The extant form is used to understand how the required function is *not* being fulfilled. These shortcomings are the misfits, and they drive the design of a new form.

In cases of high innovation, it may be difficult to identify (i.e. separate) the predecessor form within the context. This is solved by applying principles of systems thinking: entities are marked by boundaries; boundaries are where properties change; so identifying an entity means identifying key properties and then finding where they change. Even the act of drawing different boundaries can be enough to inspire innovation. For example, while the first attempts to build flying machines typically used flapping wings to generate both lift and thrust, success came relatively easily once new functional boundaries were drawn in the situation such that lift (via wings) and thrust (via propellers) were separated.

The Palm Pilot was not the first PDA to be designed, but it was the first *successful* PDA. This is because its designers found an appropriate balance point between all the factors that influence its success: cost, size, functionality, complexity, etc. To find an appropriate balance point, one must identify the appropriate systems, which in turn drives the identification of proper misfits.

The Problem of Form and Requirements

In NSF, Alexander refers often to an example of a kettle, and gives a rather extensive list of requirements that a kettle should satisfy. One of them reads "…should have a handle that…."

Alexander *assumes* that the kettle has a handle – thus implying that at least one design decision has been made (that there must be a handle) by the time the requirements were specified – even though specifying the requirements is supposed to *precede* designing. This is a logical contradiction. There may have been constraints on the kettle design problem requiring a handle, but this is not indicated in the text. This kind of logical contradiction is common in NSF; the kettle's handle is just one example of it.

More appropriate requirements would be functional, not structural, in nature; they would be more appropriate because they would make no assumptions about designed form. Two examples of how this might have been done for the kettle's handle include the following.

1. [The kettle must be such that] a person can easily carry/lift the kettle. (This begs questions about the capacity of the users, how far and how often they carry/lift the kettle, etc. Such questions should be answered with constraints.)
2. [The kettle must be such that] a person can pour the kettle's contents. (This begs questions about the position/location of the thing receiving the poured contents with respect to the kettle and its user, the rate of pour, etc. Again, these should be answered with constraints.)

There are other possibilities. The point is, however, that Alexander's requirements are not good ones. The lack of good requirements undermines his argument. However, one can recover, and at the same time refine, the overall process as follows.

Clients and users do not really know what they want. Designers serve that purpose. Clients and users *are* very good, however, at identifying what is wrong in how things are, what is wrong with the "as is" ensemble. This is precisely what misfits are for, so they are ideal for capturing what clients and users find wrong with the current situation.

However, designing requires production of form to suit function. An informal description of a process that can achieve this goal is discussed in a subsequent section.

Abstract Categories of Requirements

Alexander correctly observes in NSF that requirements are in practise often grouped according to abstract concepts like "safety" or "durability," and that such categorization is not helpful because it is arbitrary and constructed entirely by the needs of the designers rather than the needs of the situation for which the designers work. The arbitrary nature of the categorizations that designers impose only obscure the nature of the problem, which exists in an ensemble independent of the designer.

The author agrees with Alexander, that categorizations should be driven by the available information and not by the designers' needs or beliefs of what the categorization "should be." While the act of balancing will naturally include the designers' experience and perspective, the forces that are to be balanced must be those "observed" to exist in the extant ensemble.

Decomposing Misfit Networks

Much of NSF is devoted to establishing how and why networks of misfits should be decomposed and partitioned into a hierarchy. Alexander went so far as to develop software that could perform such decomposition and structuring work for a given misfit network – e.g. (Clark and Elms, 1976). Others, such as (Elms, 1983) and (Owen, 2007) have since tried to improve on Alexander's work.

Alexander states the purpose for decomposing misfit networks as follows. “We now have a graph G(M,L) which represents the design problem. …to solve the problem, we shall try to decompose the set M in such a way that it gives us a helpful program for design.” In other words, the decomposition is to help guide the designers to a solution.

However, to do this, he and all the others who have built upon his work rely on *cutting* certain links between misfits in the network graph to construct the needed hierarchical structure; this means that some relationships are ignored. Naturally, significant effort is made to identify the “weakest” relationships – those that can hopefully be ignored without invalidating the network graph itself as a representation of the design problem. More precisely, the graph is cut where the smallest damage to the network, and the greatest decrease in complexity, can be achieved. The complexity of the algorithms is driven by the need to identify those specific cuts.

The current author finds this approach problematic. In general, there is no way to know *a priori* what the impact of any change to a problem definition will be on the fitness of a designed solution. Alexander himself devotes a significant portion of NSF to arguing that design should be led by the facts, the data, the available information; so, to ignore information simply for the benefit of the designer seems inappropriate. One might make such an argument if a complete problem (as modelled by a misfit network) were demonstrably intractable – in which case, an approximate solution could be better than no solution at all – but no such demonstration is made.

There is another approach that should be able to help control complexity and organize design problems to facilitate their solution without ignoring any of its elements: a hierarchy of systems based on functional interactions, such that higher level functions emerge from, but are not necessarily directly produced by, constituent subsystems. This approach is based on recognizing properties of the entities described in a problem (the ensemble) in functional terms, and does not impose arbitrary structures on that problem. More information on this is provided in a subsequent section.

Setting these matters aside for the moment, let us examine Alexander’s two criteria for what constitutes a good misfit network decomposition, to determine if they are still reasonable given the preceding discussion.

First, with a good decomposition it must be possible to find “constructive diagrams” for each subset of misfits *individually*. This is what programmers call *encapsulation* and is inherently addressed by systems thinking, wherein a system is crisply demarcated by its boundaries with the environment and that one can swap one system for another so long as its interface (how it exchanges things with other systems) is the same.

Alexander also writes that a subset of misfits must “cohere somehow” and suggest “a physical aspect or component of the form.” The current author believes Alexander intends a coherence based on function: misfits in a set must all be functionally connected – which in turn would suggest kinds of forms. In this interpretation, systems, being functional entities, clearly fit well in Alexander’s approach.

Alexander’s second criterion is that a “useful” decomposition must be such that the representation (i.e. constructive diagrams) of a combination of two subsets of misfits must be “derived…in some simple way” from the representations of the two subsets.

This suggests that there must be a relatively straightforward superposition of representations to combine two sets of misfits. This in turn suggests that all the requirements (defined by misfits) must be known before a design solution is started. This is not generally possible because many requirements of lower level solution elements (e.g. the parts and sub-assemblies of a physical product) are derived from a combination of higher-level requirements plus design decisions that were made earlier in the process. This *co-evolution* of problem and solution (Dorst and Cross, 2001) is necessary because every design decision alters the specifics of the design problem.

However, it appears that Alexander is following a “waterfall model,” for instance when he writes in NSF that a decomposition must occur *entirely* before solutions are sought, which is not effective in design situations.

We can salvage this, however, if we admit a systems-based hierarchy. If we focus on only the requirements of one system at a time, and design as much as possible for it before moving to its subsystems, then we can implement co-evolution. At the same time, Alexander's misfit-based approach can be applied *to each level* in turn.

Thus, the author believes that a systems-based approach to misfit organization satisfies both of the requirements set forth in NSF for acceptable decomposition methods.

The author has identified one other problem in Alexander's method of combining subsets of misfits. His method does not seem to address that some properties of combined subsets are neither endemic nor constituent of the subsets; rather, these properties *emerge* from the combination itself. These emergent properties are very important for design. A systems-based approach treats these properties by associating them only with particular systems and not necessarily with their sub- or super-systems. For example, the drive train of an automobile enables the emergence of a key property of the automobile (its ability to move) without providing the property *per se*; but without the engine, that key property is not available.

Relative Independence of Requirements

Let us return to the sample requirements in NSF that Alexander gives for the kettle. Two of them are: "…must be comfortable…" and "…must be economical to heat." Alexander ponders the apparent independence of these two requirements, writing that it is hard to see if and how they relate.

Requirements can be uncoupled but still become coupled in a specific design; this is because the structure of the design may cause coupling to emerge only in that context. Borrowing from Suh's Axiomatic Design (Suh, 1990), one can demonstrate that one can decouple requirements by choosing the "right" design. That is, while it certainly is possible to develop functionally coupled requirements, truly uncoupled requirements depend on both the requirements *and* the design solution. This is evident in the kettle example: requirements that explicitly mention, for instance, the kettle's handle, create structural coupling that may not be present if the requirements were first treated functionally. The author believes this feature of how requirements couple via a design explains the uncertainty that Alexander expressed in NSF.

The distinction between functional and structural aspects is also evident in Alexander's own words: "Some sets of misfits, in view of their interactions, seem naturally to belong together, and, taken as units, suggest physical form very strongly." If there is a justifiable reason for using a certain form that causes requirement coupling, then so be it. It is still better, though, to be given the choice of deciding whether such a form is in the best interest of the designed object's users. To ensure that the designer at least has the opportunity to choose, it is important to distinguish between the form and the function – particularly in the requirements (or misfits) – so that coupling is not artificially introduced.

Balance, Misfits, and Systems

The foregoing sections presented a number of problems that the author has identified in NSF, and has suggested another approach, based on *balance* and on *systems thinking*, that could address those problems. In this section, the author will describe some further details about this balanced system approach.

A system is a set of interacting elements (which may be other systems) that provide defined functions and is crisply distinguished from its environment or context (Karnopp et al, 1990). Systems thinking is based on viewing a domain of interest as consisting entirely of systems. Systems encapsulate function, and interact physically by exchanging mass, energy, and information. System properties emerge from the interactions of subsystem elements with the system's context (which includes other systems). Changing the location of system boundaries can completely redefine the functionality and purpose of a system. A system that interacts with its context well is one that *balances* properties of the context with properties available by the system itself. The author has discussed the notion of balance in design elsewhere (Salustri et al, 2009).

The author therefore proposes that designing start with a study of the "forces" that exist in a given situation. These forces may be economic, technological, or based on needs and desires of clients and users; they may be beneficial forces or forces that give rise to misfits.

The needs and desires must be described in terms of what is "wrong" with the current situation. This requires identifying the properties that are perceived (by the designer working together with clients, users, and other stakeholders) to change in some detrimental way. Boundaries are marked where properties change. For instance, sufficient productivity at one point in a production process may become insufficient at another point; the boundary lies between those two points and identifies a poorly balanced property of one of the systems. Similarly, the layout of some architectural space may be sufficient for one population of users, but not for another; here the boundary lies between those two populations, and marks a lack of balance between the space and the user population.

Boundaries mark the interface between systems. By first identifying the boundaries, one can use them to derive systems that emerge from the situation rather than from some preconceived, arbitrary organizational structure.

Each system thus identified may be further decomposable, depending on the nature of the situation, into subsystems. Such decompositions should be again based on the study of the actual situation rather than what the designers think should be present. This results in a hierarchy of systems. Each level of the hierarchy can be a network of systems, but because the details of each system are encapsulated within them, the interactions will tend to be far fewer than has been suggested by Alexander.

This hierarchy of systems must then be functionalized (that is, changed into a network of functions, without reference to form, but still situated within the given context). When functionalizing a system network, each form element (e.g. the kettle's handle) must be treated separately because there may excellent reasons for some specific element to remain in the network. Examples of such reasons include: the client may be unwilling to assume the risk associated with removing a particular form element; or there may be safety regulations that require a particular element to be present (e.g. electrical cut-off switches, bulkheads, or warning signs). There is no way to know *a priori* if a complete functionalization of a network is possible; however, the more functionalized the network is, the less likely it is that the design situation will be over-constrained with arbitrarily assigned forms, and therefore the more likely that a good design solution will be found.

One then studies each level of the functionalized system hierarchy in turn. At each level, some interactions between systems may be quite beneficial, while others are in some kind of conflict. Those in conflict are equivalent to Alexander's misfits. Our goal then becomes to re-balance the systems to eliminate – or at least minimize – the conflicts, while causing the least detrimental change to the beneficial interactions. This requires, as Alexander has proposed in NSF, to build a network of relationships. Instead of just a network of relationships between *misfits*, though, we need a network of relationships between *properties* (i.e. including relationships that show good fit and not just bad fit). We do this one level at a time in the system hierarchy, so that we can use encapsulation to temporarily ignore the details that would cause the overall problem to become intractably complex. The details of methods suitable to assist in balancing an unbalanced system are still being developed by the author; their discussion goes beyond the scope of this paper.

The author is currently working on a demonstrative example of this approach, derived from the kettle example in NSF. Although the example is still a work in progress, it has some features that may help illustrate the balanced systems approach suggested above.

For example, if we begin by considering the kettle as a single system (i.e. we do not refer to its constituents, only to the kettle as a whole), the number of its basic functional requirements are very few: to allow water to enter it, to heat the water it contains, and to allow the water in it to come out. The *extents* to which these functions are exhibited are specified with constraints that arise from the context of the kettle-system. For instance, the amount of water to be contained by the kettle would depend on the ways in which it is to be used. If its capacity is not consistent with its use, then the design is not balanced. To re-balance it, either the kettle's capacity must be changed, or the kettle must be re-tasked to a different context.

Since the kettle's purpose is to provide hot water, we can describe its major functional elements (subsystems) as: an access system (to get water into and out of the kettle), a heating system, a containment system, and a control system (to control the kettle's dynamic behaviour). These subsystems interact to produce the required overall functions of the kettle. At the level of subsystems, further balancing will be required, but only insofar as interactions between specific subsystems are concerned.

Much more work remains to be done on this approach. However, insofar as it has been specified to date, it does appear to lend itself well to help structure design problems to facilitate creative design solutions.

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Co-design in Public Spaces: an Interdisciplinary Approach to Street Furniture Development

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Abstract

Cities are developing at a rapid pace. As a result of this growth, the importance of public spaces has increased. This paper intends to discuss the role that elements such as street furniture play in this context, whilst proposing a specific design approach to develop them. It attempts to analyze the distinct user-product relationship between people and the objects that occupy urban areas, and suggest ways to improve it. Co-design emerges as an alternative to involve all the stakeholders in the design discussion. The lay public, city planners, politicians and designers are invited to participate in the creation of pieces of street furniture. The interdisciplinary aspect of co-design becomes evident, once each actor contributes to the process with a different perspective on the urban spaces' needs. The association between co-design and street furniture development promises to be very beneficial to public spaces. Some of the positive outcomes of this association may be reduction of vandalism and urban alienation, and the enrichment of the community life. The co-design process affects, however, the roles that the referred actors play in the traditional context, and depends on the compromise of some power structures to be successful.

Keywords

co-design; co-creation; interdisciplinarity; public spaces; street furniture.

Approximately 3.2 billion people live in urban areas today (Kries, 2006). Whilst cities are developing and growing, public spaces are acquiring increasing importance. The urban elements that occupy these areas deserve major attention from designers, city planners, politicians, as well as the lay public. This paper aims to analyze the distinct user-product relationship that evolves from the interactions between the people and the elements they experience in public spaces. Since this relationship is not exempt from deficiencies, the study also intends to identify problems that might interfere with it as well as suggest ways of improvement.

Since community design approaches have met with success, it makes sense that co-design may emerge as a possible tool for street furniture development. Through literature research, this investigation attempts to explore the principles of co-creation, while analyzing their applicability to this context. Considering that co-design implies the participation of non-designers in the design process, the discussion about the roles that the lay public, politicians, city planners, and designers would assume in the co-design process becomes necessary. Designers share the creative process with the public, who is the *user* of the products. The non-designers are the most interested in the improvements of the urban areas. The changes depend, however, on the decisions of city planners and politicians, also referred to as the *choosers*. All of these actors play an essential role in this context and are invited to participate in the co-design process, using their distinct knowledge to complement the interdisciplinary experience.

The possible outcomes of the association between co-design and street furniture development are evaluated. Improvements such as the reduction of vandalism and enrichment of the life of the community are some of the advantages that the involvement of all the stakeholders in the creation of urban elements can promote.

Context

The relation between industrial designers and the urban space is recent. Even though today designers create urban furniture, playgrounds and parks, guidance systems and means of transportation, it was just in the course of the 20th century that they started to take responsibility for issues related to the city (Kries, 2006). According to Kries (2006), design received a great impetus in the post-war era. It was necessary to reconstruct the destroyed cities, and industrial designers, who before would collaborate with architects and urban planners, started to play an independent role, complementing the pragmatic and rational tendencies of Modernist architecture and urbanism.

From this time to now, much has changed. In 1950 there were 86 cities on earth with over one million inhabitants, today there are 400, and in 2015 there will be over 550 (Kries, 2006, p. 23). Cities are developing at a rapid pace, and it is clear that this growth poses challenges for designers. New demands on the design of public spaces are evolving and these professionals must be prepared to create products that satisfy the *users*' new needs. Kries (2006) exemplifies some of the new trends in public spaces by stating that “wireless Lan hot spots allow us to work and communicate anywhere within public areas” and “plasma screens and other façades transform high rises into communicative structures” (p. 23).

The new demands also affect the objects that occupy the urban areas: the urban elements. Creus (1996) defines urban elements as “objects which are used and which are integrated to the urban landscape” (p. 6). The expression ‘street furniture’ is commonly used to designate these objects as well. In this paper, both terms will be utilized as synonyms. In this category one can include benches, chairs, streetlights, flower boxes, bus shelters, bicycle racks, and litterbins, among others.

The importance of the urban elements to cities is evident. People are sometimes so accustomed to having them around that they do not even notice the role these elements play in their daily life. The significance of street furniture is strongly connected to accessibility. Urban elements make “the city accessible to everybody and easier to get around in” (Creus, 1996, p. 9). Ramps and sign panels properly situated can facilitate the public’s locomotion and orientation. Pieces of street furniture also help people effectuate their everyday activities. Bus shelters, streetlights, and bicycle racks can be cited as crucial elements to support their common needs.

The function of stimulating the use of public spaces can be attributed to the urban elements. They are capable of providing these areas with a comfortable and attractive aspect. In this sense, they are able to aggregate people (Figure 1). Benches and tables in squares and parks fulfil this purpose. Contributing to the cities’ identity is another function that street furniture can assume. Urban elements lend a city its identity, making it recognizable to us (Creus, 1996, p. 6-7). This idea becomes very clear when considering cities such as London and Paris. Britain’s red telephone booths and Paris’ metro entrances have such a strong character that they have developed a symbolic function. If these elements were removed, these cities could have their identity compromised.

Figure 1 Example of pieces of street furniture that aggregate people

In the context of this investigation, the *user* of the urban elements assumes considerable importance. Identifying the specificities of this user-product relationship is, therefore, necessary. Creus (1996) highlights the fact that *users* do not choose urban furniture by noting that “unlike indoor furniture, *users* do not buy urban furniture and, therefore, maximum citizen comprehension of the elements has to be worked at" (p. 8). Malt (1970) also points out some aspects of the relationship between the public and the street furniture. He defends the idea that "the consumer, literally, the man in the street, never sees a variety of shelf goods" (p. 41). The *users* neither do comparison-shopping, nor are allowed to exercise the traditional veto of the market place.

At this point, it is important to understand who takes the decisions on public planning and how these decisions are made. Normally, city planners and politicians, also referred to in this paper as the *choosers*, are responsible for decisions regarding the public spaces. These decisions are often made without the knowledge and participation of the lay public. King, Ferrari, Conley, and Latimer (c1989) refer to the term urban alienation to define the lack of opportunity that the actual *users* have to participate in the design discussions. According to them, when people who are the most affected by the changes are not involved in the planning practices, they are more likely to be alienated. Alienated people do not feel that public spaces are part of their lives. In the same way, they do not feel related to the objects that occupy these areas. For this reason, acts of vandalism are closely related to urban alienation.

The solution to this situation might be public participation. King et al. (c1989) defend that "public participation reduces the vandalism and enriches the life of the community" (p. 163). In spite of the controversial response to the authors' claims, a shift in the contemporary design approaches suggests that the user involvement is highly important to longevity of product design solutions. As stated by Sanders (2005), "it has become increasingly evident that everyday people are no longer satisfied with simply being 'consumers'; they want to be 'creators' as well" (p. 5). This paper presents co-design as an interdisciplinary form of street furniture development in which designers, *users*, and *choosers* are involved.

Co-design in public spaces

The co-design process

Stappers & Sanders (2008) have identified a trend in the practice of design. "Designers have been moving increasingly closer to the future users of what they design" (p. 5). Furthermore, there has been a change in the focus of the emerging design practices. They centre on people's needs and societal needs. Co-design principles, stimulating the participation of the user in the development of design solutions for a group of people or the whole society, fit these tendencies perfectly.

Although practices such as co-design and co-creation seem to be relatively new, they have been used for nearly 40 years (Stappers & Sanders, 2008). Since the 1970s, research projects on participatory design have been developed in Europe, mainly in Norway, Sweden, and Denmark.

Stappers & Sanders (2008) define co-design as "the collective creativity of designers and people not trained in design working together in the design development process" (p. 6). They defend that co-design is a specific form of co-creation since the collective creativity is applied across the whole span of a design process. Kleinsmann (as cited in Kleinsmann & Valkenburg, 2008) developed a different definition, which emphasizes the interdisciplinary aspect of the process:

> Co-design is the process in which actors from different disciplines share their knowledge about both the design process and the design content. They do that in order to create shared understanding on both aspects, to be able to integrate and explore their knowledge and to achieve the larger common objective: the new product to be designed (p. 370-371).

In this paper, it is suggested a comprehension of co-design that results from the combination of the two definitions above. Co-design may be considered, for the purpose of this study, as an interdisciplinary process that involves designers and non-designers in the development of design solutions.

Co-design differs from user-centred design mainly in the role that the *user*, the researcher, and the designer play in the design process. According to the classical user-centred design process, the *user* is a passive object of study, the researcher brings knowledge from theories and complements this knowledge through observation and interviews, and the designer passively receives this knowledge, interprets it and uses it to generate ideas, concepts, etc. (Stappers & Sanders, 2008).

Stappers & Sanders (2008) explain that “in co-design, on the other hand, the roles get mixed up: the person who will eventually be served through the design process is given the position of ‘expert of his/her experience’” (p. 12). There is “a shift in attitude from designing for *users* to one of designing with *users*” (Sanders, 2002, p. 1). The researcher supports the *user*, providing tools for ideation and expression, and the designer develops tools for ideation in collaboration with the researcher and gives form to the ideas. Many times, the designer and the researcher are the same person.

Again, the interdisciplinary nature of co-design becomes evident. If interdisciplinarity is an “individual as much as a group affair, with team members allowing the perspectives and methods of others to interpenetrate and influence their thinking and understanding of a problem” (Sillitoe, 2004, p. 14), co-design is a perfect example of interdisciplinary work, where designer, researcher, and *user* work collaboratively in order to reach a common goal. The concept of interdisciplinarity, however, becomes broader in this context where it not only results from the union of different academic disciplines, but from the combination of different perspectives on a problem or topic.

Although the *users* do not represent a specific discipline in the co-design process, they contribute with their valuable knowledge about their experience to the process, and evolve as a key element. Sanders (2005) discusses the changes in the way designers think about people (Figure 2). If in the 1980’s they were referred as customers and consumers, in the 1990’s, they started to be seen as *users*, participants, and adapters. In the 2000’s, with the participatory approaches, people are considered co-creators and are invited to participate in the actual designing. In order for this to happen, the users’ knowledge has to be considered as important as the knowledge of the other professionals in the team, which can be an obstacle to the co-design practice.

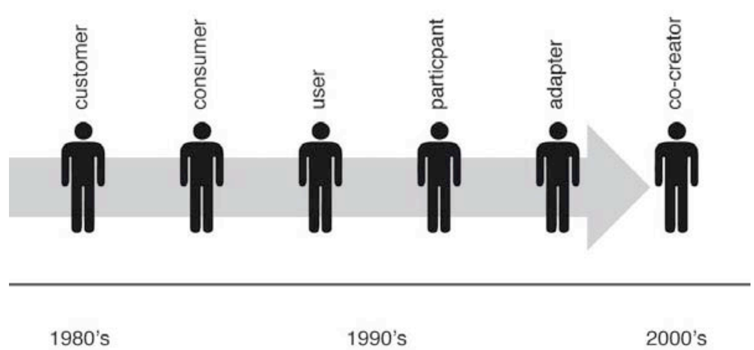

Figure 2 Changes in the way designers think about people (influenced by Sanders, 2005)

The co-design practice faces many other hurdles. As stated by Stappers & Sanders (2008), a premise for co-creativity is the idea that all people are creative. This idea is not commonly accepted, mainly by the business community. In addition, “co-designing threatens the existing power structures by requiring that control be relinquished and given to potential customers, consumers or end-users” (Stappers & Sanders, 2008, p. 9). Distributing and sharing the control is not easy for businesspeople who have been in control for a large period of time. Trained professionals are willing and eager to carry out their roles and are very often unwilling to accept input from lay people (Iacofano, Moore, & Goltsman, 1988, p. 78). Furthermore, “participatory thinking is antithetical to consumerism” (Stappers & Sanders, 2008, p. 9). Many companies base their sale strategies on convincing consumers that they will be happier buying their products and co-design does not interest them. Finally, co-creation is often seen “as [an] academic endeavor with little or no relevance for the competitive marketplace” (Stappers & Sanders, 2008, p. 10). This view on co-design is starting to change, in part because of the successful collaborative experiences between companies and universities. The groundswell of interest in ‘open source’ design has also contributed to a better acceptation of co-design, which becomes very clear in the Internet context. According to Sanders (1999), “new computer tools and applications have made self-expression through personal websites accessible to everyone with the time and desire to build one” (p.6). More recent studies reveal that “over half of all on-line American teenagers create their own content” (Sanders, 2006, p. 31).

Co-design experiences related in the literature have in many cases focused on healthcare environments and products. On some occasions, they had the purpose of improving the quality of life of people with certain diseases (Clemensen, Larsen, Kyng, & Kirkevold, 2007), or ameliorating nurses' workplaces (Stappers & Sanders, 2008) (Figure 3). In other cases, co-design principles were applied to contexts such as farms (Stappers & Sanders, 2008: 11), and learning environments (Druin, Stewart, Proft, Baderson, & Hollan, 1997).

Figure 3 Nurses co-creating a concept for ideal workflow on a patient floor (Stappers & Sanders, 2008)

King et al. (c1989) define co-design as "a combination of community, cooperative, and collaborative design" (p. 3) and affirm that architecture has been a community concern since the early days of our society. According to them, the exclusion of community from the creation of its architecture results in social alienation, and inhuman environments. Collective creativity, on the other hand, "causes neglected public buildings and open spaces to come alive and vandalism to cease" (King et al., c1989, p. 3).

As previously mentioned, this view was perceived as controversial. Nonetheless, it is possible to state that street furniture should be a community concern now. Urban elements support the community's activities, and should be designed according to the community's needs and values. It would be interesting to evaluate if co-creation in the development of these objects may also be a solution to alienation and vandalism.

The user, the chooser, and the designer

In the context of urban spaces, three actors assume crucial importance: the *user*, the *chooser*, and the *designer*. Stakeholders in the public spaces' issues, they are invited to participate in the development of street furniture, providing their distinct knowledge to the co-design process. The advantages of transforming an activity that was before practiced only by designers into an interdisciplinary collaborative process are related to a better comprehension of the *users*' needs, and the development of realistic solutions that can be more easily implemented.

The roles that lay people, city planners, politicians, and designers assume in the proposed co-design process are debated in next sections.

The public

The *users* of the urban elements assume the role of co-designers. They become a critical component of the process (Sanders, 2002), participating in "knowledge development, idea generation and concept development" (Stappers & Sanders, 2008, p. 12). Undertaking the position of 'experts of their experiences' (Stappers & Sanders, 2008), people contribute to the process with their knowledge about their way of life, the site values, history, and circulation (King et al., c1989). They are able to inform the functions that the urban elements must accommodate. They also better understand the activities that take place in specific public areas as well as the time of the day that these spaces are used. Finally, they know the local history in depth. This information is crucial to the development of urban elements that meet the community's needs.

In order to participate in the design process, the *users* must be given appropriate tools to express themselves (Stappers & Sanders, 2008). King et al. (c1989) suggest the use of an artist as a facilitator who draws the participants' ideas. More recent research, however, focuses on the development of other co-designing tools and techniques such as three-dimensional toolkits (Stappers & Sanders, 2008) (Figure 4) that allow common people to communicate their own ideas. In the case of Figure 4, the non-designer participants were primarily nurses whose experience with circulation and access to equipment, supplies, and patients was essential to the design.

Figure 4 Nurses co-designing the ideal future patient room using a three-dimensional toolkit for generative prototyping (Stappers & Sanders, 2008)

The city planners and politicians

These actors are not commonly cited in the co-design literature. Nevertheless, they should also take part in the co-design process in this context. As stakeholders in urban spaces' topics, they are capable of enhancing the interdisciplinary collaboration for the development of street furniture.

The inclusion of politicians in the process is important to "create a climate in which government action can realize community ideas" (King et al., c1989, p. 25). The planners can guarantee the continuity of the discussion on the strategies that follow the workshop (King et al., c1989). These actors provide knowledge on governmental policies, interests and restrictions, a subject that other participants are normally not familiar with.

The designers

The designers are responsible for developing the tools and methods for generative design thinking (Stappers & Sanders, 2008). These tools will support the *users* in the expression of their ideas. Designers also analyze and interpret the *users*' ideas and use them as a source of inspiration and innovation. They provide expert knowledge on existing and new technology, production processes and business context that the other stakeholders do not have (Stappers & Sanders, 2008). Taking into consideration the information and ideas provided by the other stakeholders, they design the final product that will meet the *users*' needs and the *choosers*' criteria of decision.

The outcomes of the association between co-design and street furniture development

The outcomes of the association between co-design and street furniture development promise to be very positive. The proximity between the lay public and the designer may result in a better comprehension of the *users*' needs, and can certainly improve design decisions about urban elements.

Since they are considered everybody's spaces, public areas are democratic by nature. They are, therefore, environments conducive to the acceptance of principles of idea sharing and to the democratization of the opportunity to create, which are important requirements to co-design. Furthermore, the distinct user-product relationship in these cases is not related to consumerism since pieces of street furniture are neither exposed in shelves nor participate in the exaggerated consumption dynamics. Again, urban spaces seem to be an ideal context for the development of these kinds of activities.

There are some examples in the literature that relate effective cases of use of co-design in public spaces. According to King et al. (c1989), public participation curtailed vandalism in Wessburn Park, Burnaby, British Columbia, 1977. By painting murals over the entire exterior of a community centre, children reduced the incidence of acts of vandalism in the proximities because they started to use the area intensely and care for it vigilantly. The same authors (c1989) affirm that community based design has improved community life in many cases. The collaborative experience encouraged people that had never talked to each other before to begin talking and listening. After workshops, community members interact more, which can also enrich community life.

The democratization of the innovation permits that *users* “develop what they want, rather than relying on manufacturers to act as their (often very imperfect) agents” (Von Hippel, 2005, p. 1). Likewise, the democratization of the development of street furniture pieces also allows the user to create what they want and need. It certainly guarantees a better comprehension of the product by the user. Furthermore, it enables the community to create their own identity. The products that the community members help create reflect the community's shared values (King et al., c1989), which strongly influences their attitude toward the public objects. As a result, they develop an affective relation with these objects and there could be a reduction of vandalism. The urban alienation also tends to disappear once all members of the community (young people and adults, poor and rich, powerless and powerful) are invited to enter into the design dialogue (King et al., c1989).

Discussion

The debate on co-design practices should incorporate questions about people's disposition to change and adapt to the new trends. Participatory experience is not simply a method or set of methodologies, it is a mindset and an attitude about people (Sanders, 2002, p. 1). Co-design implies a shift in the roles that the actors are used to play. The *user*, the *chooser*, and the designer represent three different views and are crucial to guarantee the interdisciplinary character of the process.

Whilst the public, who is the most affected by the decisions on urban planning, might be very interested in taking part in the process, the city planners and politicians might want to analyze the advantages and disadvantages of being involved in such kind of projects. Although the benefits of co-designing urban elements are clear, in order to participate in the discussion, the *choosers* need to share their power of decision with the other stakeholders in the project. As already mentioned, co-design threatens the power structures (Stappers & Sanders, 2008), and, in this situation, it becomes evident.

Most public involvement programmes fall in the consultation category (Iacofano et al., 1988, p. 78). It is important, then, to emphasize that co-design widely differs from this category of *user* participation (Table 1). Consultation or dialogue is based “on the concept of using *users'* knowledge as a source of information, and asking *users* to comment on the designers' proposal while the design is in progress” (Siu, 2003, p. 72). “Citizen surveys and questionnaires fall into this category” (Iacofano et al., 1988, p.78), which gives the designer the right to make the final decisions concerning the project (Siu, 2003), while the city planners and politicians make the decisions related to implementation. In co-design, the *user*, the *chooser*, and the designer are considered experts. For this reason, the *user* and the *chooser* participate in the design process since its early stages. The designer elaborates proposals with them, and shares the decision-making power with all the stakeholders. Differently from co-design, consultation does not jeopardize the established power structures, and this is probably one of the reasons why this category of *user* participation has been so largely implemented.

	CONSULTATION	CO-DESIGN
user	Source of information Comments on the designer's proposal while the design is in process Does not participate in the decision-making process	Expert of his/her experience Co-designer Participates in the design process since its early stages Participates in the decision-making process
chooser	Expert Makes the final decisions concerning the implementation	Expert Co-designer Participates in the design process since its early stages Participates in the decision-making process
designer	Expert Elaborates proposals Makes the final decisions concerning the project	Expert Elaborates proposals with the *user* and the *chooser* Participates in the decision-making process

Table 1 Differences between co-design and consultation

Another point regarding urban planning must be considered. Malt (1970) investigated the industry of street furniture fragmentation. Even today, many cities are not interested in producing an interrelated line of equipment. Given that the awareness of the importance of the urban elements is still in development, it might be difficult to convince some governments to invest in co-design projects with this purpose. Even though the advantages of involving the public in the process are obvious, changing past habits and thoughts is always a challenge.

Similarly, designers also face hurdles with the advent of co-design. To participate in this process, they have to work collaboratively with *users* and *choosers*. In the past, they used to rely on their individual creativity. Now, the acceptance of the idea that everyone can be creative too is demanded from them. It is just a matter of giving people the right tools to express themselves. In addition, designers are challenged to consider the knowledge that comes from the experience of the *users* as valuable as their own academic and experiential knowledge.

With the evolution of co-design, designers might experience the sensation of “losing [even more] control of the design process” (Sanders, 2006, p. 32). The *choosers* might feel less empowered as well. These reactions are expected when there are substantial changes in the traditional processes. However, the key to the success of co-design experiences in urban spaces is prioritizing the general well being. The stakeholders might need to compromise some power and authority. The benefits to the community and the urban environment, on the other hand, will be considerable.

Conclusion

Urban spaces are a perfect scenario for co-design. Engaging people in the development of urban elements they will use and with which they did not have any previous relationship, might be a solution for under-used and neglected areas with good potential. The co-design process almost guarantees that the final product will meet the public's needs according to their values, the history of the place and the time of the day it is used.

The outcomes of co-design exceed the features of the final product. Co-design workshops enrich the community life, promoting interaction between the community members. They claim a share in the success of the final product (King et al., c1989), and develop an affective relation with it. As a result, it might be possible to note the reduction of vandalism.

The success of the interdisciplinary process depends on the participation of all the stakeholders in the project. In this case, the *user*, the *chooser*, and the designer should be involved in the development of urban equipments. People become co-designers and contribute to the process with their expertise about their own experiences. Their creativity is explored through the use of appropriate tools. The *choosers* participate of the discussion and provide knowledge on governmental policies. They are able to discern viable from unviable solutions. Finally, the designers develop tools for the *users* to express their ideas. They also use these ideas in the conception of the final product.

It is clear that there is a shift in the roles that each actor traditionally plays. A compromise is, therefore, necessary. Instead of keeping their comfortable positions, the actors must share their power of decision, or creative process in order to reach a major goal, which is the benefit to the urban environment.

The changes that are being proposed are huge, but they are already in course. Co-design is being adopted in many contexts, and the idea that when people's creativity is amplified by co-design processes (Sanders, 2006), the results are advantageous to the society as a whole, is being increasingly accepted. Employing co-design practices to the development of street furniture might be a favourable opportunity to improve public spaces. If "all people have something to offer to the design process" (Sanders, 2002, p. 1), one can imagine how many good contributions can be made by common people, politicians, urban planners, and designers working collaboratively to ameliorate cities.

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A Study on Design Careers and the impact of Gender

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Abstract

Many of those entering the design workforce will at one point in time be affected by life choices. Some of these choices are welcomed, however, others are of necessity and are not reflective of personal preference. Life choices such as childcare, career advancement decisions, marriage, leaving the workforce, making a lateral career move, or becoming an attendant caregiver for an incapacitated family member are only a few examples of situations that can dramatically impact the course of a career in design fields. In addition, women and men may be affected differently by these choices.

The purpose of this research is to identify the impact of gender on design careers. The methodology for this research is an online survey of university alumni. The respondents represented a variety of design disciplines. This research found a statistically significant difference in perceived impact of gender on design careers.

Keywords

Design Careers, Gender, Culture, Diversity

This research analyzes and discusses the results of a survey developed to examine the perceived impact of gender by males and females on their design careers. The survey is a collaborative research effort by faculty in graphic design, interior design, integrated studio art, architecture, and the Institute of Design Research and Outreach. The survey will be used to measure the perceived impact of gender issues on design careers based on responses from alumni of these design programs and to analyze the actual impacts that were experienced by these respondents regarding issues such as leaving the workforce to raise children, care for elderly parents, or other life situations.

The results of the survey are analyzed and discussed with regard to how students in design programs could be better prepared for life situations through specific modifications to design curricula. Specifically, the data is discussed with regard to its ability to inform curriculum designs that can better address the life and career needs of men and women in design careers. The information will also be discussed with regard to how it can be used to increase awareness among students about life issues and their impact on design careers.

Literature Review

Existing literature with regard to design, gender and workforce issues was examined to determine what areas of study might improve curriculum in design programs. It was used to identify areas of concern both in design and the workforce in general. This literature review is used to identify ways of better preparing males and females for successful careers in design based on gender relevant information for curriculum design.

Gender Differences in the Workforce

Gender studies in design have shown distinct difference between how men and women are treated in school during the design jury process (Frederickson, 1993, p.38). In addition, Clegg, Mayfield, and Trayhurn say that men and women are differently attracted to various design careers. Perceptions of the dominant disciplinary discourse, they say, influences how men and women choose design careers and suggests how gender constraints define the design field. (Clegg, Mayfield, and Trauhurn, 1999, pp. 43-54).

Sex differentiation and sex stratification have been observed in the workforce. Cognitive psychologists indicate that there is an impulse to categorize people according to factors such as age and gender. This process of marking people by personal characteristics is called social differentiation. Social differentiation in turn leads to the unequal treatment for members of different categories, which is called social stratification. According to sociologists, Reskin and Bielby, all societies use sex as well as age to stratify members across virtually all domains. They also say that these disparities are indicated by more men that women participating in the workforce. And those men average more hours worked per year, hold different and more complex jobs, work in different industries, out earn women, are more likely to supervise workers of the opposite sex, and dominate the top positions in their organizations. (Reskin and Bielby, 2005, pp. 71-72).

These differences and disparities have also been noted in the design industry. Michael Bierut, in a post to the DesignObserver, notes a question that was raised at a panel discussion on book design. The question posed by an audience member questioned why all three panel members: Milton Glaser, Chip Kidd, and Dave Eggers; were men. Glaser offered the following reply:

> "…the reason there are so few female rock star graphic designers is that women get pregnant, have children, go home and take care of their children. And those essential years that men are building their careers and becoming visible are basically denied to women who choose to be at home…unless something very dramatic happens to the nature of the human experience then it's never going to change." [1]

According to Matlow, with regard to gender differences in graphic design education, it is apparent that women experience additional pressures when working in a typically male-oriented environment. They have to work harder than men, be more committed to their work, and become more involved in it. (2000, p.83).

Clegg and Mayfield note that women are under-represented in what they refer to as "hard design" areas such as product and furniture design and over-represented in "soft design" areas such as fashion and jewelry. They identify this dualism as a stereotypical association of women with the body and decorative fields and men with fields in the areas of technology and shaping nature. (1999, p.3).

Even in the realm of business ownership gender differences have been noted. Marlow, Henry and Carter examined the "female under-performance hypothesis" in small business ventures. However, when analyzed it was found that differences exist in how female owned start-up businesses are capitalized with women receiving more costly financing. When female-owned businesses are capitalized in the same way as male-owned businesses there were no differences in their levels of performance (Marlow, Henry, and Carter, 2009, pp.139-143).

In business, according to Lobel and St. Clair, research has been done to explain the differences in job performance and outcomes. The Human Capital Theory describes how voluntary life choices are made in allocating time and effort to tasks such as work or family. This theory has been used to suggest that because persons who are involved in labor-intensive tasks such as childcare and housework tend to select jobs that are comparatively less demanding. This theory thus predicts that because less effort and time is devoted to the job there are fewer positive performance outcomes such as pay or promotions. Another performance difference business theory is the Sex Discrimination Theory which focuses on the idea that men perceive women as a child rearer and as such it is appropriate to scale back their work duties and outcomes accordingly. Both of these approaches of describing the effects of family responsibility on job performance, say Lobel and St. Clair, suggest that family responsibility has an adverse effect on work effort, particularly for women. This limits women's opportunities for positive performance outcomes such as merit increases and promotions. (Lobel, S. and St. Clair,1992, pp. 1057-1058).

An in-depth interview with 48 highly successful women, conducted by psychologist Barbara White, indicated that there are several key commonalities to their success. White found the success of these women was predicated by a high centrality of their career to their lives, working continuously and full-time, fitting their family life around their work, and conforming to male standards of success. One common pattern of these women was to wait to contemplate a family until their careers were well established. If they decided to have children at all, the mean age of starting their families was 33 years old. They also chose to take a minimum amount of maternity leave. Of the women surveyed, 50% had children and reported that they did not see work and family to be mutually exclusive. In fact, they felt that their family was enriching and the time they spent on family was quality time. Other key issues for their success were to achieve promotions and positive evidence of their achievements at an early age. They also noted that they benefitted from a mentor. According to White, 38% of these women said that their abilities had been raised by the support and encouragement of a mentor. (White, B., 1995, pp. 4-15)

Research Methodology

The research methodology involved the development and pre-testing of a survey tool. The survey questions were based on a literature review of existing data about job satisfaction in design careers from research studies done on design and architecture.

Additional survey questions were developed based on research from focus groups with students and faculty groups in design. The survey questionnaires were carefully developed to measure the perceived impact of gender issues on design careers for alumni. The self-administered online survey was conducted through SurveyMonkey in December 2009. Eighty-eight alumni responded and participated in the survey. The survey collected participants' demographic information including gender, age, major, degree, internship experiences, ethnicity, and income ranger per month.

The respondents were all alumni from a Midwest land-grant university with approximately 28,000 students located in a town with a population of 50,000 people. The respondents were all from design disciplines in programs of Architecture, Community Regional Planning (CRP), Graphic Design, Interior Design, Landscape Architecture, Studio Art, Applied Art Education, or double majors in these programs.

Discussion and Findings

The data from this survey will be examined based on gender, age, and discipline with regard to their impact on design careers. The information will be analyzed with regard to those who stayed in design careers, those who left design careers for a period of time with the intention of returning, and those who permanently left their career either for another career, retirement, or unemployment. The information provided by the respondents will be used to identify the impact of gender, job satisfaction, life situations, and other issues on the decision to continue in a design career. Architecture (33%), Graphic Design (21.5%) and Interior Design (18.5%) were the three top survey respondents with a total of 73% of the total respondents.

The Interior Design respondents were all female, while both male and female were represented architecture and graphic design.

Retention in Design Careers

Out of the 88 total respondents, 61 (72.6%) are still working in design-related careers. Of these people still in design careers, 40%are male and 60% are female. However, of these people, 28% report that they left the workforce at some point in their career and 72% report that they have never left the workforce.

With regard to retention of females in their design careers, there were several distinguishing features between the disciplines. In architecture and landscape architecture, all of the female respondents remained in their design careers. However, in graphic design only 79% of the females who entered that career remained in their field and in interior design only 70% of the females remained in that career. By contrast, in CRP only 40% of females remained in their design careers and in studio arts 50% of females remained in their careers.

With regard to retention of males in their design careers, graphic design had 100% retention of males in the career compared to architecture with 87%, CRP with 67%, and landscape architecture with 71%. However, studio art did not have any retention of males in the career as reported by this survey.

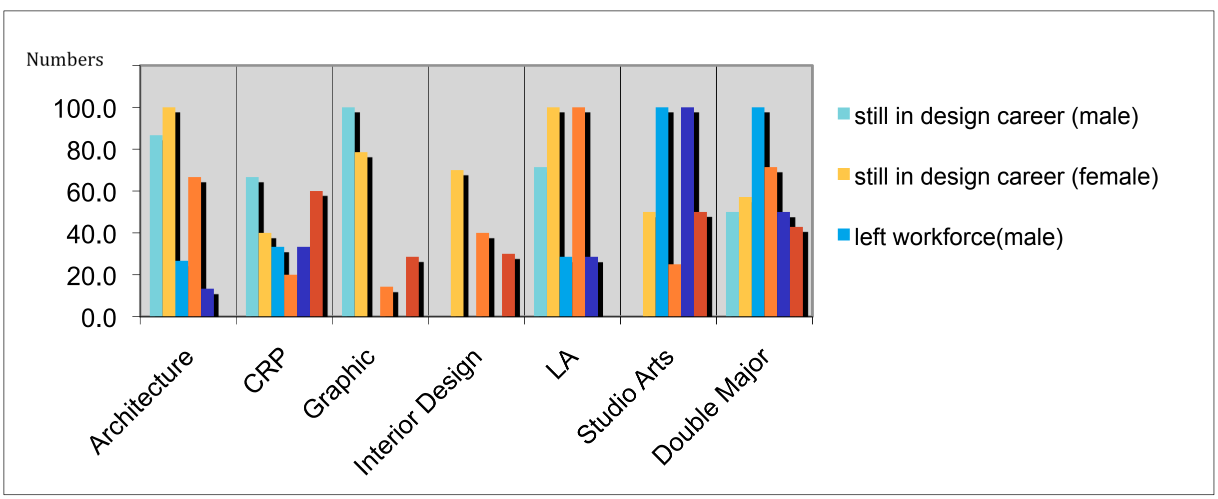

Figure 1. Gender Comparison of Numbers of Persons in Design Careers

Overall, the retention rate of all degrees in design careers was high. This may be related to the fact that 81.4% of respondents who are still in their careers report that they find their work rewarding. Figure 1 compares the percentages of total respondents in each discipline broken down by gender with those who stayed in design careers compared to those who left design careers.

Leaving Design Careers

Leaving a design career can be broken down into two basic categories. First, those who left design for what they perceived to be a temporary period of time and second, those who left design permanently. People who left design careers on a temporary basis did so for reasons such as going back to school, becoming an attendant caregiver, or maternity leave. Persons who left design careers permanently did so for reasons such as retirement, career changes, poor job markets, or unemployment. These reasons for leaving design careers were highly dependent on variables such as gender, age, and income levels.

Leaving Design Careers for a Period of Time

The survey asked respondents about whether they had ever left the workforce. Of males, 34% indicated that they had left the workforce for a period of time compared to 66% of females who indicated they had left for a period of time. Leaving the workforce for a period of time was also greater among those respondents who identified themselves as no longer in design-related careers. The primary reason given for leaving the workforce was returning to school (25%); however, 22% indicated becoming a primary caregiver was their reason for leaving the workforce for a period of time. An additional 12.5% indicated that they left the workforce for a period of time because of family issues.

According to the data in Figure 2, males only indicated leaving design careers for a change in career (29%), retirement (29%), and unemployment (14). None of the females indicated unemployment as a reason for leaving a design career. Women, on the other hand, listed change in career (14%) and retirement (14%) for reasons for leaving design careers. Females also indicated that they left design careers because of a poor job market (50%), limited or outdated job skills (29%), poor pay (21%), and children or family (14%). None of the male respondents indicated any of those four categories as reasons for leaving a design career.

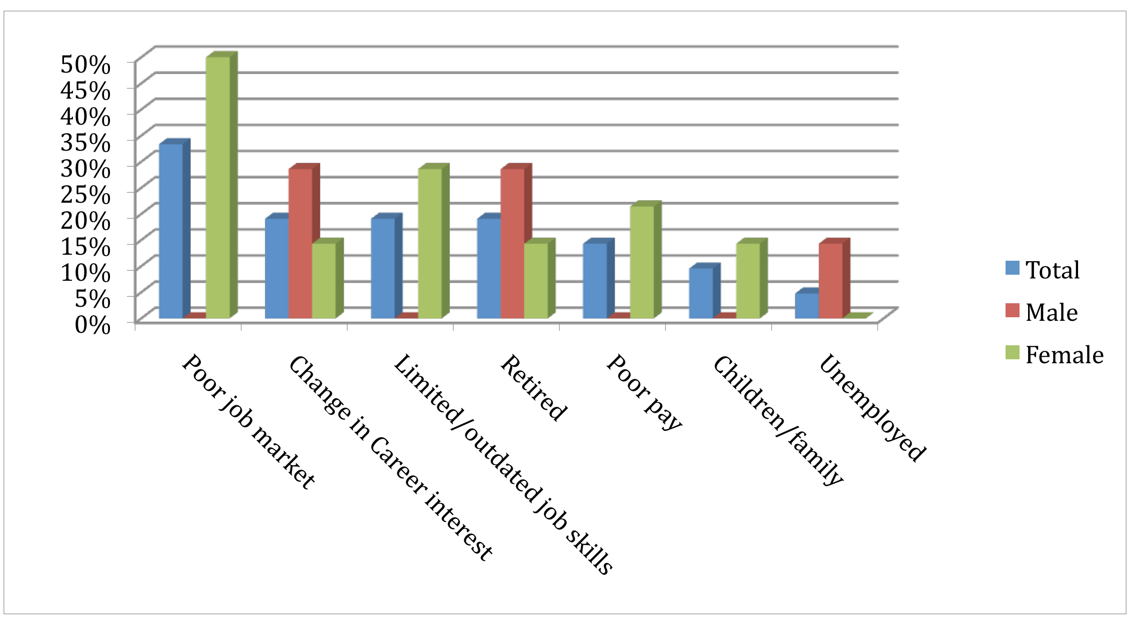

Figure 2. Reasons for Leaving Design Careers by Gender

Respondents No Longer in a Design Careers

The percentages of people who identified themselves as still working in their current field varied greatly by discipline. Architecture had the highest number of respondents who identified themselves as still in their career.

Gender, as seen in Figure 3, had a statistically significant difference between the responses of men and women. Men indicated that they never or were not affected by their gender in the school or work environment. Women, however, indicated that they were uncertain if their gender had affected their school or work environment.

Of the respondents, 27.4% indicated they were no longer in design careers. Males left design to change careers at 35%, females left design to change careers at 65%. The primary reason given for leaving design careers was a poor job market at 33%.

Table 1. Gender Significance for Those who Left Design Careers

	Gender	Number	Mean	Std. Deviation	Std. Error Mean	Sig. level
Gender	Male	8	1.88	0.83	0.30	.001
	Female	15	2.80	1.57	0.40	

Table 1 shows the statistical significance between males and females in how they perceived the impact of gender on their careers. Females significantly think they are more affected by the impact of gender than were their male counterparts.

Comparing respondents in design careers with those no longer in design careers, as seen in Figure 3-3, females are leaving design careers in higher percentages than their male counterparts. This is true when leaving both temporarily and permanently (figure 3-1 to 3-4).

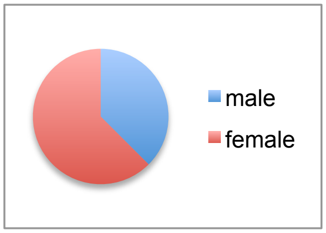

Figure 3-1 All Participants n=80

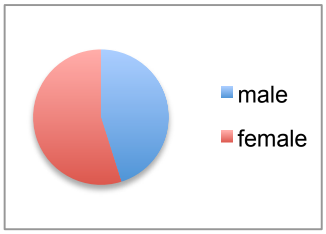

Figure 3-2 still in design career (n=61)

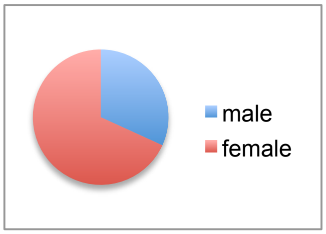

Figure 3-3 no longer in design career (n=22)

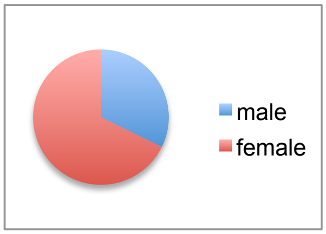

Figure 3-4 left workforce for a period of time (n=31)

Age, as seen in Figure 4, seems to affect the number of people who are in design careers according to a number of factors. The peak age for leaving design careers is between the ages of 36 and 45 (30%). This may be caused by factors such as career change or family issues.

Another peak time for leaving design is between the ages of 56 and 65. This is more likely attributable to retirement. However between the ages of 46 and 55 there is a resurgence of people returning to design careers.

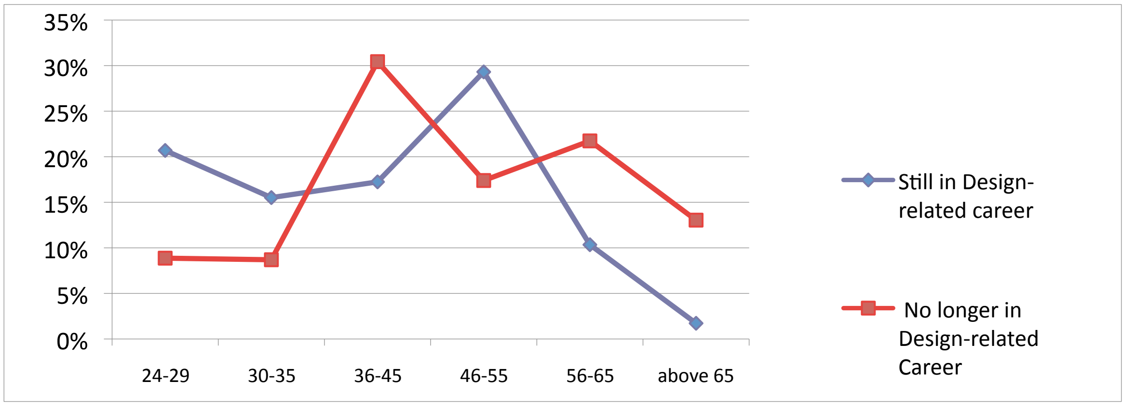

Figure 4. Age Comparison of Persons in Design Careers and No Longer in Design Careers

Respondents in higher income brackets, as seen in Figure 5, were more likely to stay in design careers. Those with lower income levels were more likely to leave design careers. Low income was indicated as a reason for leaving design in this survey.

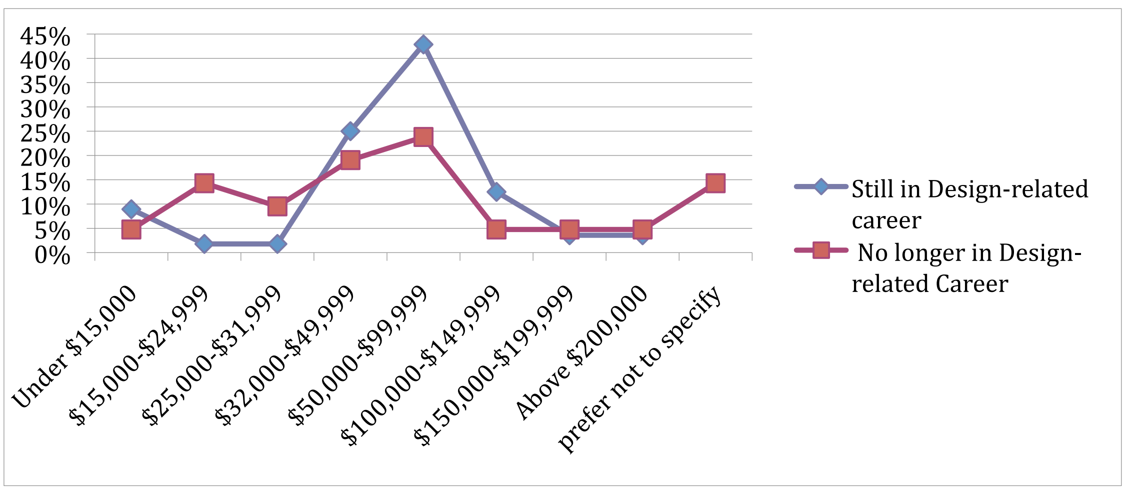

Figure 5. Income Comparison of Persons in Design Careers and No Longer in Design Careers

Conclusions

The analysis in this research is focused mainly on the respondents who left design careers on either a temporary or permanent basis. Leaving the workforce for a period of time, such as for returning to school (25%) or becoming a primary caregiver (22%), was greater among those respondents who identified themselves as no longer in design-related careers. Among those still in design careers, the vast majority indicated that they had not left the workforce even for short periods of time.

Of the respondents who left design careers, women indicated poor job markets, limited or outdated skills, poor pay, and children/family as the top four reasons for leaving design careers. It is possible that temporarily leaving the job market leaves women at a distinct disadvantage compared to their male counterparts in design careers.

Based on this research, design curriculum needs to address the different life situations experienced by men and women. Men tended to leave design careers based on changing careers, retirement, and unemployment. For men, there were fewer obstacles to their success. For this reason, design curriculum seems to be working well in the current business climate.

Because women are greatly affected by temporary leaves from design careers, it is important to equip them with education in areas such as business and entrepreneurial studies. This would allow them another career option other than simply returning to their previous positions. It is also important to provide women with role models and mentors in successful design careers and businesses.

Limitations

The study was limited by the number of respondents and the geographic area. This research was also restricted to the alumni of one university and should be expanded to see if similar outcomes are obtained from additional data collection sites. In addition, this study did not distinguish between part-time and full-time employment in design careers. This distinction may be significant with regard to the final outcomes.

Areas for Future Research

This study will be expanded to include a larger number of respondents from a wider geographic area. It will also include part-time and full-time data sets. From the current data, curriculum changes will be proposed and implemented for further testing with regard to their impact on retention in design careers.

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A Matter of negotiation: Managing uncertainties in an open design process

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Abstract

Designing is a highly collaborative and communicative process. To achieve good results effective teamwork is extremely important. Digital technology makes it possible for this process to be distributed across different spatial locations. Despite the potential of digital networks, commercial systems in the field of Computer Aided Architectural Design remain stuck in old patterns with strict role definitions and linear working processes. Open Architectural Design offers an alternative to this “sequential model” by providing an approach to distributed work oriented around "Open Strategies”. Open strategies facilitate an open exchange of ideas and artefacts with the aim of making better use of distributed resources and realising greater creative potential. The goal of our project is to apply open strategies to the architectural design process. The technical basis for our research is FREAC, a software framework developed in-house which provides a collaboration space for co-operation between different users and tools. This framework is designed not just for exchanging the outcome of the design process but also for opening up the design process itself and making it more transparent. Such highly open and distributed design processes, however, also present new problems and uncertainties which need to be taken into account in order to reach successful design outcomes. As a result proposals for the management of such processes need to be developed that facilitate collaborative work but do not unnecessarily constrain the inherent complexity of the design process. The focus therefore lies on the improvement of the negotiation process between users, tools and architectural design models. The actor-network theory, and other different management concepts, provides a theoretical underpinning for our approach. The project is a collaboration between the fields of computer science in architecture and media management.

Keywords

Collaborative Design; Open Design Processes; Actor-Network Theory; Media-Management.

Contemporary architectural design brings new challenges to the design process: internationalisation, digitisation, increased differentiation between disciplines as well as spatially and temporally distributed working methods. Effective coordination between different participants plays more than ever an important role in fulfilling the complex requirements of today’s building constructions and to achieve high quality results. Although the architectural design and planning process is now almost completely digital, computer-aided spatially distributed collaboration and the associated use of distributed expertise in the key phases of design have still be implemented successfully. While current developments in building information modelling (BIM) are centred around the integrative aspects of a common model, they focus primarily on effective data exchange and maintain a strict division of roles. Although the exchange of data is being conducted at a faster rate than ever before, the working process is still dominated by a linear and sequential pattern. According to the practice of designing, which typically deals with wicked problems (Rittel, 1973), such “a priori” hierarchically organised structures, hinder the emergence of creative processes and innovation.

The potential of digital technology lies not only in the acceleration of already established working methods, but also enables them to be restructured entirely. A good example of how structures are changing across many fields is the emergence of open development methods, e.g. open source initiatives in computer science (Raymond, 2001) or collective intelligence or swarm intelligence in economics (Levy, 1997). These make it possible to access and exploit decentralised skills more effectively. “Open” thereby designates the free exchange of information, licenses, ideas, data and artefacts. How this exchange is designed varies from

case to case. Initial approaches to applying such open strategies to the process of designing are evident, for example, in "Wikitecture" (Chase et al, 2008), the urban planning project "divercity" (Königs et al, 2000) as well as in product design (www.theoscarproject.org). All these projects, however, lack suitable management strategy approaches for successfully facilitating a genuinely open negotiation process. Typical problems include issues of quality assurance and motivation, the enabling of coherent action, the mapping and storage of information and knowledge, and effective communication between actors.

Our goal is the development of techniques and methods to enable spatially distributed design processes based on such open strategies in the field of architecture. A key challenge of the project is to avoid hindering the creative process of designing in digital environments, in other words to create “enabling spaces”. At the same time, it addresses approaches to coordinating processes occurring within these “spaces” without constraining their inherent complexity and unpredictability. In the following we introduce a technical and theoretical foundation that provides insights into how and with what mechanisms such open design processes can be controlled.

1. A technical framework for open architectural design in digital networks

In an open architectural design process the design object is constantly in developement. The negotiation process, in which this object is changed, manipulated, newly created or discarded, is therefore not innately suited to a sequential chain of fixed stages but is instead characterised by simultaneity, plurality and the mutual production of interconnected information (see for example the work of Rittel (1972), Lawson (2006), Schön (1983) and others). Everyone involved is a potential actor that informs the design object by contributing ideas and skills (fig.1).

To exploit such networked expertise as accessibly as possible, a space needs to be created on a technical level that facilitates the act of contributing. For several years we have been developing tools based on our in-house experimental programming platform FREAC (Framework for Enhancing Research in Architectural Design and Communication). This platform provides a flexible data structure for the integration and linking of digital tools. It allows an open exchange and transfer between different users and provides a flexible technical framework for different research projects. The main aspects of this framework are as follows:

Seamless coupling of heterogeneous tools

Almost all collaborative design projects face the problem of having to develop interfaces between different tools. As a result, many projects are limited to an asynchronous exchange of data over the net in the form of web platforms, etc. These “interruptions” reinforce a phase-oriented working method and thus interfere with the flow of the creative design process. To facilitate networking as an open process, it is vital that the barriers between tools are kept as low as possible. Rather than using one complicated universal program, it should be possible to create and use many small, easy-to-use tools that can be seamlessly interconnected and combined as required. The FREAC platform uses a TCP client-server principle to effect communication between these tools. When changes are made to the digital model all clients linked with the server are automatically informed and can synchronise their local models. The resulting seamless coupling of different tools means that every tool can immediately “see” how other tools have affected the model and can build directly on the changes made. It also allows different tools, methods and technologies to be brought into direct relationship with one another, for example to seamlessly integrate a freehand sketching module into a 3D Modeling environment (Schneider & Petzold, 2009). The resulting content is therefore always linked to each other in one or the other semantic form, creating networks of design tools and artefacts. (fig. 2)

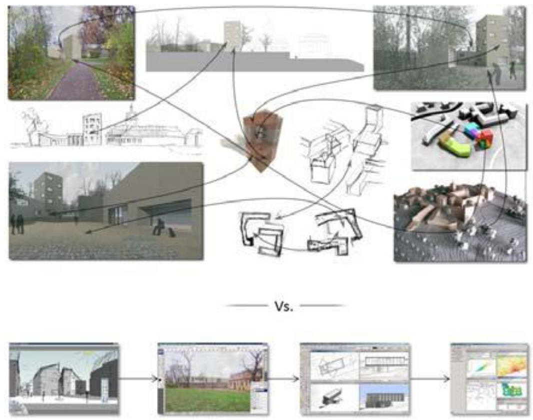

Figure 1 Different kinds of representation condition one another Vs. The Separation of these contents in traditional digital design applications

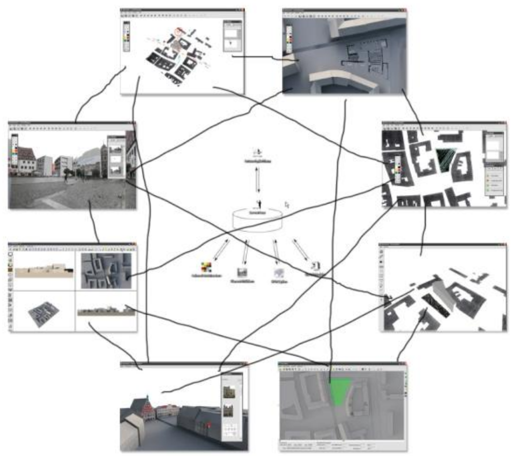

Figure 2 Via FREAC all (connected) tools are interlinked and form a complex network of heterogeneous data / content (video online at: http://vimeo.com/8591465)

Connecting users (seamlessly)

Negotiation processes within spatially distributed design actions is always mediated – by the digital tools as well as the design objects and artefacts created with them. These are stored on a server which all parties are able to access in real time using different tools. The seamless technical interlinking of digital tools and their users enables them to circulate freely and without barriers in the network. Modifications can occur both asynchronously and synchronously at any time creating a smooth transition between individual and group editing and facilitating the dynamic formation of networks (flexible group sizes) of human actors.

Storing processes (automatically)

The FREAC server can handle all kinds of data. Each item of data receives a reference detailing when it was created, with which client and by which user. Each reference can be called up, combined with others and interpreted selectively. To avoid unnecessary data load, the model only changes within the transactions, i.e. only the changes are saved, not the whole model. The aim is the emergence of an ordered structure that obviates the need to structure the data manually.

The technical framework is a basis for the creation and use of (design) tools and creates an open negotiation space for collaborative design projects. In the following, the theoretical foundation (from a management perspective) for capturing, analysing and evaluating designing in open networks is discussed.

2. The actor-network theory as a framework theory for an open architectural design model

The creation of technical networks is simultaneously the creation of social and organisational contexts and spaces of action and negotiation. To coordinate complex negotiation processes in such technical and social networks (different tools, content, users), it is crucial to make visible the processes taking place. The actor-network theory (ANT) is used to describe these multiple interactions between the actors in their necessary complexity. Decisive here is the acceptance of complexity, as a complex open design network is able to respond more innovatively and flexibly to changes and gives rise to creative synergies.

The actors play a key role in the ANT. They represent entities that freely interact within a network and behave in different ways. Their “capabilities lie in how they are able to affect other actors, how they change, transform or produce them” (Belliger/Krieger, 2006). A special aspect of the actors lies in the assumption that there is a coexistence or symmetry of human and non-human actors, who mutually ascribe one another actions (Belliger/ Krieger, 2006). As such, in the process of (computer-aided) architectural design, there are heterogeneous human and non-human actors that act differently within the network and influence one another mutually.

Besides the architect, expert planners and developers, one can also regard design objects, design tools, environmental conditions, laws, norms and institutions as contributing actors in the design process. In the ANT, so-called micro-actors such as individuals and single tools are treated equally alongside macro-actors such as institutions and organisations. While their differences are not denied, the construction of networks helps to uncover their differences and their available capacities and influence. Overall, the resulting design can no longer be seen as the work of a single actor, but as a net-work of all contributing actors, regardless of their importance or size. Although the network gradually stabilises over time, it can be understood as an open network: it is open to ongoing change produced by the participating actors, as well as any new actors that enter the process, and as such is in a state of permanent flux.

During the formation of networks it is assumed that the world is contingent, that is, that it does not have to be the way it is (Belliger / Krieger, 2006). Because they are able to bring about innumerable references and effects that emanate from something, selection processes are necessary to reduce complexity and create order. As each selection of “something” results in the introduction of a difference in the world, selection processes can be interpreted as actions. In the ANT these are generally referred to as translations and not attributed to humans or human-actors. “Translation is a complex process that consists of a number of different communicative acts, all of which are destined to construct a network.” (Belliger / Krieger, 2006). Actors become involved in a network “by ‘translating’ their interests and roles”, that is, by adapting their interests to one another to pursue a common direction. Translations in one or the other form therefore allow some form of cooperative action, since such joint action implies common objectives and interests (Belliger / Krieger, 2006).

Relationships between actors in open architectural design

The ANT extends our understanding of the design process as a matter of negotiation by considering not only human-to-human relations, but also actions that relate to objects. In the ANT, person-to-person relations are therefore complemented by object-to-person, person-to-object or even object-to-object relations, adding new dimensions to the notion of actions in the design process. In the Open Architectural Design process (using FREAC as a basis), the following relations have a significant influence on the digital design process and have therefore been considered in greater detail. Here we should note that the term “designer” refers to any human actor involved in the design process.

Data : tool relationship as an object-to-object relation:
The data : tool relationship describes how tools draw material from the data container and as such assume the role of an active actor in the network. The FREAC server provides an open data container, which can be filled with a variety of data that is then available to all other tools connected. This allows an exchange of heterogeneous information in real time.

Tool : tool relationship as an object-to-object relation:
This level of relationship examines the extent to which different tools interoperate with one another and how they are involved in network formation. The connection between different tools can occur, for example, by visually superimposing different tool contents. It can also occur by directly coupling or chaining the content or algorithms of different tools (e.g., building volume coupled with plan generator). Each new tool may therefore potentially change the structure of the relationships.

Tool : designer as a human-to-object or object-to-human relationship:
With tools, artefacts are created to articulate specific intentions and content, as well as to gain insight into the object to be designed. The designer as a human actor influences the design tool and likewise the design tools influence the actions of the designer. Crucial for designing in the digital space is therefore the ability to effortlessly switch between different tools and action spaces.

Designer : designer as a human-to-human relationship:
In distributed design processes, human to human communications are mediated by digital tools. As such, direct and indirect communication overlap in the interaction. The more "seamless" the connection between various actors within an action space is, the more direct and immediate their participation and their ability to form networks.

Designer : external constraints as a human-to-object relationship:
External factors such as environmental conditions, social-factors, laws, etc., are often difficult to transfer into the digital realm due to their specific context-dependency or their ambiguous form. To make them available to all the actors involved, they have to be translated into the digital model by the designers and the tools available to them.

At a technical (digital) level it is important that the different demands, ideas, constraints, rules, designers and tools can be integrated in a suitable manner to guarantee effective translation processes. The relationships between these actors influence the entire design process, and navigation, mediation and translation processes take place constantly between these heterogeneous components in the network. The more seamlessly they are integrated into the overall process, the more effective negotiation processes can occur and more easier networks can emerge.

3. Accepting and managing uncertainty and complexity in an open architectural design process

Open development methods, such as those suggested here for the creative design process, make it possible to effectively use and process decentralised skills and competencies. A complex network emerges with a high degree of variability (Malik, 1998). The more complex a network, the greater its behaviour spectrum and the more innovatively and variably it can respond to changes. At the same time, however, it is more difficult and challenging to keep it under control. Together with the emerging complexity, different sources of uncertainties appear, which raise questions about how to coordinate them effectively. Bruno Latour addresses, in conjunction with the actor-network theory, five sources of uncertainty in order to highlight the discrepancies between a sociology of the social and a sociology of associations (Latour, 2007). Below, four of these sources are used to address the most important uncertainties that have to be considered in an open design process in more detail.

The first uncertainty according to Latour lies in "the nature of groups". He describes the fact that within a network actors are constantly regrouping, leaving traces that can be analysed (Latour, 2007). Accordingly, a network is never pre-existent but must always be assembled anew through association. It is here that the design process manifests itself as an open network formed by many actors into which many ideas and skills can flow. It is a fluid and constantly evolving network which has no stable structure.

The second source of uncertainty is concerned with the nature of actions. Human activity is not transparent, but a conglomeration of many, often surprising sources which have to be unravelled to be able to make statements about who is in fact acting (Latour, 2007). Accordingly, one never knows who is actually acting. But if individual actions in the design process are difficult to identify, it is also difficult to coordinate and motivate these actors.

The third source of uncertainty – the nature of objects – describes that different threads of action intermingle arbitrarily, so that they rarely consist purely of human-to-human or object-to-object relations (Latour, 2007). Without objects / artefacts, architectural design processes would be unthinkable. Digital tools and the design object itsself have an impact on the perception and the actions of the designers and the entire design proces s, and should accordingly be taken into account for the purposes of effective management.

The fourth source of uncertainty – the nature of the facts – Latour stresses that an object of study should always be understood as a controversial and not as an indisputable fact. In architectural design processes, we are always dealing with unfinished, incomplete and vague constructions of reality. There is, therefore, a permanent need for interpretation, which in turn depends on the experience and knowledge of the actors involved.

The uncertainties discussed above, which occur in an open design process, raise questions about the coordination or management of the heterogeneous elements of a network. Unlike in traditional management approaches (e.g., principal-agent theory), it is not sufficient to search for moments of indeterminacy in only one other subject (Schreyögg, 2003). So how can one coordinate processes that take place in constantly evolving networks in which it is hard to draw conclusions about who is actually acting, where the influence of non-actors must be considered and where interactions occur with artefacts and design objects that are interpreted individually by each of the actors but must nevertheless be identifiable by their core characteristic?

4. Coordinating negotiation processes in open design networks

In our project, FREAC serves as a digital platform that provides the negotiation space for an open design process. For this to work, mechanisms and tools need to be developed to manage this process in its complexity. Based on the aforementioned uncertainties, we examine a series of possible solutions as to how these can be coordinated in a virtual design environment.

4.1. Uncertainty about the nature of the groups

An open design network is characterised by instability and constant change. The coherency of actions and the consistency of the results therefore appears vague because, unlike previous approaches, they do not take place within a fixed structure. The ongoing changes to networks with no predetermined structure are triggered by the free, creative and networked actions of different actors. Human and non-human actors contribute to each other, initiating translation and network-formation processes, changing them, expanding or limiting them. Through the seamless coupling of different tools and the temporally and spatially distributed constellation of designers made possible by FREAC, a high degree of openness and flexibility is created. This openness in the design network must be coordinated to facilitate consistency in action and consistency in results. Bruno Latour assumes that groups are not held together by existing commitments, but that the social network is created by mediators (Latour, 2007). Mediators complement the actors participating in a network. They circulate between the actors, modifying, translating and transforming the ideas of one actor into other ideas. Therefore the actions of the actors have to be mapped. With the help of FREAC these different stages of development are recorded in a process-oriented way. With the information collected, including the intermediate steps and links that were necessary for their creation, navigation techniques have to be developed that make permanent changes understandable and thus possible to coordinate. Individual actors cannot and need not understand all the complex processes of change nor integrate them into their local activities. They select only the relevant change processes and accordingly adapt them for their actions. Their changes are automatically stored and in turn available to other actors and their adjustment processes.

4.2. Uncertainty about the nature of actions

The scope for actors in an open design network is much larger than in a linear design process. However, assigning actions to actors is more difficult and may lead to motivation as well as quality problems. A decreased level of direct external regulation must therefore be compensated for by increased self-control. In addition to a policy of seeing and being seen, digital tools can be used for storing and reading evaluations and feedback. Beyond that, monitoring occurs not only directly but also, and more importantly, indirectly through networked action. As anyone is able to partner with another actor, actors need to react flexibly to one another, continually adjusting their actions and their designs to each other. Monitoring, control and by implication also feedback is therefore already an aspect of the open design process itself. Each actor stands in the centre of observation and is himself an observer of all the others involved. Observation is not limited solely to other human actors, but can also be undertaken by digital evaluation and simulation tools. Feedback from other actors allows the actor to adapt flexibly to the expectations of their environment. As in an open and complex network one is not able to immediately identify who does what at a particular moment in time, open design networks can potentially be seen as a permanent space and stimulus for self-reflection (Bröckling, 2007). Through the seamless linkage of actors and the permanent and automatic saving of changes in the design process, a technical basis is created for such self-reflection and self-optimisation processes. The seamless coupling of actors establishes a 360 degree field of vision, which makes it possible for actors to continuously monitor, evaluate and compare. By recording changes in the design process, it is possible to trace actions to a specific tool, user and point in time.

4.3. Uncertainty about the nature of objects

Digital tools, design objects and other non-human actors such as norms and laws have a significant impact on the overall process, as well as on human action and human perception. Here we need to consider the affect of individual tools and the impact of their limited functionality and action-space in the design process. The use of a tool of any kind sets up a temporary ‘world’, which is limited or defined by the scope of the respective tool (its functionality) and its compatibility with other ‘worlds’ (which in turn are the product of other tools). For example, while using a volumetric modelling tool, one can design volumetric models and is therefore restricted to this view. Since the process of designing occurs in parallel at many levels of abstraction and scale, one needs to be able to switch between tools and the functionality they provide according to the respective situation. In the case of digital tools, a crucial aspect is therefore the ease with which one can switch – the smoothness of transition – from one tool to the next. In FREAC heterogeneous tools (sketches, models, drawings, simulations) coexist within the same design space and one is not so tightly focused on one tool (and its scope), but can move freely between different ‘worlds’. The tools do, however, leave recognisable traces which can therefore be tracked and analysed.

4.4. Uncertainty about the nature of facts

When designing, constructs are constantly being negotiated and exchanged which need interpretation. This requires knowledge and competence on the part of human actors and means that design objects as boundary objects need to be robust and plastic so that they are able to constantly communicate meaning between different actors. "Boundary objects are objects which possess different meanings in different social worlds and yet are able to create a link between these worlds.” (Rossler, 2008). In this respect, we are concerned with the mapping, storage, transfer and use of knowledge and information. In digital design processes greater importance is therefore accorded to the transparency and stability of knowledge and information resources than in linear hierarchical design processes. Human actors must accordingly possess the competence to interpret the structures and develop this ability constantly. In addition, they must be able to work and learn independently without direct instruction. Non-human actors, such as digital design objects must constitute and maintain a connection between the different worlds of knowledge. Overall, it is difficult to coordinate a negotiation network of completely heterogeneous components, since the interpretation of the different content itself is problematic. This is due not least to the fact that their construction and interpretation depends on the specific knowledge of the respective individuals and is as a consequence highly subjective. Likewise, in many cases different tools are not directly comparable, and even artefacts created with the same tools can transport entirely different meanings, intentions, etc. Of course, ambiguity of meaning on the one hand and the specificity of the individual actors on the other can represent a creative potential that does not necessarily need conclusive clarification.

In the technical implementation, it is therefore necessary to establish connections between different virtual artefacts. These different pieces of information or artefacts must have some kind of semantic relationship to one another (e.g. a sketch belongs to a model from a particular viewpoint, authored by someone). Using this information, navigation structures can be derived which enable one to represent contextual links. Thus it becomes possible to browse between different states of artefacts, to derive and record intentions.

5. Conclusion and outlook

At the outset we discussed the concept of “open” as denoting the free exchange of ideas and artefacts, much in the same way that open source projects make their source data freely accessible. Using the technical framework FREAC presented in this paper, we extend this definition to open up the design process itself and understand it as a constant matter of negotiation. In this way, it is possible to facilitate the networking of actions by many different actors. However, open systems require efficient coordination mechanisms to keep the network under control, without – and this is the biggest challenge – limiting its degree of openness. The extent to which creative processes can actually be opened up, and whether this has added value for the quality of the results needs to be explored further. This paper has discussed a theoretical framework to assist in the conception of digital tools and design objects. In future work we will create coordination prototypes using FREAC, in order to extend “negotiation spaces” and manage them sensibly. Additional problems and issues relating to the management of these action-spaces can then be evaluated empirically.

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A Case Study of an Andragogical Model in Design Education: *Experiments in interactive teaching and learning in graphic design pedagogy*

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Abstract
The purpose of this study is to seek an interactive pedagogical model in teaching graphic design in higher education. Malcolm Shepherd Knowles, an American adult educator, adopted the theory of 'Andragogy' which focused on self-directed learning theories. This author applied the 'Andragogical Model' to upper division design studios and addresses effective instructions and tips through case studies. In terms of the digital academic environment favored by Generation Y, educators in graphic design fields have been faced with difficulties balancing practical and theoretical disciplines for successful academic achievement. The challenge for educators caused by the digital culture is convincing students that professional jobs mostly require students to achieve multiple creative abilities. This phenomenon demonstrates the problems of giving students precise direction for academic achievement. Thus, this paper brings up questions about how we should structure design education in a digital environment, and how we define boundaries between pedagogical and andragogical models.

Keywords
Design Education, Pedagogy, Andragogy

What to teach, and how do we teach it?
For the past 10 years, mass communication has rapidly developed in various media both online and offline. As consumers demand more of a variety of mass media, new methods in visual communication have become more technical thus creating new challenges in graphic design education. (Samara, 2007) In comparison with earlier studio practices without computer aids, educators are currently confronted with enormous concerns regarding teaching strategies. Assignments need to be intensive with both practical application and theory. Also, due to lack of time and space in the educational environment, graphic design studios often require students/employees to expand their knowledge and skills outside classroom/studio as well. In addition, it often appears a difficult matter to deliver all disciplines of traditional design practices and add the challenge of new computer technology in computer graphics. Professional designer jobs require various qualifications, yet students strive to build their portfolio to show a number of computation skills instead of visual quality and uniqueness of design. "The challenge for educators today is to help designers become the masters, not the slaves, of technology." (Lupton, 2006) Students are looking for professional careers in their future, but students should be aware of important factors in professionalism relating to digital technologies. What is a good direction and strategy for educators? Should we instruct more in teaching computer techniques or advise students to build sophisticated portfolios in the way of traditional graphic design?

Teaching digital to Generation “Y”

Generation “Y”, also known as the Millennial Generation, Generation Next, or Net Generation defined by the age group between twenty (20) and twenty-six (26), has grown up with digital media from their earlier education. They are used to obtaining necessary or useful information through online and mobile applications. This digital environment refers to the new online culture such as “instant”, “virtual”, or “multi-media” and it often reflects their attitudes and manners which can appear as a lack of craftsmanship in studio practices. Because they have grown up relying on their parents for information, they are not independent in learning responsibility. (Alsop, 2008) The problem is perceived as a major detriment to achieving academic goals when following traditional pedagogical strategies. Their final submissions are often observed with mistakes and no attention is paid to detailed visual descriptions. This has caused Generation “Y” to misunderstand the definition of graphic design regarding computer simulation and its effects in design quality. They start and end creativity from “Google” to “Adobe” software and many educators view this matter as a main learning challenge. Computer technology has replaced traditional design tools such as rulers, pencils, colors, papers, etc., and students often mistake the magic of computer graphic tools as creativity. This phenomenon has many educators confused about academic goals, a lack of interaction between practical and theoretical disciplines in pedagogy and difficulties balancing the two. There are so many rules and various methods students should learn to achieve successful outcomes, but following traditional instructions is becoming an unproductive education problem. (Exley, 2008) It is important that graphic design educators understand Generation “Y” from different perspectives. Unless we seek solutions for this challenge, it will be difficult to educate this generation of students, let alone the generation that follows.

Andragogy in design disciplines

Pedagogy describes a traditional approach of teaching based on teacher-directed learning theories, but ‘andragogy’ is based upong self-directed learning theories. (Knowles, 1970) Malcolm Knowles addressed various andragogical models for helping adults learn. In contrast to andragogical methods, pedagogical methods usually appear in earlier foundation level courses, especially design fundamental studios. The structure of instruction is very strict and organized with various activities to gain basic knowledge and experience of required artistic capability. As a student moves into upper division levels, disciplines require more subjective and critical thinking in concept development. This means design outcomes should be more practical and of professional quality rather than how to create design. An andragogical model should be considered more in advanced levels, but it is necessary to apply it in all different levels for Generation “Y” in terms of lack of responsibility in their learning. As the main objectives of design education are to have diverse experiments and conduct research in many ways, an andragogical model can help them seek various methods in problem-solving. Applying these two different models in art and design education is also effective in terms of critical or conceptual tasks in each discipline. The reasons are: 1) Studio classes differ from other lecture classes in terms of both passive and active activities, working individually and in groups; learning design subjects requires more activities such as brainstorming, critique, communication, design management, etc.; 2) Students are isolated when using computers despite their perception that the computer is the whole structure of the learning process. The computer environment in graphic design field is accurate, but it is also a major problem in learning and teaching design education (Locker, 2008). In this case, many educators in art and design studio classes are often struggling to supervise or develop quality demanded at the higher educational level; and 3) Students are faced with difficulties with experimental approaches based on design fundamental theories in spite of their artistic talent or work experiences. For instance, some students in intermediate or advanced studio classes often have various problems due to aesthetic/functional knowledge in design fundamentals. These students need to pay more attention to teacher-directed learning in order to practice various design examples instead of continuing unproductive quality in their design before they follow andragogical direction. Thus, teaching methods should be distinguished by different diagnosis from each student and applying either one of them or both simultaneously.

Teaching strategies in a case study

In order to seek constructive teaching methods between pedagogical and andragogical model, this author has observed Generation "Y" applying different pedagogies in graphic design studios through two (2) semesters. In order to compare different responses from students between pedagogy and andragogy, this author applied either one of them or both properly in terms of lectures, assessments, assignments, design process, critique, individual work and group work, etc. Information from examined classes follows:

Table 1. A class information

Class	Assignments	Enrollment	
		Spring 2009	Fall 2009
Art 356 (Graphic Design II) Junior level	1. Sign and symbol 2. Sequential design 3. Information design 4. Advertising design	N/A	24
Art 358 (Typography) Junior level	1. Typographic expression (Static & Kinetic) 2. Typographic form and symbol 3. Typographic composition 4. Kinetic typography	20	22
Art 456 (Graphic Design III) Senior level	1. Corporate Identity 2. Stationery 3. Promotion Design 4. Signage and wayfinding system 5. System Manual	30	19

Table 2 introduces different pedagogical and andragogical models in terms of each task of the design process. The indicated symbols represent in which task each method has been applied and more effective in learning process. Instructions between students and teacher have been adjusted in terms of additional handouts per each assignment and process. The pedagogical method is defined by following instructor's guidelines, but self-direction is used in the andragogical model. Pedagogical model also refers to developing idea in a group, but andragogical method has been used for self-study in creative activities.

Table 2. Assumptions of proper teaching methods between pedagogy and andragogy

Task	Teaching methods

	Pedagogical	Andragogical
Project Introduction	O	X
Research	X	O
Brainstorming	X	O
Idea Sketches	X	O
Mid-Critique	O	O
Project Evaluation	O	O
Revisions	X	O
Final Presentation	O	O

Project Introduction
Project introduction is the first thing to define the each assignment's goal and it is composed of three different components including additional handouts: lectures, syllabus and checklist of design process (Appendix A). Because students are required to pay attention to understand problems and guidelines, the teaching method should be based on 100% pedagogical methods. Table 3 shows the main consideration, methods and strategies in the whole design process.

Table 3. Tips for the project introduction methods

Task	Teaching and learning methods	
	Pedagogical	Andragogical
Project Introduction	- Require full attention to the lecture and discussion - Analyze design examples - Clarify objectives and guidelines - Hand out repeating information - Explain evaluation criteria	N/A

Table 3 addresses tips for teaching methods in project introduction. It is necessary to push students into the subject-centered of the learning orientation. (Knowles, 1992) Turning off the computer and any mobile devices is mandatory during lectures. The lecture provides exact subject matter, objectives and design process requirements. It also brings out group discussions for understanding which design works or not. All design examples are from various student work related to concept development, design methodology and media exploration. This lecture is important to help students understand their role, and understand the importance of class participation. Clarifying objectives and analyzing examples of the successful designs demonstrates three things: 1) what they already know or do not know, 2) what they need to learn and achieve, and 3) what they can challenge and experiment with in new approaches. All instructions are handed out in the beginning of the new assignment, including evaluation criteria and the instructor should check their progress through individual meetings.

Design process
The design process is composed of four (4) different stages to develop design concepts and ideas: research, brainstorming/analysis, idea sketches, and mid-critique. There are two different models for each assignment. Figure 1 addresses distinctive methods

between academic and practical research type. The diamond method from the academic model indicates more time consumption than other stages, but the pyramid method follows the sequential problem-solving process to narrow down the final solution from the heavy amount in the research stage. Both are productive learning models to achieve the goal of successful outcomes in design process, but require a critical balance between pedagogy and andragogical teaching methods.

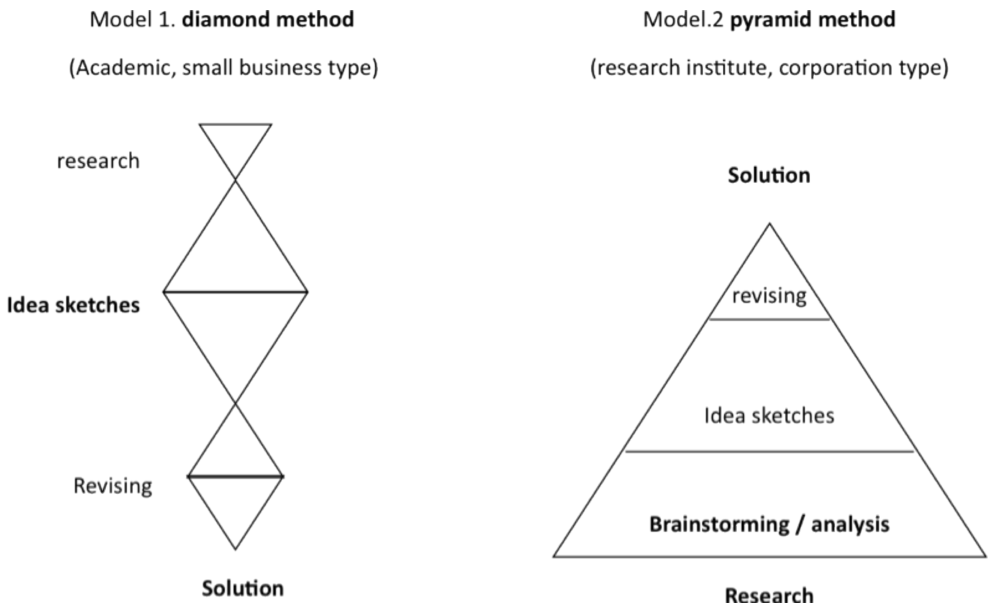

Figure 1. Structure of design process

Research & Brainstorming

In design research, andragogical direction should be 100%. This means students are responsible to seek the direction of study goals and design achievement. Research often requires unlimited resources and references to contribute a unique concept and creative ideas in visual communication.(Figure 2)

Figure 2. Research towards andragogical direction

Knowles (1977) wrote that the adult learner brings a greater volume and quality of experience and it becomes the source of self-identity. Therefore, enhanced and intensive research based on an andragogical model brings out good quality and successful outcomes in both aesthetical and functional aspects of design. In addition, research direction is determined by design methods. Students are always encouraged to invent their design method in order to contribute their concept and narratives in communication methods. This resolved the major problem when students begin with unproductive research with a few image collections from an online “Google” search. For example, in an upper level typography studio class, an andragogical model was used for a “typographic symbol” project. The goal of this project was to create a new typeface, but compose letters as type symbols. In order to lead students into self-centered thinking, each student submits a few keywords and then picks one randomly. We often observed students prefer to repeat same or similar concept and idea through different projects. In this research task, andragogical direction changes students’ learning methods for understanding self-direction in individual and group work instead of following the teacher’s direction.

Table 4. Tips for the research methods

Task	Teaching and learning methods	
	Pedagogical	Andragogical
Research	N/A	- Avoid “Google” research only - Apply research methods from design methods

Idea Development with Sketches

Many educators have discussed the problems with idea sketches. A major number of design schools emphasize the importance of idea sketches for the creative quality and uniqueness of idea in disciplines. Instructors address all guidelines and processes of idea development in syllabi but students consider it being satisfied with minimum work. For instance, this author observed the different responses from students between pedagogical and andragogical direction.

Table 5. The learners’ responses from pedagogy vs andragogy in idea development

	The Learners responses from Pedagogy vs Andragogy in idea development	
	Pedagogical	Andragogical
Quality	Considering only visual attractions in self-satisfaction	Going back and forth with visual research for audiences
Quantity	Following exact guidelines	Applying design methodology
Depth	Lack of Details	Profusion of ideas and solid finals

Table 5 shows the difference between pedagogy and andragogy on how students perceive the learning process in terms of different perspectives. In the task of conducting visual concept development, an andragogical model is more effective in achieving the goal of final design quality in both aesthetical and functional aspects. Therefore, students should not be limited to the number of sketches, but use any design method to expand their idea and creativity.

Critique & Project Evaluation

Critique and evaluation requires both pedagogy and andragogy in the various graphic design disciplines. Communication between teacher and student needs interactive methods: both written and verbal. Students are encouraged to participate on the final group critique. In order to have dynamic and productive criticism, there are pedagogical requirements in this process, but also andragogical encouragement by each student in class. Table 6 addresses an example of instruction for the teacher and students in terms of different directions between pedagogical and andragogical approaches. Andragogical direction should come after the pedagogical model. It gives students better direction to be motivated towards professionalism: perceiving lack of design ability and learning from comparisons, and achieving the goal of creativity to prove portfolio quality.

Table 6. Instructions for critique and evaluation

	Instructions for critique and evaluation	
	Pedagogical (Teacher-Directed)	Andragogical (Self-Directed)
Presentation methods	**Teacher**: Should provide guidelines and a list of design contents which students will follow.	**Students**: Use additional resources and references to explain their concept and idea clearly and interactively with others.
Participation	**Teacher:** Should ask each student questions to bring out their opinions because students are afraid of saying something wrong.	**Students**: Are motivated with sharing ideas and productive discussion for clients and designers to reach better solutions in self-direction.
Evaluation methods	**Teacher**: Should analyze design problems from each student's outcomes because students need to know exactly each problem in detail. (Figure 3) (Appendix B).	**Students**: Requires analyzing their own problems from the group critique and attempt to communicate with teachers to fully understand their directions.
Revising	**Teacher**: Give another chance to give an extra point and chances to see their improvement by teacher's instruction. In addition, it is effective if teacher provides them a demo and examples from a similar case study individually.	**Students**: Improve the final design following evaluations and experiments with problem-solving. Students should be aware of this process for building a quality portfolio.
Final feedback	**Teacher**: Should examine their final and provide the second comments to fix and change problems.	**Students**: Are willing to continue to revise their designs to achieve success and professionalism. (Figure 4)

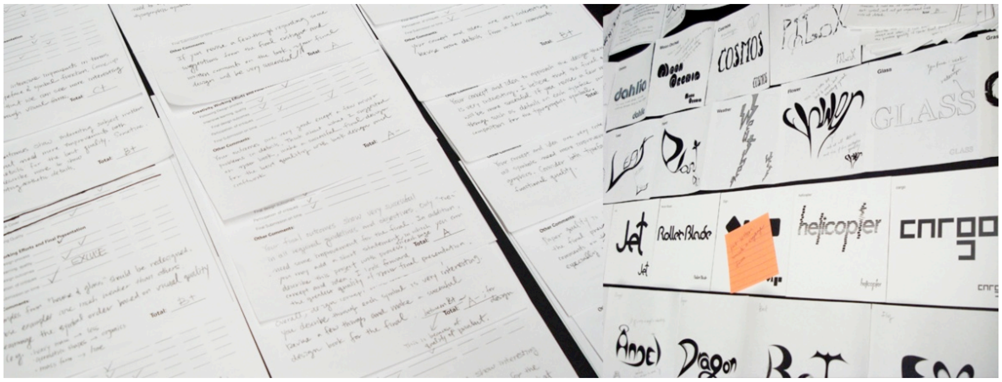

Figure 3. Research towards andragogical direction

Figure 4 is an example of students' works following an andragogical model. It shows great improvement after the final group critique and sequential revising process. Through advice and several comments from evaluations, students begin with revising and fixing major problems in their design. This method is critical in improving learning and teaching in design studios: especially in understanding objectives, perceiving all problems, and raising academic achievement.

Figure 4. Revising and fixing problems from the critique and evaluation.

Conclusion

Through this case study comparing pedagogical and andragogical models in graphic design studio instruction, this author observed that an andragogical model improved student outcomes over a pedagogical model. Students improved in intensive research, enhanced visual quality, and heighten their professionalism. In addition, applying an andragogical model appears effective in managing students as adult learners.

Another positive result is an increased interaction between students and the teacher which increases the number of student with successful outcomes. This approach also decreases the number of misunderstandings, increases motivation in self-direction, and also increases student-to-student feedback over traditional pedagogical approaches.

In conclusion, this case study will not only help educators improve student outcomes in design studio classrooms with members of Generation "Y", but also help frame future discussion regarding teaching and learning in graphic design education.

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Appendix A: An example of the checklist for design process and individual feedback

Art456 Graphic Design III

Corporate Identity

Name: ______________________________

	Excellent (A)90-100	Good (B)80-89	Need Improvement (C)70-79	Poor (D)60-69	Unacceptable (F)0
Problem 1. Symbol & Signature					
Quality of efficient communication method	______	______	______	______	______
Proportion ratio	______	______	______	______	______
Uniqueness / Clarity	______	______	______	______	______
Problem 2. Stationery					
Layout/composition	______	______	______	______	______
Typography and graphics	______	______	______	______	______
Uniqueness of visual identity	______	______	______	______	______
Quality of paper construction and production	______	______	______	______	______
Problem 3. Promotion					
Design layout / Composition	______	______	______	______	______
Efficient visual elements / graphics	______	______	______	______	______
Quality of contents/communication methods	______	______	______	______	______
Problem 4. Sginage/wayfinding					
Clarity and uniqueness of information	______	______	______	______	______
Efficient environmental presentation	______	______	______	______	______
Quality of contents/communication methods	______	______	______	______	______
Problem 5. Package					
Quality of Mock-up	______	______	______	______	______
Efficient presentation of visual identity	______	______	______	______	______
Integration with 2D and 3D	______	______	______	______	______
Problem 6. Manual Book					
Creativity of Book design	______	______	______	______	______
Details & quality of presenting contents	______	______	______	______	______
Design layout/composition	______	______	______	______	______

Total: ______________________

Checklist for final submission

1. Symbol and Signature (Manual book)

2. Stationery (Printout and mock-up)
Business card, letterhead and envelope (big & small)
Event/invitation card, Official business folder, CD case.

3. Promotion (Printout brochure and name tag, mock-up for shopping/goodies bag)
Shopping/goodies bag (paper construction required)
Company brochure (folding or book type: no bigger than 8 X 11 inch)
Poster or banner design (8 1/2 X 11), conference signage, name tag,
Website (main page: 800 x 600 pixel)

4. Signage/Wayfinding (Template and images on the manual book)
Exterior: building, wayfinding (parking, entrance)
Interior: door signage (office door, restroom), information center (standing or wall)
Banner: outside street
Transportation: front/side/rear

5. **Package** (Mock-up)
Product package box or bag (3D structure)

6. System Manual Book (Mock-up: book design)

Appendix B: An example of the final group critique evaluation

Art358 Typography,
Assignment 3.Typographic Form and Symbol

Name: ______

	Excellent	*Good*	*Need Improvement*	*Poor*	*Unacceptable*
Concept Approches/Developments					
Challenge the given subject matters	___	___	___	___	___
Profusion of idea	___	___	___	___	___
Concet/Idea Development	___	___	___	___	___
Innovation/Distinctive Idea	___	___	___	___	___
Innovative idea	___	___	___	___	___
Typography Expeirements/Creativities					
Uniqueness visual form	___	___	___	___	___
Clariety of visual message	___	___	___	___	___
Typeface Function	___	___	___	___	___
Quality of Typographic Symbol	___	___	___	___	___
Detials and Quality in typeface	___	___	___	___	___
Composition with 8 symbols	___	___	___	___	___
Clariety of visual message	___	___	___	___	___
Book Cover	___	___	___	___	___
Quality of Typographic Symbol	___	___	___	___	___
Finishing Quality	___	___	___	___	___
Creativity, Working Efforts and Final Presentation					
Following Design process	___	___	___	___	___
Intensive learning quality	___	___	___	___	___
Final design outcomes	___	___	___	___	___
Participation of critiques	___	___	___	___	___
Final Submission on time	___	___	___	___	___

Other Comments:

Total: ______

Contradictions, complexity and the 'conversational self' design research methodology: "Australian Citizens' Parliament" documentary

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Abstract

This paper addresses the role of the designer as actor/agency working within and across flows of knowledge, perception and information for filtering, negotiating and mediating design decision-making. The research methodology uses auto-ethnographic writing to construct and explore a series of deliberative conversations as (I /You/ Me / We). Each of these personas offers a distinctive mediatory stance for the designer/self to engage with relations to *other-ness* across personal and public social contexts. As a second order cybernetic approach, the designer/self is thus constructed as being simultaneously participant and observer in ongoing collaborative design conversations as synthesis. These fictive and auto/biographical personae provide access to a range of viewpoints and perspectives, which can be used to actively reflect, mirror and respond to stakeholder interests and investments, whilst effectively being considered in light of the designer's own reflections on, in, and through action (Schön).

Whilst the paper proposes this methodology as having general benefit for design research in any field, its application for a visual design narrative project is described. The case study is of the making of a video documentary about the 'Australian Citizens' Parliament' (2009), as 150 randomly selected citizen participants take part in a deliberation about ways to improve Australian democratic governance systems. The designer's process of decision-making and story telling is guided by using the personae methodology to engage with synthesis of multiple perspectives from the video capture process. Key stages of the script design process are described, where the designer uses the framing and mediating concepts of public/private; and individual/collective (I/ You/ Me/ We) to generate a revised form for the documentary as an essayistic work consisting of a series of ambient scenes. What emerges in this final video piece is an engaging narrative treatment and shared understanding about a uniquely Australian political context, titled 'Deliberation Nation'.

Keywords

designer as actor/agency, experiential narrative, ambient scene design methodology

For the designer as agency/actor, engaging with *social experiential knowledge* in complex negotiations and communication contexts involves working closely with multiple perspectives and approaches from 'problem' stages towards 'solution' stages. The kinds of decision-making that take place throughout these fluid processes are often difficult to make transparent due to the pragmatic and contingent nature of collective/individual mentalities, expertise and sensibilities which carry with them implicit and explicit values and normative assumptions. Kolko (2010) discusses the push towards synthesis in designing as a practice that can be described in terms of what is termed 'sense making'. He comments that synthesis is a means to apply abductive logic 'within the confines of a design problem' (2010,p 20). Kolko describes synthesis practice methods in design as 'reframing, concept mapping, and insight combination', which all emphasise 'prioritizing, judging, and forging connections'. (2010, p27). In this paper, I describe a particular approach for building about design synthesis by capturing project knowledge through auto-ethnographic writing from the designer 'self'. What this approach produces is a set of multiple personae (voices) through written form - as (I, You, Me, and We) personae insights and perspectives about the design problem context. The multiplicity that is generated by the usage of these perspectives provide a range of insights into possible solutions and sub problems which is similar to Kolko's description of abductive sense-making as 'judging, prioritizing and forging connections'.

Whilst initiated within the subjectivity of the designer's own thoughts and reflections, these personas gather momentum, and become ways to signify and represent a range of external stakeholder perspectives and project concerns. For design research generally, the use of fictive persona is already a well-established methodology shown to be useful and effective for establishing user characteristics and constraints for product designing (Carroll 2000; Pruitt& Adlin 2006). In this paper, I show how the synthesis work of design thinking can be made more concrete when written out using the (I/ You/ Me/ We) personae method. By writing and thinking about design practice using these subjective personae, both individual and collective viewpoints are kept in mind as dynamic spaces of private/public and individual/collective are mediated within and through the design process as it shifts across the space of problem to solution in design practice.

Methodology: Conversational learning and auto-ethnographic writing

Design and Conversation Theory

The cybernetic theory of conversation (Pask 1975) offers ways in which design communication can be explained and understood in terms of knowledge emergence, as new knowledge comes through the productive and generative interactions between conversationalists. The underlying ontology of conversation theory is the premise of an agreement, or, an agreement to dis-agree which is an interaction producing some kind of new knowledge as shared agreement about the particular context, as suggested by Glanville (2007). As key actor in the process, the designer brings 'expert' knowledge about how these communication scenarios may be nurtured and managed, towards innovation and successful outcomes. The designer is thus in a unique position to mediate, observe and oversight the influence and presence of all manner of experiential knowledge, events and actions which make up the project context as a real-life messy conglomerate. The fluidity of the design as 'problem' becomes clearer as norms and boundaries emerge, which provide frames for the further development of a design 'solution'. The random and contingent nature of such an understanding is similar to Latour's (1986) 'Actor Network Theory', where influences and active contingencies which are both human, and nonhuman (i.e. situational), are recognized and described as part of the social knowledge context – as a form of ‘assemblage’ (Latour) which the designer seeks to manage and explore. The designer thus leads from the knowledge space of the semi tacit, balancing the effects of concrete everyday experiences into a framing of social knowledge as abstractions as the design process unfolds over time. The designer as expert, understands knowledge complexity, and is also well able to both participate in as well as observe the design activity where they are actively and directly involved. I propose that these are significant features of how designers do design, but which are often so self-evident as to be not fully taken into account in the designing process.

Summary of theory behind the 'conversational self' writing methodology

The methodology for journal writing using these self-personae employs Baker, Jensen and Kolb's (2002) five dialectic frames for conversational learning. In using these frames the designer/author also employs two 'voices' of self, as 'subject' participant, and as 'object' observer, an approach adapted from the work of Margaret Archer (2003). This is show in Figure 1 below, as a form of what Maturana and Varela (1980) describe as an 'autopoetic' self-producing system for generating and exploring experiential knowledge.

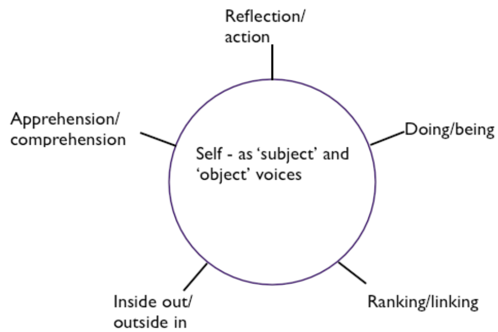

Fig 1: Conversational self as learning system: adapted from Archer (2003) and Baker, Jensen & Kolb (2002)

The configuration shown in Figure 1 provides a constructive means for developing written entries as layers of observation, reflection, and personal commentary. As a result stories within stories are recorded, as instances and episodes that take place in the designing. As a system for writing, these frames may be taken up at any point in the journal writing, they are not linear or prescriptive, but rather, suggestive of nuances of tonality and emphasis in writing styles and content. The first frame, 'Apprehension /Comprehension' provides a starting point to gather up and scope out a diversity of knowledge influences which may be of value for the design context, often linked to a sense of context and time passing. 'Reflection /Action' often takes place as longer forms of writing narrative which relate the history and background of the context. 'Doing /Being' offers a means to capture and note perceptions of the present time and place, as the doing action in a present time frame of human being-ness. 'Inside Out /Outside In' provides a means to evaluate what is emerging against a background of normative values and benchmarks around the design problem context. 'Ranking /Linking' provides a strategic approach for specifically assessing the value of the designing in relation to wider external social contexts. By continual use of the two 'voices' of self, an ambience is maintained across the writing, providing a kind of coherent narrative where idiosyncratic notations and codings come into play. The uses of the two voices of self (as 'subject' self and 'object' self) provide an opening up of the situation for engaging with experiential knowledge at many levels. In the process of writing in this way, the personae of (I/ You/ Me/ We) become personae as points of reference for views and commentary that address all manner of knowledge and knowing about the design problem and possible solutions.

Archer (2003) describes these states of self, as forms of self as agency, which emerge as a result of this self-conscious and deliberate positioning. Archer describes these states as the 'I', 'You', 'Me' and 'We' of the self-reviewing itself as social object. This is shown in Figure 2 as a process of self in review, shifting through different states of self as forms of agency showing how the identity of self is developed through a progressive working through of 'Self' ('I'), 'Primary agency' ('Me'), 'Corporate agency' ('We'), and 'Actor' ('You'). The conversations take place in a concrete way through writing as 'subject' self (SS) and 'Object self (OS) as shown in Figure 2. Thus, 'self' (I) begins the conversation, which progresses through the identifications of 'Me', and 'We', to reach a mature and considered status, as 'You' (Actor). In this way, the self converses with 'itself', as both observer and participant, across past, present and future. What results is a foregrounding of the dynamic interplays between what is 'individual/personal', and what is otherwise 'public/collective'. In effect, these states of self become metaphors for a variety of social communication scenarios. They exist as a unity of parts - they may be addressed and understood as separate approaches, yet they are also one to each other, as analogous components of human interactions within a design context. This sounds complicated, but when used as a process of self-capture, it provides a rich set of options for gathering and reflecting on the wide range of possibilities within a design situation. It is a way of capturing what one could and often is, thinking implicitly, and making these half-formed thoughts more explicit.

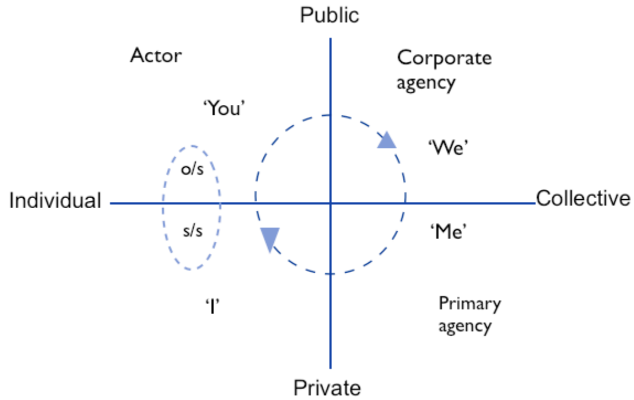

Figure 2: Adapted from Archer (2003: p 124): How the subject reviews itself as social object

As a result of the overall process of writing in this way for design research purposes, key themes emerge about place, time, characters, action, and tension relationships between story elements. The development of the 'what' is integrally bound up with the telling about 'how' and 'why' as the narrative evolves through contextually based references to time, place, actors, intentions, characters, objects, actions. The writing process evolves and configures the personae of self as characters, as voices within the narrative who participate and observe, who join forces at times, and or disagree as they work towards a shared or in-common understanding of some-thing about the situation at hand. What occurs is effectively a writing practice of mediation that takes place between the stances of observation/objectivity; and participation/ subjectivity (Shumack, 2009). As a design research method this is a particular style of abductive thinking for engaging with experiential knowledge and knowing. The method has value for design thinking practice, if and when it suits the designer's own interest and orientation. The process of writing out one's own thinking in this way is initially clumsy and can be fraught with self-doubt and a sense of being 'too personal' (Roth, 2005). However, over time and with practice, I have found the writing begins to flow more easily, and as part of my own designing I have been able to identify and engage with the object/subject voices of self to generate integral and meaningful insights. In effect, what is happening is that I am articulating what it is that I would be thinking, but doing so in a way that orders or structures, makes more self aware the depth of thoughts and influences which are occurring around the design problem. What also occurs is that the focus around being object/subject self creates a rich body of experiential project knowledge about what is collective/ what is individual; what is private/ and what is public. These knowledge strands can be seen as *dialogic framings* of the project that can be woven together towards the problem's solution.

I suggest that this approach to methodological framing using multiple points of view and narrative distance has a particular value for visual design story telling practices in communicating social knowledge, systems and contexts. In visual design, the designer is always present in some way, as a form of silent author, as explicit director, and always as a mediator of the context that is being explored and represented. By explicitly revealing the dialectics of object/subject relationships, the visual designer has much to gain from adapting and exploring the relational spaces of object/subject: participant/observer to encompass the designer's intentions and bias, alongside the capturing and understanding of stakeholders views. In the case study that follows I explain how this approach was explored in the design development of a documentary video that tells the story of an extraordinary national event, the Australian Citizens' Parliament. The final title given to this documentary is 'Deliberation Nation'.

Application: Design of 'Deliberation Nation' documentary

Background

The project involved a collaboration with researchers from the disciplines of political science, political theory and applied politics, and a partner not-for-profit organization (newDemocracy) on the video documentation of what is know as the Australian Citizens' Parliament (CP) research project. Our design team's brief was to produce video documentation of the project over several months. The mission of deliberative processes like the Australian Citizens' Parliament is to review the way the public discusses and engages with politics and political decision-making processes - the space of the 'commons'. The event took place as 150 randomly selected citizens deliberated, then delivered their recommendations at Old Parliament House, Canberra in February 2009.Their task was to answer the question: "How can Australia's political system be strengthened to serve us better?"

It is rare for such large-scale initiatives of deliberative democracy to occur. The success of the Australian CP event was largely due to the planning and coordination that took place prior to the actual three days of the event itself. As a government funded research project the CP had its own objectives, which were driven by research questions from the fields of applied politics, law, political theory and social policy. These involved the design of a system for conversational interactions to occur through deliberation processes, as a staged facilitation around generating new ideas and the process itself of conversation and engagement with the issues at hand using techniques such as the 'World café' and the '21st -century dialogue' with computer tabulated summaries of large scale conversations and suggestions.

The CP event provided a significant opportunity for the researchers and agencies involved to understand better the processes of deliberation and to be able to examine and trace the development of mass scale conversations as an experiment in deliberative democracy at work. As commented by Carson (2008) this large-scale public event can be characterised as an 'insisted space' for democratic participation as distinct to an 'invited space' which would be managed and promoted by governments and power brokers:

"The newDemocracy case study is an example of a nascent social movement of citizens-as-electoral reformers who insist on a place at the decision making table for a mini public because of the democratic deficit that has arisen as a consequence of a faulty system of governance. This site of activity can be described as an "insisted space". " (Carson, p7)

The CP event was momentous and extraordinary, in bringing together a large number of randomly selected citizens with academics, public figures, experts and researchers. Working with an experienced media team, my role was to direct the documentary of the event in its complexity, as a record of the event, but also to capture the essential qualities of deliberative philosophical thinking which underpinned the process. A challenging broad question was asked of the 150 randomly selected citizen participants. The video documentary aims to represent the findings in light of the event goals – to answer the initial research question.

Initial journal writing research

The initial journal writings assisted in framing the shooting script treatments, and approaches. Consideration was also given to how to encapsulate the 'conflict' or key question as a basis for the documentary work. The journal includes references to key protagonists, contingencies of production and resource constraints, and ideas about how to position and extend outward to the viewer. Figure 3 shows the baseline shooting script as a basic the narrative spine for the project. The initial story 'arc' was loosely aimed at showing the way the event played out based on linear time - the background, the event taking place, and reflections about what was learnt. Part of the design problem was the diversity of footage shot and the sheer amount of material with which to select from.

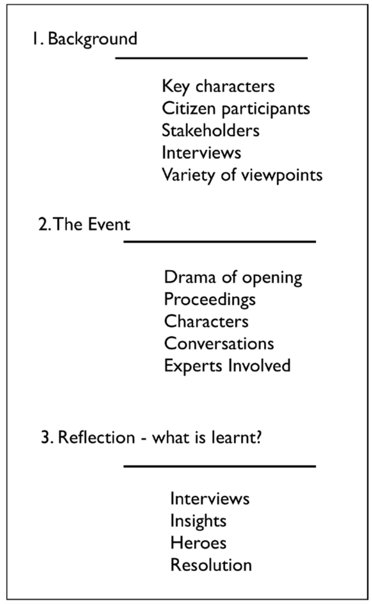

Figure 3: Baseline shooting script for documentary

Second stage script design concept

As the shooting progressed, key characters emerged, and the story lines became cluttered with possibilities and options for nuances and story 'hooks' on which to hang audience interest. The initial editing process followed the shooting script structure as a chronological unfolding of the event. Despite variety of video material that was included the tone or voice which came through in this first draft was authorial, factual, dry and often confusing. In order to develop a finer and more insightful story with greater human interest, the second draft focused on building a story around the theme of 'journey'. This was portrayed on several levels - as a journey being taken by a range of different stakeholder groups, and as a transformative process involving individuals, and groups. As shown in Figure 4 these themes were elders, teachers, hero characters, interaction, knowledge transfer, self-esteem and taking actions.

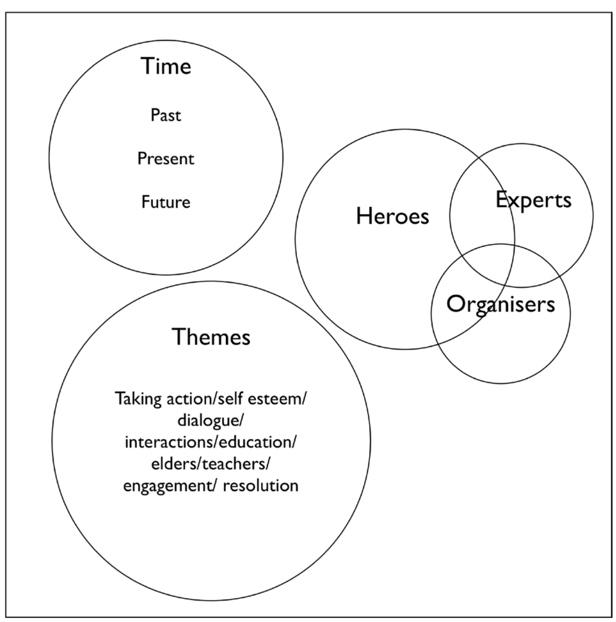

Figure 4: Second stage script as 'journey' thematic

Introducing the Personae of Self as Frames for the Script Design

Figure 4 shows the second phase of the documentary script development. It was thought that the story journey was still unclear, and lacked a sense of depth and cohesion in the script treatment and ambience. On reflection, it seemed that the first draft (Figure 1) of the shooting script presented a kind of authorial tone that was factual and highly distanced. The second draft (Figure 4) was overly personal, too close, a collection of many insights, thoughts and views which did not really tell a meaningful story about what had happened at this momentous event. Reflections led to a structural shift from an exposition about the actions of the event, to a more essayistic approach where a narrator asks a series of questions, and then these are answered through a layering process of different subject/object voices. The story telling needed a protagonist, a narrator figure to provide continuity and as an insight bridge for the imagined viewer, to balance views and perspectives, to moderate and mediate the range of views and tonalities being introduced. In order to begin to work with this dynamic, the four personae of self from the 'conversational self' research were overlaid onto the script map as a means of weaving the storylines together. One of the CP participants became the ‘everyman’ protagonist narrator as a focus for these new scripting directions. The journal writing process guided these reflections and decisions, resulting in a new approach where the personae of self were introduced to help frame the script's structure.

Figure 5 shows the way in which the four personae of subject/object self are now considered within the visual text. Each of these voices within the documentary represents a different mediatory presence and tone as a result of a sense of *rhetorical distance*. *‘I’* works primarily through self-expression and engagement with individual concrete experiences through curiosity and interest, providing an idiosyncratic and personal mediatory tone. *‘You’* self is the mature and resolved custodian of the emerging decisions about a particular design situation, the authorial factual voice. *‘Me’* engages with commitment to in-common histories and cultural and social identities, so is the often vague and imaginative mediatory tone. *‘We’* operates in the domain of current expert knowledge, and what is already part of a shared common public social context. This structure provides a scaffold upon which to begin re-shaping the script design around these concepts as ambient scenes.

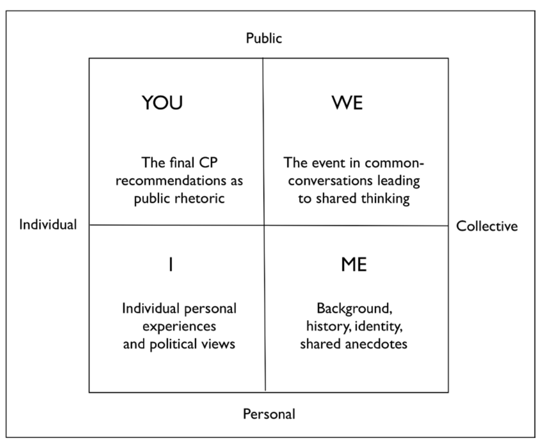

Figure 5: Alignment of personae as mediatory presences within the re-design for documentary script

The Process of Concept Development Using Self Personae – a series of ambient scenes

As a result of this new approach, the video material, which had been already selected from the first cut of video footage, was broken down into component parts, loosely framed around a series of narrator 'questions'. This initially took place using coloured index cards, resulting in a rich layered script treatment that highlighted the new role of a narrator in guiding the storytelling. The introduction of the 'narrator' creates an ambience around each section that is structured around a rhythm of the (I/ You/ Me/ We) perspectives within the visual script design. The key question or 'conflict' remains central, and the short essayistic vignettes each addresses aspects of complexity, contradiction and deliberations as the event unfolds. What is critical in adopting this ambient scenes approach is that the narrator's role is dialectic - presenting at least two perspectives relative to each other, not a single viewpoint to drive the overall story-telling forward. This takes place as a form of questioning which keeps the ambience of the themes open-ended and dynamic, but with a clear narrative idea. Figure 6 shows how the ambient scenes are constructed as a form of semantic architecture to underpin the script re-writing. Each of the fourteen vignettes is based around:

1/ A concept ideas for the development of the story

2/ The narrator evident before, during, or after the main action

3/ An ambient emphasis on each setting as a dialectic interaction between various combinations of these personae (as I/Me/We/You)

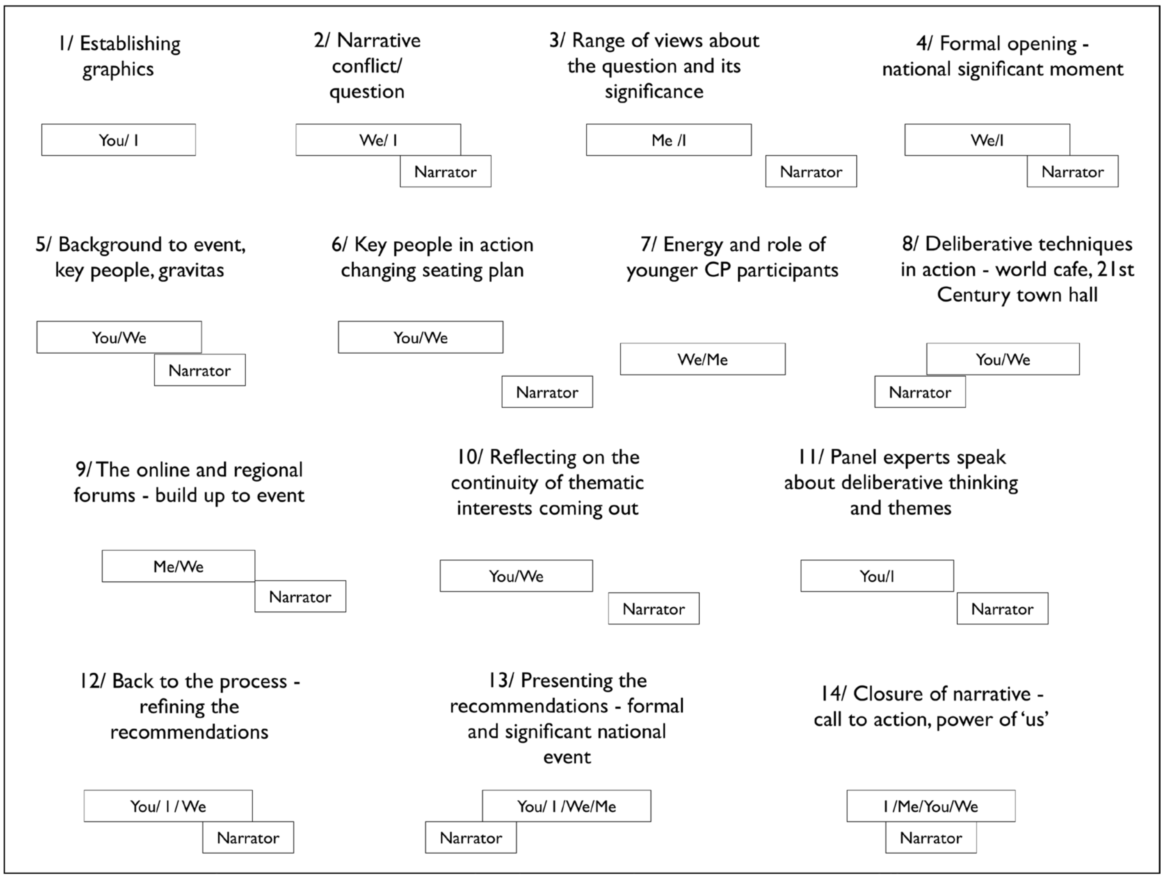

Figure 6: The script design as ambient scenes - a concept mapping of the narrator with the self-personae

As a result of configuring the script design using this approach, the story continued to become clearer, and key moments and characters emerged within the visual text. The narrator became a critical figure in the telling of the story, as a linking element across the hour-long documentary program. As the editing continued to shape and refine the work, further changes were integrated, but the semantic scaffolding that was established as a result of this approach continues to support and endure. On reflection, I believe that this approach was of particular benefit in the shaping of a rich documentary story where, as with documentary scripts in general, the actual ending is unknown in the initial planning stages. The application of a design methodology such as this one is, I propose, a valid and purposeful manner for the design of both documentary and factual narratives.

Conclusion

This paper has outlined an approach to design synthesis which engages with multiple subjectivities, as the designer self, is extended and negotiated through understandings of complexity, contradiction and negotiations with understanding other-ness and story-telling. The design process is shown as a movement towards solution, which takes place as a process that has its own momentum, critical pathways, and points of interest. What emerges from this design research approach is a focus on the development of a language around, and about, the dynamics of synthesis as a practice that involves transformative and creative thinking. The value of this approach has been shown in its application to a particular process of visual story-telling for managing complex knowledge and for how it can assist in crafting the 'raw material' of experience towards documentary design practices in a 'solid, useful and unique way' (Benjamin 1992).

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Author Biography

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Kaye is an Associate Professor, who lectures in design thinking, methods and visual media at the University of Western Sydney, Australia. She is the director, producer and key writer for the ‘Deliberation Nation’ documentary. Kaye is currently working with researchers in the ‘Culture, Nature and Environments’ team at the Centre for Cultural Research (CCR) exploring digital locative and experiential mapping practices and technologies for cultural research projects.

Interpretation as a design method

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Abstract

Interpretation as a method to be applied by the designer is based on the principle of building a new rationality: constructing material culture, holding as a reference the user, ultimate recipient for the projected product. Interpretation as a method further strengthens the specificity of 'designerly ways of thinking and designerly ways of knowing' (Nigel Cross). With this approach we aim to contribute towards the characterization of an innovative design: neither a singular problem solver nor solely solution-oriented devoid of dialogue with the question, but rather a semantic agent, a designium interpreter, a maker of meanings through the generated forms, a builder of new circumstances and contexts to contribute to human freedom. The methodological processes applied to an innovative design cannot be conceived as a sequential and linear process with no room for questioning or constraints. Interpretation as a method in design practice holds as a model the application of the hermeneutic cycle: a proposal of dynamic reasoning between an initial question (situation, problem) and a final solution. The development of the project takes place vis-à-vis with the context, culture, place, language, use, and these variables interfere with the initial proposal, reinstating and reformulating it. The choice of new and unexpected answers acknowledges the user as dynamic individual and key player in the interaction process between the proposed 'product' and its use. This research focuses specifically on the 'skin of buildings' as city's constituent component. To support that 'the skin of buildings' has a function-meaning we perform a comparative study on the use of interpretation as a method by the designer Daciano da Costa and the architect Carlo Scarpa. One of the outcomes of this approach is that postulating interpretation as a design method characterizes the designer as an interpreter. In our research we intend to address the designer as a role player in the city, intervention scenario, as an analyst of the cultural value of the context, coming upon a sustainable and innovative answer. This approach seeks to justify the use of a method that instead of designing an object aims at construing the object's meaning for the user, hence his relationship with the surrounding space.

Keywords

interpretation design, signification, pattern, material culture, equipment scenarios

Stemming from a hermeneutical perspective on the action and expansion of design we intend to reflect on interpretation design, qualifying the nature of the artifacts through their function-meaning instead of merely by their use-value. In such process, to reflect implies grasping a meaning for the referent. In other words, understanding (in this case the material or immaterial culture) through dialectics among and within all players (people, context, culture, complexity of factors, time) and abduction (logical inference, reasoning to evaluate and explain through the process of attribution of meaning). The first part of this text will present the advantages of interpretation as a method in design regarding other models, using a definition of the concept of design, to justify the hermeneutic circle as a model in the design process. In the second part of the text we apply interpretation design in searching for new solutions in the equipment scenarios, namely 'skin of buildings'. Design reasoning has several meanings, disclosing the abstract nature between conception and attribution of meaning ready for interpretation. Therefore, the exercise of design is competent to interfere with the function-meaning of space and disclose new connotations. Attribution of meaning as process of interpretation of the space may lead us to the understanding of semiotics applied to the design process. To support the function-meaning of the 'skin of buildings' we will analyze two cases of interpretation design, in Lisbon and Venice. To conclude, we will briefly approach the 'pattern language' rationale (Christopher Alexander, 1979) as autonomous units of thought installed in the membrane of the already existing buildings expressing onto the exterior what happens inside, an exterior skin connoting the status of the internal body organs.

Performing interpretation design

In 2008, the philosopher and anthropologist Bruno Latour presented the text ‘Prometeo cauto? Primi passi verso una filosofia del design’ at a Design History Society congress, calling upon reflection on the development of the term ‘design’, both in understanding and diffusion. In his text, the author argues that "più gli oggetti si trasformano in cose, cioè più le 'materie di fatto' si trasformano in 'materie in questione', più esse divengono sempre più profondamente oggetti di design"[1] (Latour, 2009:256). In his reflection Bruno Latour examines five benefits of the design concept: (1) modesty (2) attention to detail, (3) semiotic competence, (4) a process in which projecting is always re-projecting and (5) the ethical dimension, to conclude that today, design calls for precaution and attribution of meaning. Regarding the five benefits of design concept as autonomous 'patterns' of thought, we will commence by posing as a question one of the benefits that seems directly related to interpretation design: why is projecting always a re-projecting process?

Design action is displayed in the rapport with the context and in the ability to explore and evaluate emerging solutions. A path with no apparent right answer, but with truth, affected by the use and meaning we attribute to things resulting from our own creation. This allows understanding design in the second half of the twentieth century. As explained by Bernhard Bürdek regarding the influence of Leibniz's thought in German design: "se interesó igualmente por los procedimientos combinatorios e hijo aportaciones importantes para el perfeccionamiento de la lógica matemática. Precisamente estos aspectos fueron el fundamento del trabajo sobre a metodología del diseño en la Escuela Superior de Diseño de Ulm”[2] (Bürdek, 1994, p. 127). A process between finding and demonstrating (reflection, analysis, synthesis, rationale and selection of alternatives) and that although exported by his students as the ‘Ulm Model’, became one of the reasons for the shutting down of the school. During Maldonado’s administration, any project of industrial or craft nature was ignored, the attentions were entirely focused on the development of the concept for mass-communication with all other disciplines regarded as design supports. According to Bürdek, the Hochscule für Gestaltung in Ulm “no se mostró receptiva frente a lá entonces incipiente crítica al funcionalismo y al debate iniciado poco más tarde en torno a cuestiones ecológicas. Sobre todo en sus institutos reinó una comercialización tal, a través de proyectos industriales, que en el caso de algunos profesores ya no era posible hablar de independencia y distancia critica.”[3] (Bürdek, 1994, p. 42). The classic projectual method, science-based and product-oriented had revealed weaknesses by ignoring the external factors inherent to the process and to the impact of the final product on the user.

However, this model was not adopted in all contexts, as the English context or the Italian, in the sixties. In the former persisted a debate between craft and industry that endures to this day. In the later, the influence of the Renaissance and Futurism describes Italian culture as a broad context, once everything is presented in movement and ready for questioning and reinterpretation. This high propensity for debate will be decisive to the definition and development of projectual methodologies as a discipline.

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[1] (Authors’ translation): the more the objects are transformed into things, also more the 'factual material' becomes the 'matter in question', as they increasingly become design objects.

[2] (Authors’ translation): also interested in combining procedures and made significant contributions to the development of mathematical logic. These aspects were precisely the foundation for design methodology studies in the Ulm School of Design.

[3] (Authors’ translation): was not receptive to the then emerging functionalism critique and to the debate started somewhat later regarding environmental issues. Especially in these institutes, commercialization was so dominant through industrial projects that in the case of some teachers, independence and fair criticism became impaired.

According to Nigel Cross (1981), if the scientific method controls the experiments, classifying and analyzing them, and the social sciences and humanities method employs an analogy, metaphor and evaluation method, the interpretation method employs an intellective and dialectical method which sets and analyzes hypotheses, followed by a phase of verification of errors and satisfactory solutions (Cross, 2007) as they arise. The prudent designer ponders the complexity of factors constituting the problem, grasping and therefore issuing a judgment before setting for action. But this method does not avert others, it is achieved through literary culture, scientific culture and technical culture, but by means of education, in the sense that, as argued by Peters (1965), if "an 'educated man' is distinguished not so much by what he does as by what he 'sees' or 'grasps'. If he does something very well, in which he has been trained, he must see this in perspective, as related to other things. It is difficult to conceive of a training that would result in an 'educated' man in which a modicum of instruction has no place. For being educated involves 'knowing that' as well as 'knowing how". (Peters cit in Cross, 2007, p. 4). This implies applying a method that assumes there is prior knowledge on the existence of things in the sense that there is a predisposition to know. There is always a set data, a projectual limit, therefore, in order to operate, the designer does not start from void but from a new problem, new questions, hypotheses: "I designer più intelligenti non partono mai da una tabula rasa."[4] (Latour, 2009, p. 257). The designer must depart from the already existing that longs for a new interpretation. The benefit of a process in which projecting is always re-projecting is relevant to design practice that is strongly process-oriented, engaged in a cognitive and prudent method related to the concept of comprehension. As explained by Nigel Cross: "An aspect of cognitive strategy that emerges from some studies is that, especially during creative periods of conceptual design, expert designers alternate rapidly in shifts of attention between different aspects of their task, or between different modes of activity." (Cross, 2007, p. 88). The designer, who draws advantage from the sense of time and plunges into different scopes to re-project, sets a path that summons the process of attributing meaning, summoning new interpretations. An ambiguous comprehension framework, in the sense that the onset referent apparently stable in other context or time, in a new scope – design, in this case – may become a new hypothesis, an intelligent question. A process that is close to the abstract nature of design but also to the practice of the hermeneutic cycle. This path of interpretation design is totally different from methodological analysis, for etymologically, design has more than one sense and manifests in different ways depending on the endless evaluation of the variants defining the context. Therefore, the practice of the hermeneutic cycle can be faced as the reading key for interpretation as a design method; "The operation of the hermeneutical circle is not the employment of a method. It is not something we can choose to use or not, in the manner of a tool. It is, rather, embedded in all thought and in all action." (Snodgrass-Coyne, 2006, p. 45). The two authors further argue that clarifying a project does not imply formulating a procedure as the alternative to any other, but devising what is operational in each stage of comprehension. The benefit of interpretation design lies in the possibility to always hold something as a reference, to question each stage of comprehension with satisfactory hypotheses, with examples and not merely with knowledge. Because they are sufficient, these hypotheses acquire the quality of rethinking all possible scenarios without prejudice, unlike absolute hypotheses which by nature consider one scenario only. Interpretation design meets the operation of the hermeneutic cycle that raises questions and that according to the use and meaning found (depending on time, context, etc.) may (or may not) shift, becoming a new question, an hypothesis, satisfactory solutions open to new questioning. The design that relates to the context, in the use and meaning of things, allows these variables to interfere with the onset proposal, constantly revisiting, reformulating and reprojecting it. The process is more important than the result, compelling the designer to operate at that present moment with complex and expansive factors. The designer transforms the initial question onto a new question, reevaluates it, considers all parties engaged along the evaluation path between the identification of the problem and the hypotheses found, with a particular type of knowing that may be classified as 'pensiero debole', weak thought (Vattimo, 1983), not in the deductive sense that for being weak it is frail or faint, but because the presented 'truth' is mobile and susceptible to an infinite number of interpretations.

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[4] (Authors' translation): the more intelligent designer does not start from scratch anymore.

The semiotic competence in design

Interpretation design on the skin of buildings

In a conversation with Jean Baudrillard about the uniqueness of objects in architecture, Jean Nouvel (2002) raises the issue of architecture in the twenty-first century still being coupled to Vitruvius formulas, ignoring or avoiding new difficulties emerging in the second half of the twentieth century. According to the author, the demographic increase, the exodus towards the cities or the expansion of cities, but also the administrative inefficiency were new problems that architects were not prepared to deal with and whose answer lies essentially at the level of urban planning. Jean Nouvel denounces the gap and imprudence of architecture for ignoring this new scenario, “so in this sense, I’m against everything that is part of same order as Architecture. This means that from this point on, we must make use of another strategy, where we’re required to be slightly more intelligent – to the extent that we can be – required to constantly diagnose the situation, required to face the fact that architecture is no longer the invention of a world but that it exist simply with respect to a geological layer applied to all the cities…” (Nouvel, 2002, p. 18). Jean Nouvel even states he takes the side of whatever opposes this notion of culture. According to several authors such as Andrea Branzi (1975), the analysis of this complex and new city was the cause of architecture’s internal crisis. An investigation that for Branzi is never pondered by the architects, a project requesting orientation “verso i limiti oggettivi della città come strumento di vita, verso limiti ormai esplorabili di una disciplina che vive una propria contraddizione storica e intravede la propria possibile morte naturale all’interno di più ampi e profondi fenomeni di trasformazione culturale e sociale.”[5] We highlight two core issues from this reflection confirming the premises previously discussed regarding interpretation design: 1) It is essential to set conjectural answers oriented towards new solutions that meet the demands of the moment (time as truth). The project answer given by architects in the construction of buildings in the cities remains a sort of automatic procedure, an attention failure that urges resolution. It is important that the project’s designer recognizes in the complexity one opportunity to propose solutions. 2) The diagnosis to the complexity of factors is something that must be done continuously, not something that may or not be done. Projectual intervention in the city requires departing from architecture for historical and semiotic reasons, but architectural solutions are not necessarily the model for interpretation. Which architecture would be an interpretation model? Regarding the intervention in which the interpretation of the place is the style and/or the language of the project performer as response targeting a solution, architecture cannot be a reference for the interpretation of the city. Intervention is required specifically in the subproject of the ‘skin of buildings’, with a project tool from the twenty-first century and reflecting the volatile reality of the inhabitants, now more dynamic and ephemeral. An ambiguous reality, as is design’s nature, between conception and attribution of meaning. It is important to address the singularity of the ‘skin of buildings’ operating an inspiring model of interpretation originated from a fundamental concept, assessing and reassessing before delivering an answer. The interpretation design on the ‘skin of buildings’ is, for that reason, hermeneutical and dialectical. The skin is one of the components of the scenario interacting with man.

The singularity of the objects in the city as a space requesting interpretation may be understood as a premise for our research on interpretation design in the equipment scenarios, namely on the ‘skin of buildings’. Given that one of the roles of design is the connotative function and that semiotics[6], as theory of signs, deals with communication and connotation, we pursuit

[5] (Authors’ translation): towards the objective limits of the city as a way of life, towards limits now exploitable of a discipline that is undergoing an historical contradiction and assisting the own natural death as possible within a broader and deeper phenomenon of cultural and social transformation. BRANZI, Andrea 2003. Article from "L'architettura cronache e storia", n°234, April 1975. Andrea Branzi sulla linguistica architettonica di Andrea Branzi - Bruno Zevi. 13.2.2003. <http://www.antithesi.info/testi/testo_2_pdf.asp?ID=242>

[6] “Semiotics (Greek semeion ‘mark, sign’) older spelling of semiotics. This term was coined by Hippocrates (460-777 BC), the founder Western medical science, who established semeiotics as a branch of medicine for the study of symptoms – a symptom being, in effect, a semeion ‘mark, sign’ that stands for something other than itself. (...) American philosopher Charles S. Peirce as the basis for circumscribing an autonomous field of inquiry that de, like, Lock, defined as the doctrine of signs.’ The word doctrine was not used by Peirce in its religious sense, but rather in its basic meaning of ‘system of principles.” (DANESI, Marcel in Encyclopaedic Dictionary of Semiotics, Ed. Media and Communications, 2000: 203-204).

understanding how semiotics inform design, or as advocated by Bruno Latour (2009), understanding the benefits of semiotic competence to design. We are concerned with the space singularity referred by Jean Baudrillard (2002), the sense of location, expression, construction, attribution of meaning, and not the architectural meaning of buildings. The relationship established between the project performer and the citizen is a need to attribute and retrieve meaning, not merely an ability to communicate. Interpretation allows starting from a sign to travel a path leading to the understanding of the referent by means of other signs conveying connotation. According to Peirce “a sign, or ‘representamen’, is something which stands to somebody for something in some respect or capacity. It addresses somebody, that is, creates in the mind of that person an equivalent sign, or perhaps a more developed sign. That sign which it creates I call the ‘interpretant’ of the first sign. The sign stands for something, its ‘object’. It stands for that object, not in all respects, but in reference to a sort of idea (...)” (Peirce, 1955, p. 99). Peirce advocates a thought based on a theory of knowledge that asserts that the sign calls for sense, for meaning, emphasizing the importance of knowing what the sign means rather than what it represents, since the semiotic act regards understanding senses and meanings, instead of merely creating signs. With Charles Peirce the action takes place through signs, therefore it is crucial to grasp the definition of sign, analyzed according to each era. The meaning of the word ‘sign’ inserted in its context, the definition semiotics as a science has acquired and therefore interpretation as process of attributing meaning may lead us to the understanding of semiotics applied to interpretation design regarding the ‘skin of buildings’. Peirce called this pragmatic thinking ‘abduction'[7], as only logical operation which introduces any new idea. In the field of design, it can be translated into a process of suppositions, intuitions and not of certainties. In the present research on the action of interpretation design, this 'intuition' leads us to question and ponder about the ‘skin of buildings’, wanting to understand the difference regarding what might have been in its place, considering the characteristics that define the context. A path upon which the project’s hypotheses are autonomous cultural entities requesting permanent interpretation as in a narrative process whose characters (people, time, culture, context, ground, the skin of buildings, negative and/or positive factors) summon the narrator to provide them their speeches. An action exclusive to each actor, therefore qualified as identity of the space, but that will only be meaningful if there is a relationship between all characters. The façades request establishing dialogue with other 'patterns' so that reality may connote identity.

The logic intuition of new building skin solutions: the cases of Daciano da Costa and Carlo Scarpa

The interpretation of ‘genius loci’ (reason for the place) and the 'milieu' (environment) may be considered as an 'abduction' leading to the understanding of the function-meaning of the ‘skin of buildings’. Presenting innovative solutions, the designer can/should address the ‘skin of buildings’ as one of the city elements. To support this reasoning we will analyze two interpretation design cases, in Lisbon and in Venice.

In the first case, the atelier of Daciano da Costa started a proposal in 1999 for the reclassification of Praça da Figueira in downtown Lisbon. This intervention named by Daciano da Costa as ‘design as city fragment’ should reinforce the unity of the different façades in the square, simultaneously respecting their original diversity, given that this square belongs to the historic centre of the city, characterized by successive interventions over time. Through the ages, Praça da Figueira has been a meeting place for people, markets and communication, a public square, for public use, requesting a logical interpretation of signs requesting decoding. “O recurso a um leque restrito de cores e de motivos, tomados directamente da tradição de revestimento azulejares de fachada, a exploração sistemática das suas possibilidades de combinação, por forma a definir uma tipologia de padrões e a gradação das respectivas densidades, permitiu estabelecer uma série de critérios de aplicação (…)” (Costa Martins cit in Martins, 2001, p. 224). The result is the miscegenation of

[7] Abduction, from the Latin AB ‘away’ + DUCERE ‘to lead’ (see also *deduction, *induction). Term used by Charles Peirce to designate the kind of reasoning whereby a concept is formed on the basis of an existing concept or model; an abduction is essentially a ‘hunch’ as to what something entails or presupposes (DANESI, Marcel. Encyclopedic Dictionary of Semiotics, Media & Communications, 2000:3).

graphics elements connoting the experience of the square as if it were a scenic stage: the interpretation of immaterial culture, as the Lisbon city cries, the colors, and the trading feast at the square. Because it was process-oriented, the sub-project or the 'pattern' of the façade of the requalification project of Praça da Figueira in Lisbon has not ended yet. In terms of product and according to the City Hall, a total of about 150 thousand Portuguese ceramic tiles (azulejos) made the intervention 'too' expensive and therefore only partially executed, indefinitely postponing the façade intervention.

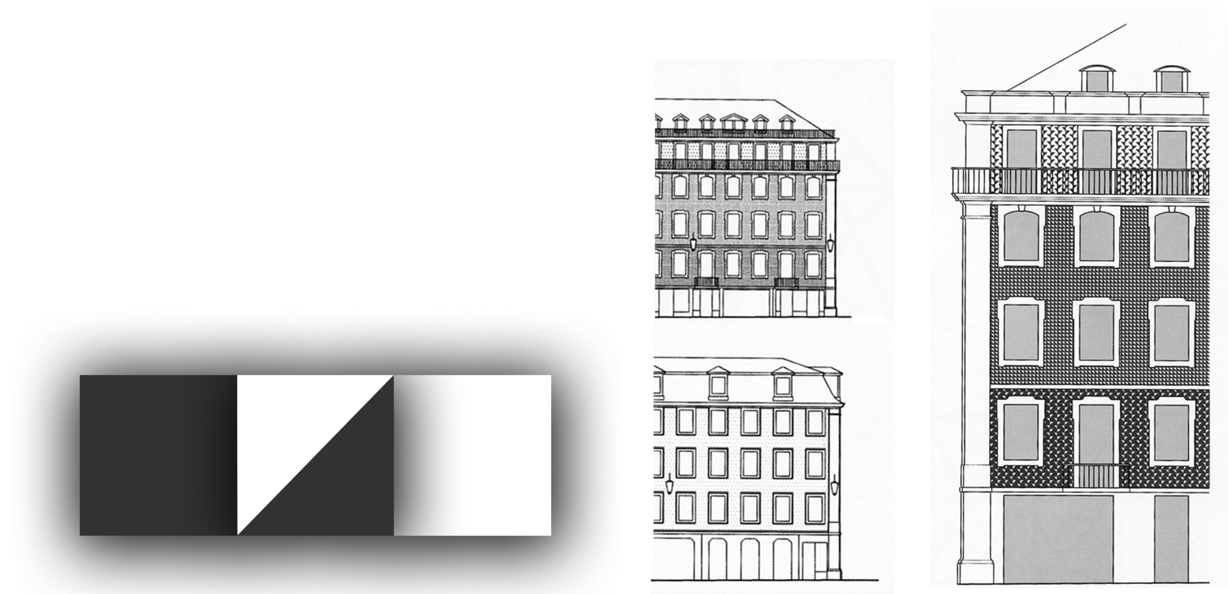

Figure 1 Project of the building skin by Daciano da Costa (1999 -). From left to right: Drawing of the 3 tiles (azulejos) used on the buildings skin at Praça da Figueira in Lisbon – Image by the authors. East Project and South Project. Vertical monochromatic sequence with variation of densities – Images adapted from the book 'Daciano da Costa, designer' (Martins, 2001, p. 225).

The second case regards Carlo Scarpa's interpretation on the restructuring of the Olivetti's shop in San Marco square in Venice, between 1957 and 1958, whereas the restoring of the Venetian shops began in 1950. As explained by Carlo Scarpa "Adesso ho per la testa un progetto per un negozio a Venezia, per un cliente molto danaroso. Poiché non posso toccare nulla, debbo fare una pelle, una fodera - ma quale è la più idonea in quel posto?..." (Scarpa cit in Dalco-Mazzariol, 1987, p. 287). After studying the problem, Scarpa intervenes in an emptied space, starting from a previously defined context, combining the tradition of the materials with the new technological developments available at the time: the Istrian marble, the Aurisina marble, tamped concrete, lapidated crystal in metallic structures, teak wood, ebony wood, pate de verre, stainless steel, stone, and opal glass. The process was performed by local artisans and fortunately, as stated by the author, limited by the client. The skin should be the outcome of the inside of the shop, therefore should reflect the luxury in materials and construction methods through handmade techniques. The complexity of elements that constitute the façade would infer the value of a client intending to connote the visit to one of the most luxurious squares in Europe. In this case, as argued by Carlo Scarpa, the intention was not to make one more shop. As he defined regarding the Venetian Olivetti store: "Chiesi al committente: "Cosa volete? Devo fare degli uffici?" -"No, no... un biglietto da visita..." (Scarpa cit in Dal Co-Mazzariol, 1987, p. 287).

Daciano da Costa and Carlo Scarpa, in different times and contexts perceived the need to apply a procedure based on a design project rationale that would call upon the complexity of signs that interpret the city. Through narrative proficiency, both creators called not only upon reflection but also upon the excellent opportunity to devise a system with the ability to define and relate the sub-projects in a dialogue between citizen and space. As advocated by Nigel Coates (2008), architect and head of Architecture at the Royal College of Art, nowadays it is important to think about the experience involving the body, not the body itself. "The city can reach a density of meaning because of the spirit in which it is put together rather than the sum of its individual parts. With today's means it is not only possible to explore architecture as an assembly of physical fragments, but as a ‘filmic’ continuum of events and experiences. In doing so it would ‘contain’ the interface between the individual and the place, and the various built bodies in it.” (Coates, 2008, p. 43). The sub-projects are 'patterns', autonomous units of thought installed in the ‘skin of buildings’ whose exterior means what happens inside.

Figure 2 Olivetti Store in Venice by Carlo Scarpa (1957 – 1958). Left to right: Main façade of the Olivetti store in Venice (Picture by Seier+Seier), stairs detail from the outside perspective (Archivio Fotografico della Fondazione La Triennale di Milano) and detail of the building skin (Picture by Seier+Seier).

Conclusion

We dare assuming that the project of the vertical surface of the city should take into consideration the design of the cultural experience. Among various satisfactory hypotheses we may consider Daciano da Costa and Carlo Scarpa, who made an intervention in a historical centre as a project’s answer with cultural implications. However, the designer (Daciano da Costa) gives an answer in a broader scale than the architect (Carlo Scarpa) who develops an intervention at the level of the detail. Da Costa is interested in the urban perspective and not in the building per se. It is important to refer that the clients of both of them are different: a town (Lisboa) and a brand (Olivetti). The first client is more generalist and asks for an inclusive project, for all people. The second asks for a luxurious project related with S.Marcos which cultural factor is the element of recognition of a town like Venice. Thus, the designer as an interpreter applies a combination of factors, such as existence, time and place, before pondering the city project. An action in distinctive parts, exhibiting the relationship established between fragments and man. To consider the ‘skin of buildings’ one of the components in this scenario indicates interpreting the city membrane as an 'intelligent skin' that relates to the citizen, to the building that historically already exists and to the other elements of the city. The project’s hypotheses are answers turned into questions, establishing a dialectic process with the initial question, and for that reason, with man. Fragments for which the designer lays out a language, an identity that connotes the citizen’s will for self-representation. Fragments interpreted like in movies, with core components as the Luchino Visconti’s draperies or Wim Wenders’ city. An intelligent skin that addresses all elements: people, culture, context, the (old and new) technological developments, the morphology of the materials, but also with the negative factors that persistently and relentlessly define the twenty-first century scenario. A skin that relates to the space and that for being interpreted through design action appears as a cognitive and dialectical skin: connoting meanings upon which the citizen is self-recognized in the outside, as a mirror reflecting various 'selves' in a building façade. As if by projecting outwards what takes place inside the skin would acquire a twenty-first century human body, a skin that mustn’t necessarily reveal the actual age of the body. Something happens, that other disciplines like cinema, fashion, literature or music have already explored, result of the evolutionary analysis of context and man. As if revisited, the skin of buildings yearns to be restored acquiring as many faces as the states of mind of the activity/ies taking place inside the building.

The experience of interpreting the city through design action already has a few decades, holding as chief reference the example of the experimental projects in the sixties by Peter Cook’s

Archigram or Andrea Branzi's Archizoom. The former based on an experimental utopia and the latter departing from the city as it was, not as it might be. We shall consider both cases as other satisfactory hypotheses to reflect on the operation of the hermeneutic cycle applied to design practice. An operation that is not intended to conceive new objects or new buildings, but rather product systems to qualify the objects singularity, in the present case: the peculiarity of the 'skin of buildings'. Operation for the designer to doubt, discuss and question with autonomy, with room for error and for certainty.

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Retail Design and Sensory Experience: Design Inquiry of Complex Reality

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Abstract
Understanding sensory stimulation of people in human environments is vital to designing an interior space. The senses play critical roles in human experience and the memories and emotions tied to it. In retail design brands associated to sensory experience attract customers and stimulate strong, positive, and distinctive impression across all five senses. In this case multiple sensory cues are found in a store interior including store and display layout, lighting, interior fixtures and furnishings, music, and air quality such as fragrance and temperature. All contribute and complement each other in orchestrating the complexity of interiors.

Malnar and Vodvarka provide sensory schematics to analyze the built environment. They devised a *sensory slider* to tap the clarity for a particular sense (Malnar & Vodvarka, 2004). Analysis of resulting sensory levels in interior environments provides expanded understanding of the interior's physical condition in relation to sensory perception of users. For retail, the sensory slider was simplified and adapted to analyze visual, acoustical, olfactory and tactile information in store "S". Key factors are found: (1) visual cues are most evident in retail interiors supporting previous research; (2) non-visual stimulations are evident in design narratives revealing emotional domains; (3) multi sensory experience supports literature on branding practices in retail; (4) interior detailing appear to impact all senses.

Using the tool contributes to creating a conceptual framework when evaluating physical environments and emotional factors concerning customers satisfaction. Implication on the application of the method to the design practice is noted. Interior designers as collaborators with retailers will find it useful for the branding and for new store design and services. Insights and directives from this work suggest added research possibilities and application in interior design, graphic design, as well as store marketing and retailing.

Keywords
Design methods; interior design; human factors; sensory experience; experiential knowledge

Introduction
Issue
In retail, storeowners and retail designers are concerned with success of market strategies driven by customers' desire, perception and satisfaction. As sensation-seekers, according to Floor (2006), consumers enjoy being inspired by a unique range of experiential shopping environments. These experiences and attractions include seeing, hearing, touching, smelling, and tasting products on display. Further, Healey relates customers' brand experience with what is memorable. He addresses customers' purchasing behavior as being driven by storytelling and emotions. A fact exploited by brands (2008). Other studies suggest that store location, atmosphere, emotional attributes, sensory stimulation, and visual presentation are contributing factors to customers' behavioral responses (Ahn, 2008; Andreu, 2006; Gobé, 2001; Lam, 2001; Park & Farr, 2007; Healy, 2008; Song, 2009). While studies show these factors influence visitors' perception of the store, the application and understanding of sensory stimulation and its

association in retail interiors remain limited. In what manner do people perceive memorable shopping experiences? How does the physical environment draw customers' attraction through human senses? How might we design a space to create positive memory and sensory appeal?

Sensory Branding in Retail Design

The effect of sensory stimulation on people and their environment is vital to designing an interior space. The senses play critical roles in memories and emotions attached to human experience. Lindstrom (2005) states that our emotions are linked to the information gathered through the senses. He introduced the concept of *sensory* branding that stimulates and enhances consumers' imagination and perception, creating emotional ties between the brand and consumer. Sensory stimuli can motivate consumers' purchasing behavior, spark their interest, and allow emotional responses to dominate their rational thinking (Lindstrom, 2005). Lindstrom gives an example of customers' personal interaction at Starbucks' coffee shop where the brand is associated with a sensory experience stimulating a strong, positive, and distinctive impression across all five senses. In this case multiple sensory cues are tapped; lighting, furniture, interior furnishings, music, coffee and aroma, which all contribute and complement each other as if a sensory orchestration. When the sensory experience is maximized, the store atmosphere creates a compelling experience that consumers will want to repeat through repeated visits.

According to Gobé "Understanding your customer well and catering to the taste and the aspiration of that customer is the key to building a long-lasting relationship" (Hellman, 2007, p.135). His philosophy of using the *senses* for a retail brand led to the success in redesigning the brand new style for Godiva. He emphasized that the connection between the sensuality of chocolate and the retail design creates an emotional dimension that customers could experience within the retail store (Hellman, 2007). At Godiva, the store experience is enhanced by a stylistic design of the interior, incorporating the brand's history and origins in Art Nouveau in Brussels (Figure 1). Visual sense is emphasized by adding interior details such as brass light fixtures, the wall mural, a large curved glass case, wire sign holders, white marble tabletops and cherry-wood counters, all contributing to European elegance and luxury. Sensory appeal is

Figure 1. The entrance to the Godiva store

doubled with the unpackaged individual pieces of chocolate that are displayed for the customers to taste and smell, bringing multi-sensory level and personal bond with the customers. Healy (2008) addressed the impact of using a brand history and states that most buying behavior is driven by storytelling, experience and emotion. "The experience of enjoying a great story is powerful one that pulls in all of our senses and immerses us so that we feel as if we are actually living the story" (Healy, 2008, p.28). His branding perspective reminds designers a fact that emotions drive our behavior including buying. Experience is the best way for consumer to appreciate things, whether the service or the product; experience is usually the most memorable aspect of each thing we buy (Healy, 2008).

Purpose

This study involved customers' sensory experience related to the overall store interior. The objectives have a two step design: (1) to develop an analysis tool to identify and describe sensory strengths, sensory limitations and their potentials in retail settings and (2) then using the tool examine existing sensory conditions from consumer and employee perspectives. Research questions include: (1) what kinds of sensory experiences currently occur in retail environments? (2) In what manner do the physical environmental features interface with these kinds of human senses? (3) What directives emerge for interior designers doing retail spaces? The answers to these questions will amplify the development of sensory design in the field.

Review of Literature

> *"The external senses have a double province; to make us feel, and to make us perceive. They furnish us with a variety of sensations, some pleasant, others painful, and others indifferent; at the same time they give us a conception, and an invincible belief of the existence of external objects…...The feeling which goes along with the perception, we call sensation. The perception and its corresponding sensation are produced at the same time. In our experience we never find them disjoined. Hence we are led to consider them as one thing, to give them one name, and to confound their different attributes…." (Reid, 1785)*

Sense, Sensation and Sensory Experience

Knowledge of sensation and perception, particularly their causes and processes, has been studied across fields such as philosophy, psychology, physiology, and psychophysics through cognitive theory. Researchers in scientific inquiry suggest how senses are detected, how it feels to perceive them and how they provide sensory information (Goldstein, 1996). Gibson (1966) defines the term *senses* as the systems for human perception that furnish us with a variety of sensations. He explains that the *senses* can obtain information about objects in the world without the intervention of an intellectual process (Gibson, 1966). When the senses are stimulated, each sound, taste, smell, touch, and image sends *sensory* information to our brain, where the sources and causes of stimulation are processed and perceived (Augustin, 2009).

The process of perceiving our built environment involves more than a sequence of steps resulting in experiences called *sensation*. Human experience is affected by cognitive processes such as thinking and memory that are obtained by organizing and integrating information and making inferences from it. Researchers accounted for the perceptual complexity of *sensation* that was converted into perception by past experience or memory (Helmholtz, 1925; Titchener, 1910). Human sensory experience involves more than a single sense (Augustin, 2009; Gibson, 1966; Goldstein, 1996). The ways in which humans respond by looking, listening, sniffing, tasting, and touching are not only achieved by the single input of sensation, but also by a combination of perceptual systems that overlap one another (Gibson, 1966). Goldstein (1996) describes the process of perception as an interaction between the information stimulating the receptors and information from our past experiences that already exists. Sensory inputs have direct influence on human behaviors and attitudes. Our emotional and cognitive responses are affected by our feelings from seeing, hearing, tasting, touching, and smelling (Augustin, 2009).

In retail environments, different levels of stimulation can add multiple dimensions to the sensory experience. A customers' experience is extended when exploring, orienting, and investigating different levels of sensory inputs that are available in the retail space. Thus sensory experiences are of particular importance to retailers because the store environment has a greater effect on a customers' emotional response to an object or place.

Visual Sense and Sensory Information

Sensory experience has origins from visual, auditory, tactile, and olfactory systems influencing humans' cognitive responses (Augustin, 2009; Gibson, 1996). Among the different sensory systems visual information primarily influences how we analyze things around us. Sight not only affects humans physically and psychologically, but also has strong association with other senses. When we touch something that we don't see, we try to determine what we are touching with the sound, smell, and taste of the object. Lindstrom (2005) mentioned that sight often overrules the other senses, and has the power to persuade us against all logic. Designers always consider physical visual stimulation, which is just one role of visual design. Furthermore, intricate details are used to prolong visitor's stay. According to Clark's study, people remember simple figures more easily than complex ones (Lawless, 1978). People are fascinated by ornament details, because those details cannot be remembered for along time. It is thus ever new and interesting, and people are willing to devote their information-seeking attention to it (Malnar & Vodvarka, 2004). Therefore, people linger longer time in a space where there are more details than in one with fewer details. This approach can be used by designers to control rate of movement. Far from concealing deficiency or redundancies, ornament delivers vital function. It precisely identifies a space, including its social and cultural function, and transmits that identity to the audience (Malnar & Vodvarka, 2004).

Through the visual sense, all the store elements in front of the customers' eyes will have a role in their perceived impact. Massara and Pelloso (2006) introduced the concept of the macro, the meso and the micro environment (Figure 2). The macro-environment concerns all the variable

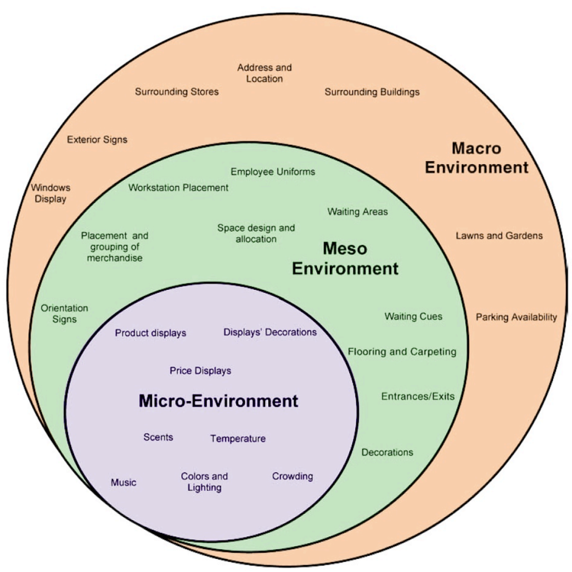

Figure 2. Scales of the store environment (Massara & Pelloso, 2006, p. 521)

on the exterior of the store whereas the meso-environment contains the variables that determine the structure of the interior. The micro-environment includes elements within close proximity to the customers such as shelves and tabletops. This impact on the customers' memorable experience starts from meso-environment elements, such as floors finish and ceiling materials, to micro-environment elements, such as product packaging and brand logo. The glare on the floor, the distraction from light fixture, and the hidden product in the package may affect the customers' experience and create a negative impact. Their judgment will be embedded in their mind with the brand. Therefore the sensory experience will be focused within the meso and the micro-environment.

Non-Visual Sense and Sensory Information

Even though vision is our primary sense, we use our other senses more often than we realize. Our other senses contribute a significant amount of extra information and experience to our everyday lives. Healy (2008) expressed the need for branding professionals to consider the other senses in designing every aspect of the brand experience: product, packaging, advertisement, and designing of retail environment.

In interior design practice, smell seldom receives attention. However, smell has a strong association with feeling and influences people's activities. Odor is a key motivational factor in human behavior, playing a critical role in behavior patterns. Smell affects areas of the brain that deal with emotions, feelings, and motivation, which can lead to a specific behavioral response. According to Malnar and Vodvarka, taste and smell usually function in concert and can be regarded as alternatives ways to experience similar phenomenon (Malnar &Vodvarka, 2004). Tuan suggested that odors lend character to objects and places, making them distinctive, easier to identify and remember (Tuan, 1977). Pleasant odor and fragrance provide a space with a favorable identity. Floor (2006) stated that coffee shops, candle stores, perfumeries, bakeries, and lots of other stores are characterized by the smell of their products as part of their meso and micro experience. Specific fragrances perform precise functions. For example, lemon and peppermint can reinforce alertness and energy; lavender and cedar can reduce tension (Iwahashi, 1992). This is why lavender fragrance is adopted in spas, and air fresheners mainly have a lemony smell. This theory has been put into use by interior designers. For example, several large companies introduce fragrance to heating and air condition systems to boost work efficiency and reduce stress. Fragrance makes a space more favorable to some; while if allergic to smells some could object. Knowing a range of responses has application in interior design practice.

"Without sounds, visual perception is different: less contrasting, less attention-demanding, and less informative" (Malnar & Vodvarka, 2004, p.138). When referring to the sense of sound, background music may be the first thing to come to mind. However, hearing as related to sensory design, is more complicated than that. Sound has strong association with human emotion. According to Floor (2006), older shoppers shop longer and purchase more when background music is playing, while younger shopper respond similarly to foreground music. Sound can be used to attract more attention to specific products or to reach specific target groups. Sound also plays an important role perceiving a space and enhances sight sensory perceptions. An example of applying sound in retail environment is found at Abercrombie & Fitch stores (Gobé, 2001). They have DJs in the store that carefully select music appealing to the shoppers that is consistent with the brand' personality and attitude. Sound may complement vision to perceive space in respect that it enlarges one's spatial awareness to include areas behinds the head that cannot be seen. Therefore, sound dramatizes spatial experience (Tuan, 1977).

Like sight, the haptic information plays a significant role in perceiving the world. According to Malnar and Vodvarka, the haptic system includes three branches: touch, temperature and humidity, and kinesthesia (Malnar & Vodvarka, 2004). Designers may pay more attention to surfaces which customers regularly touch, applying different textures to achieve sensory perceptions. Lindstrom (2007) states that the feel of a product is essential in forming the perception we have of the brand. Enquist (n.d) adds to it that the sense of touch establishes our existence because as we touch we feel ourselves touching: it confirms the presence of whatever it is we are touching. This is important for the designer, especially in complex reality where people's stress levels generally seem to be at a maximum, and where there is a deficiency of connection and exchanges. According to Lindstrom's study 35 percent of the interviewed consumers stated that the micro experience of how the phone felt was more important than the appearance. Further the study revealed that 46 percent of U.S consumers thought the weight of the phone was more important than the look in their purchasing decision. The Apple store demonstrates its new iPhone on a display table so that customers can touch, hold, and fell their new product, making full use of the sense of touch. Studies have shown that customers are more likely to touch a product in the process of evaluating it. Mainly because touching substitutes the absence of information at the meso level where shoppers use their senses to gain more information, whether it includes the product itself, the store fixture, the room temperature, or even the door's handle. The ability to touch the product increases the chance that the product will be bought. If customer can grasp or feel products, shopping can become more pleasurable.

Research Method

Overview

Malnar and Vodvarka's book on *Sensory Design* offers a sensory slider, a tool (Figure 3) for analyzing and measuring sensory existence and its intensity in existing buildings.

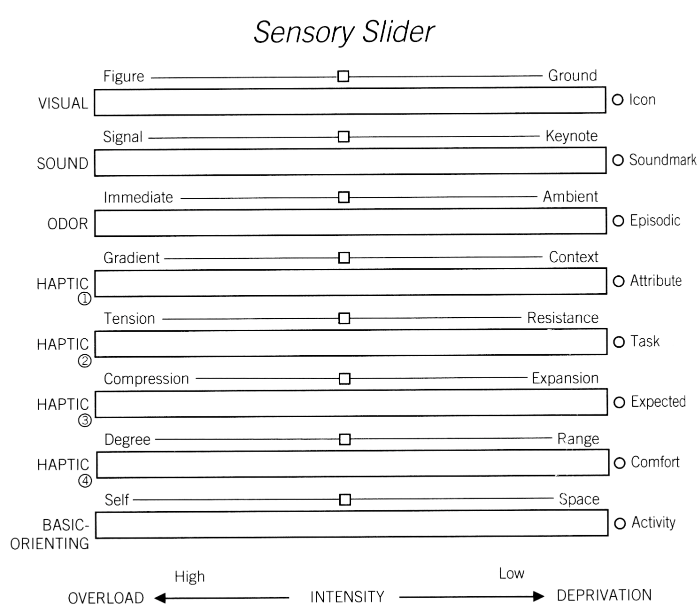

Figure 3. Sensory slider created by Malnar & Vodvarka (2004, p.248)

Analysis of sensory levels in interior environments requires observation of the interior's physical condition in relation to sensory perception of users. In order to study sensory stimulation and association in retail settings, a simplified version of the sensory slider was created (Figure 4). Using this adapted sensory tool, visual, sound, odor and haptic senses were analyzed to evaluate positive and negative values of existing sensory stimuli. The existing perception level, represented by a circle symbol (●) for each one of the four senses is shown in the slider while addressing the reasons that leads to that result. The expected value of sensory perception of the environment, represented by a square symbol (■), is shown as well while explaining what was supposed to be expected from that particular environment.

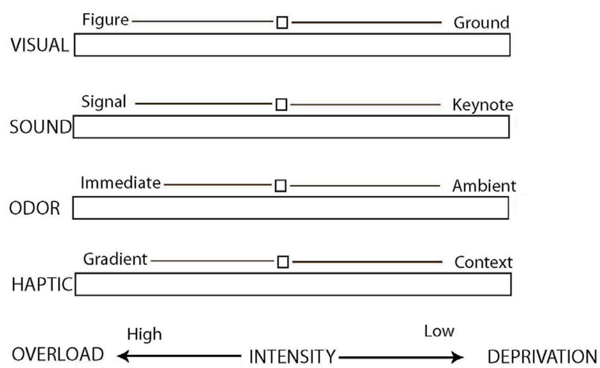

Figure 4. A simplified sensory slider

Site observations and sensory analysis followed three steps. (1) *Sensory diagnosis*: identifying common concepts to determine sensory strengths and sensory limitations, (2) *Sensory exploration*: testing the tool by analyzing consumer's sensory experience on the selected environment, (3) *Sensory treatment*: refining concepts and suggesting the sensory changes. Frequent on-site observation was conducted focusing consumers' use of space and their interaction within the store environment.

Site Analysis: "S" Retail Store

Analyzing the sensory level of an interior environment requires program information of the existing space in relation to sensory perception. The interior of "S" store is located within a two-story building with a total area of 1,992 square foot. The main entrance of the building faces Main Street of downtown providing visible access to the pedestrians. However, the display windows are not noticeable in terms of the store's identity, products, and service offered to attract customers from outside to inside. The interior space is divided into three distinctive zones: entry, point of sales and seating.

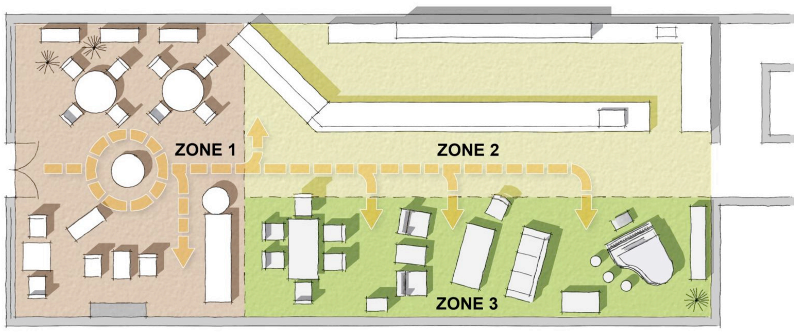

Figure 5. Circulation and zoning of existing store

Visitors enter the space through the entry door located at the front. Zone 1 is entry area that allows multiple seating, creating visitors' first impression. There is obvious flow of traffic along with distinct noise from the street, and other background sounds that are related to sales activity. This area exhibits a variety of items either for sale or for display only, creating distraction to a brand perception.

Major point of sales occurs in Zone 2 where gelato ice cream, fresh chocolate products and packaged items are displayed. Along the linear path traffic is congested by either groups or individuals due to the limited space facing the sales area. The majority of the visitors had their attention on the fresh product, although other visitors seemed interested in the products on display including pre-packed chocolate, coffee beans, gift items that are associated with a brand. Zone 3 has additional seating arrangement with a mixture of furniture types such as a dining table, a sofa and armchairs, a grand piano, and display cabinets.

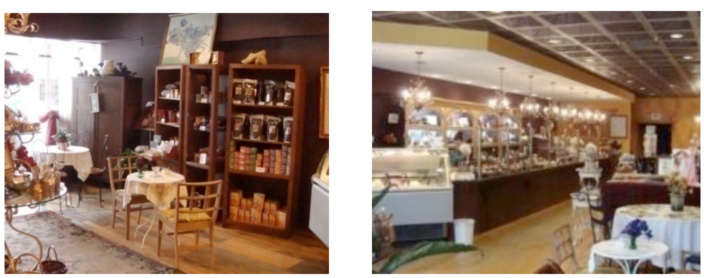

Figure 6. Interior view

Sensory Analysis

The layout of space gives an understanding of space flow relevant to human behavior and responses. Based on the site analysis problems are identified by analyzing consumer's sensory experience on the overall store environment.

Visual Information

The sensory level is overloaded for this main sensory perception. This result is derived from the following reasons:

- Visual clutter all over the space
- Over stimulation from quantity and type of furnishings, fabrics, and finishes
- Distraction of unintended illumination
- Reflection from the high glass barrier

- Over crowded with non-related products such as personal photos

Figure 7. Indirect lighting

Figure 8. Visual clutter

The expected level of visual information is higher than the current level. The unmatched expectation for this sensory perception is missing the following:

- Organized layout
- Clear pathways
- Quality fabrics and finishes
- Focused and non-distracting lighting
- Cohesive presentation of product

The sensory level is analyzed in the sensory slider (Figure 9). The slider for the visual bar is set at a high intensity. There is a strong figural content and high level of differentiation from ground. However, the visual quality of existing condition is misleading due to the excessive amount of light, reflection and glare from the surface materials, and type and furnishings and fabrics causing over stimulation. The circle symbol represents the existing level of visual information while the square symbol represents the expected sensory level.

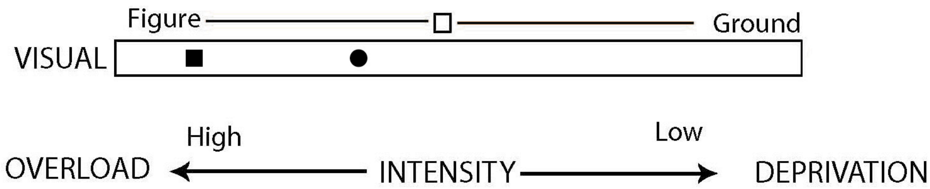

Figure 9. Visual rating on the sensory slider

Acoustical Information

The sensory level is set at a moderate level, providing a rich sound attribute. This result is derived from the following reasons:

- Sound system positioned at two ends of the store
- Diverse type of background music
- Musical performance on the weekend
- Customer's dialog, especially at the sales counter area
- Change in flooring material
- White noise, sounds from service area and mechanical sounds

Figure 10. Placement of grand piano

Figure 11. Speaker location

The expected level of acoustical information is higher than the current level. The unmatched expectation for this sensory perception is missing the following:

- Calm, controlled, and unified music
- Quiet environment for human interaction at the sales area

The sensory level is analyzed in the sensory slider (Figure 12). The slider for the sound bar is set at a high intensity. There is a low signal/keynote ratio, suggesting higher value to the expected level. The circle symbol represents the existing level of visual information while the square symbol represents the expected sensory level.

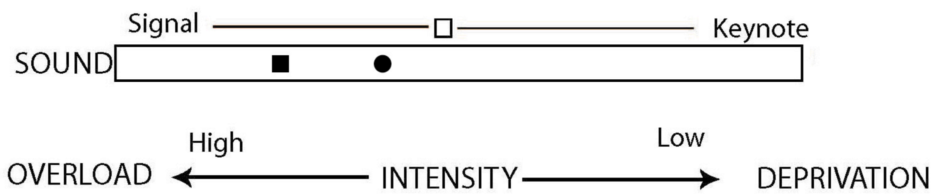

Figure 12. Sound rating on the sensory slider

Olfactory Information

The sensory stimulation is absent and the sensory level is at zero. This result is derived from the following reasons:

- No odor at all
- Temperature and atmosphere results in diminished smell
- Chocolate products are not made in-house

The expected level of olfactory information is significantly higher than the current level. The unmatched expectation for this sensory perception is missing the following:

- Given characteristics of the product and purpose of the space, the olfactory sense would be perceived to be high
- Low air circulation in certain areas
- Production of in-house chocolate products to have the freshly made chocolate smell

The sensory level is analyzed in the sensory slider (Figure 13). The odor information is very limited, however set at a central point. There is a high immediate/ambient ratio, suggesting higher value to the expected level. The circle symbol represents the existing level of visual information while the square symbol represents the expected sensory level.

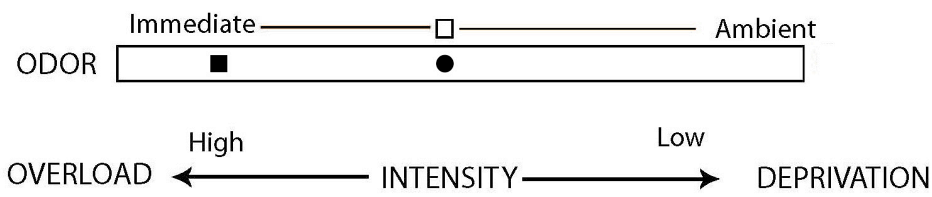

Figure 13. Odor rating on the sensory slider

Tactile Information

The sensory level is set at a moderate level, reflecting relatively low haptic rating. This result is derived from the following reasons:

- Tactile interaction is a secondary sense in the space
- Tactile stimulus comes from interaction with packaged products
- Coldness from the high glass barrier between customers and product at the sales counter
- Interference of multi-textured surfaces

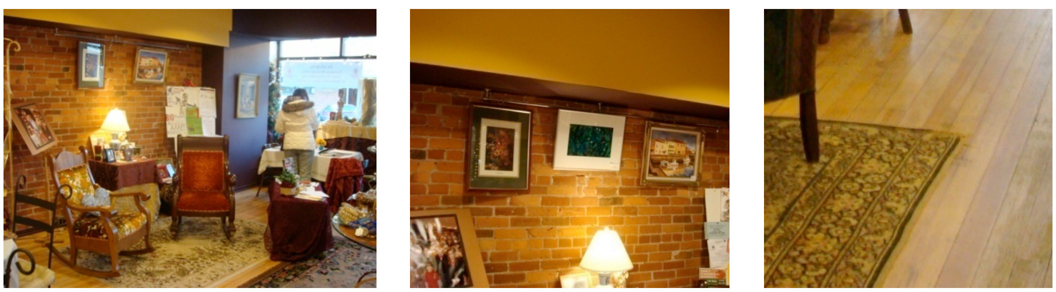

Figure 14. Interior furnishings

The expected level of olfactory information is significantly higher than the current level. The unmatched expectation for this sensory perception is missing the following:

- Main objective of a space to observe, sit, eat and have social interaction without tactile interference
- The main source of tactile stimulus should be the product

The sensory level is analyzed in the sensory slider (Figure 15). The haptic information is set lower level. The circle symbol represents the existing level of visual information while the square symbol represents the expected sensory level.

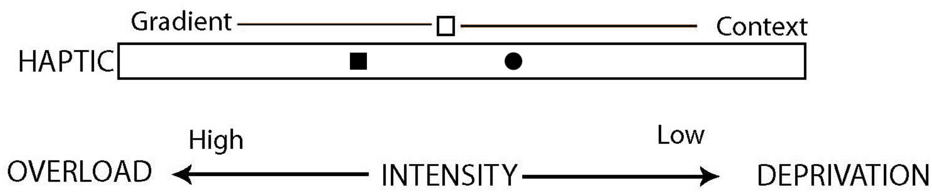

Figure 15. Haptic rating on the sensory slider

Conclusion

Relevance to Interior Design

The goal of sensory analysis of retail interiors is to determine problems and issues relevant to the customers' multi-sensory experience during the activity of sales, service, shopping, entertaining, and marketing. This study was exploratory given little research and writing on the relationship of human senses and retail interiors. The work does give direction for advancing the understanding of sensory perception as a key determinant of customers' attraction and satisfaction in retail. It clarifies for further study the hypothesis that a range and heightened sensory experience will induce stronger customers' shopping experience and thus sales and its meaning to design. Data can be further enhanced for maintaining or enhancing the existing condition and operational, aesthetic, expressive, and other qualities of retail design. Ultimately, the sensory tool may be applied to the creation of a unique retail experience as well as a range of other settings. Using the tool suggests the idea of creating a conceptual framework when evaluating the physical environment and creating emotional attributes toward customers' satisfaction. Interior designers as collaborators with retailers may find it useful for the branding of new store environments and related services. Insights and directions from this work suggest research possibilities and application in interior design, as well as store marketing and retail business.

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On the Impact of Systemic Thinking in Sustainable Design

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Abstract

The world faces significant problems of high complexity. The potential of knowledge, methods and tools used in design education and practice are useful for the development of sustainable solutions. Sustainable design is regarded in this paper as the integration of multiple competencies in order to generate and implement creative interventions that trigger positive changes in complex socio-technical systems. In this paper, a multidisciplinary case study is created for experimentation on the way in which different student groups approach complex problems, the type and level of thinking used, and the evaluation of the adequateness of their proposals by experts. The groups analysed encompass eighty subjects enrolled in four different undergraduate and graduate programs. In the experimental groups, the lecturers integrated a number of methods and tools that target purposeful change in complex adaptative systems. In the control courses, the lecturers applied the more traditional methods and tools that are customary of their disciplines, without explicit linkage to complexity and systemic change. Students participated voluntarily in a team activity dealing with the pervasive and complex problem of garbage disposal and transportation in large urban settlements. The resulting proposals provide valuable insights, for example regarding the way in which students analyse the situation, the type and level of change that their proposals imply, and the scope and depth of their causal analysis. This study demonstrates that the set of methods and tools currently used in some of our courses are valuable tools for promoting systemic thinking in our students. Evidence is also provided to suggest that regarding systemic reasoning, the distinctions between disciplinary and multi-disciplinary teamwork may be weaker than what was expected. Furthermore, diagnosing systemic thinking in a team or a person would remain largely irrelevant if this type of reasoning failed to produce more creative and higher quality responses. Our study confirms the premise that teams with high-order systemic thinking consistently yield high-quality and original solutions.

Keywords

systemic thinking; design education; sustainable design; complex systems; creativity.

Rethinking systemic sustainability

The world faces a number of significant social, economic and environmental problems of high complexity, for example as a result of population growth and resource depletion. The potential of knowledge, methods and tools used in design education and practice are increasingly being recognised beyond the areas conventionally associated with the design disciplines, i.e., products, buildings, visual communication, and digital media. Strategies, services and experiences designed to address complex problems are being considered of key relevance for creatively conceiving and implementing sustainable solutions across the disciplines. The work presented in this paper emerges from the coincidence of a group of scholars from diverse disciplinary backgrounds who share a deep concern about the type of creative thinking that may be necessary to develop in our students if they are to face the complex problems in years ahead.

Sustainable design is here considered beyond currently limited interpretations such as the use of recyclable and certified materials, 'green' gadgets, or bioclimatic buildings. Sustainable design is regarded in this paper as the integration of multiple competencies in order to generate and implement creative interventions that trigger positive changes in complex socio-technical systems. Such a broad view of design is likely to demand a disruptive change in how we educate designers today. Moreover, it may demand a major review of education in general, for instance by integrating strategic design skills in all disciplines including engineering and business.

An implication of this paradigmatic change of view of design, is that the established design disciplines do not have the prerogative in the purposeful formulation of creative interventions in complex systems. Arguably, n-disciplinary teams (where multiple or n disciplines are integrated) are more likely to achieve creative collaborative interventions than teams from any separate discipline alone. Such teams may find design strategies, methods and techniques to be valuable in the generation of creative solutions to complex problems. Nonetheless, to our knowledge, there is insufficient evidence available to date regarding the contribution of design principles beyond ambiguous buzzwords like “design thinking”.

In this paper, a multidisciplinary case study is created for experimentation on the way in which different student groups approach complex problems, the type and level of thinking used, and the evaluation of the adequateness of their proposals by experts. The groups analysed include four undergraduate courses and two multidisciplinary graduate courses encompassing a population of eighty subjects enrolled in Industrial Design, Electronic Engineering, Manufacturing Systems and Business Administration.

In two experimental groups, the lecturers integrated a number of methods and tools throughout the semester that target purposeful change in complex adaptative systems. In the four control courses, the lecturers applied the more traditional methods and tools that are customary of their disciplines, without explicit linkage to complexity and systemic change. Students participated voluntarily at the end of the semester in a three-hour team activity dealing with the pervasive and complex problem of garbage disposal and transportation in large urban settlements. The resulting proposals provide valuable insights related to the impact of educational interventions, the composition of multidisciplinary teams, and the way in which students analyse complex situations.

The following section of this paper briefly introduces the theoretical underpinnings of systems thinking and introduces the concept of systemic thinking. Section 3 presents the context of our case study and our research hypotheses. Section 4 details the experimental details of our work. In section 5 the main results are analysed. Finally, section 6 presents a discussion of the significance of this work and concludes with a future research agenda to develop toolkits for systemic thinking.

Targeting sustainability through systemic thinking

Systems thinking has been defined as the type of problem-solving reasoning skills that deal with how causes and effects interact adopting a non-reductionism approach [3]. Existing frameworks distinguish basic/low-level, intermediate/mid-level and advanced/high-level systems thinking styles [6]. In other words, this range has also been defined as systematic or analytical thinking in the lower end, to systemic thinking in the higher end [7]. The term “systemic thinking” also corresponds to higher-order cognitive skills (HOCS) [11].

Systemic thinking describes the cognitive processes that “see relationships rather than things; cause-effect relations as reciprocal; multiple causes/multiple effects; and system structures that cause system behaviour” [2]. This level of reasoning is distinguished from basic or low-level reasoning, which is ascribed to subjects who “see things, not relationships; see cause-effect relations as one-way: one cause/one effect; and external events causing system reaction” [2]. Systemic thinking is valuable for sustainability because it “enables the dealing with complex systems with the appropriate scope, depth, versatility and insight to generate qualitative changes that increase the sustainability of products and systems” [1].

In order to characterise and diagnose systemic thinking, in this paper we adapt a three-tier framework based on [2, 9] where ideas generated by subjects are classified from low-level (SL), to mid-level (SM) and high-level (SH) systems thinking. At the base of this range, SL corresponds to systematic and analytical reasoning that is based on recognising variables, ascribing simple causal explanations, is aimed at system-wide solutions, and is focused on improvements and efficiency. SM integrates the linkages and relations between variables, identifies scales and stages in the system, generates strategies based on expected future effects including indirect consequences, and recognises stakeholders and information flows. At the top of the range, systemic thinking (SH) emerges when the person adopts a wider view of the system and shows evidence of reasoning about contextual and situational conditions, feedback cycles, second-order interactions, system trajectories, and exogenous trends and influences. SH includes reflection on the role of the problem solver in understanding, framing and approaching the problem. The SH person learns within the situation at hand and aims to develop new strategies, models, and policies that trigger sustainable paradigm changes.

We define “sustainable strategy proposal” here as a simple yet comprehensive approach to a complex problem that considers its economic, social and environmental dimensions. Such proposals are difficult to evaluate upon their generation, since their impact in transforming the system is fully understood only after their contingent implementation; but their potential can be estimated, particularly by experts [3]. Recent examples of sustainable strategy proposals include massive urban transportation systems, integrated energy and waste management systems, and other initiatives that address a large number of issues and stakeholders, anticipate first and second-order consequences, promote positive feedback cycles, deal with information flows and power structures, reveal hidden connections between system elements, seek emergent results, etc. Creative value is associated with SH, as there is wide consensus about its potential to transform paradigms and open new solution spaces [27].

Assessing systemic thinking across disciplines

This paper extends previous work where systems thinking was analysed in design and engineering students [1]. The goal here has been to extend our sample population, improve our experimental design, and to incorporate business students in our studies. In particular, the aim of the work presented here is to provide insights regarding the effectiveness of current teaching strategies and methodologies in achieving systemic thinking and creative responses in our students. The long-term objective of our work is to understand the role of creativity and innovation methods and group dynamics in promoting systemic thinking to empower n-disciplinary teams to achieve sustainable strategy proposals. Starting points for this inquiry include: to test the validity of these learning activities in the development of systemic thinking, to assess the relation between systemic thinking and multidisciplinary teamwork, and to understand the role of systemic thinking in the synthesis of valuable and creative solutions.

Hypotheses development

Being consistent with the theory developed in the literature discussed in section 2, we would expect that our teaching interventions designed to cope with complex problems will have an impact on the level of students’ systemic thinking when approaching with complex situations. Considering this, we propose the following hypothesis:

H1: "A combination of methods and activities geared towards the creative intervention of complex problems has a positive effect on the development of systemic thinking"

Considering that the level of heterogeneity in ideas among a group of people from different disciplines and backgrounds will be higher with respect to same-discipline groups, we expect that multidisciplinary teams will tend to provide a more systemic view of a problem due to the variety of ideas and information emerged from the team. Therefore, we propose the following hypothesis:

H2: "Students who work in n-disciplinary teams show increased systemic thinking compared against those in specialized or uni-disciplinary teams"

Finally, we expect that those teams with a higher systemic view when facing complex problems will be more likely to suggest more effective and creative solutions compared with teams with lower systemic view. Therefore, we propose the following hypothesis:

H3: "The level of systemic thinking of teams will be positively related to the quality of their strategy proposals"

Research methodology

We did an experiment using 28 different teams of students across three academic disciplines: design, engineering and business. For the first two hypotheses we created treatment and control groups – intervened vs non-intervened teams, and disciplinary vs non-disciplinary teams. We wrote a real-world case study in which we describe a complex situation. Each team had to work on the problem and propose a possible solution. In the following sections we describe in detail how we set up the experiment.

Educational settings

This section provides a brief description of each course and summarises the experimental conditions of our study. Six courses were selected from the Bachelor and Master programs at Tecnologico de Monterrey (Queretaro). The authors are lecturers of these courses, thus providing access to experimental activities throughout the semester. In two of these courses, the authors have been gradually incorporating teaching strategies, methods and tools related to sustainability and in particular, to the design of creative interventions in complex adaptive systems.

The first four groups selected for our study include three undergraduate courses from the Electronic Engineering, Industrial Design and Business Administration programs, and a graduate course from the MBA program. These cases are labelled as “non-intervened” because their emphasis is not on the generation of change initiatives in complex systems. Two of these cases are courses that do deal with innovation, entrepreneurship and sustainability principles, but do not incorporate the specific toolkits and their application in applied projects. The two remaining groups are an undegraduate course from the Industrial Design and a graduate seminar from the Master of Science in Manufacturing Systems. These courses are taught by different lecturers, and they are both based on team projects where the students apply methods and tools expressly aimed at triggering change processes in complex adaptive systems that include social, economic and environmental problems. The following coding is used to distinguish the groups:

a. Disciplinary (D) or Multidisciplinary (M)

b. Intervened (I) or Non-intervened (N)

c. Undergraduate (U) or Graduate (G)

Non-intervened (N) groups

- Course title: "Design of social-based wireless personal and body area networks" (DNU01) Last year of the Bachelor of Computer Systems and Computer Science. This is a project-based elective course on Wireless Personal and Body Area Networks (W-PAN/BAN). The course includes laboratory practices and the development of a project including the following stages: problem/need identification, idea generation, solution election, prototyping, and final presentation. The project incorporates a social-based framework for the design of technological systems to address social problems. The course also incorporates visits to industry, creativity sessions and principles of intellectual property. The final projects were submitted to the "Bluetooth Innovation World Cup 2009" [12].
- Course title: "Innovation by design" (DNU02). Final year seminar of the Bachelor of Industrial Design. The goal of this seminar is to introduce students to the reflexive practice of innovative design. At this stage, students have undertaken six design studio subjects in a wide range of themes and in an increasing degree of complexity. The design projects in those learning experiences had focused mainly on form, function, user and manufacturing issues, but they left unaddressed the complexities of innovative business strategies. This seminar challenges students' notions regarding the role of creativity, design and innovation, and provides concepts and techniques to incorporate strategic innovation into their design practice. The seminar includes a partial term on sustainable development, but the nature of this seminar is mainly theoretical and reflective, and does not include project development.
- Course title: "Information Technology Management" (DNU03). Second-year undergraduate course for Business majors. This course focuses on the operational and strategic role of information technology in the organization as well as on individual information-seeking skills. The main objective of the course is to learn how information technology can enhance organizational efficiency and even transform business strategy. The students practice their

abilities to search for, analyze and organize information using up-to-date information technology tools.

- Course title: "Innovation and Entrepreneurship" (MNG). First-year graduate course for the Master of Business Administration. This course focuses on the the challenges of entrepreneurial innovation and product/process design within a business model. More specifically, students acquire hands-on experience on identifying a social need, looking for business opportunities accordingly, and then the students have to come up with a sustainable business model to address those social needs and exploit the business opportunity. In addition, students are exposed to real-world entrepreneurship experienceses with local entrepreneurs, and also they receive lectures about innovation and business models. At the end of the course, students grouped in multidisciplinary teams present a business model as a final evaluation. They have to provide evidence for the social need, and also they have to show evidence of market, technical and financial feasibility.

Intervened (I) groups

- Course title: "Systems thinking design studio" (DIU). Eighth semester of the Bachelor of Industrial Design. This design studio addresses design interventions in complex social, economic and environmental systems. As is customary, students tend to think first in the design of consumer products. Through group debates around sustainability, ecological footprint, life-cycle assessment, consumerism, social wellbeing and biomimicry, students reinterpret their project goals in order to surpass the realm of objects. Concepts related to systems and services emerge, and the team proposals increasingly encompass a complex network of innovative decisions about people, economics, politics, markets, function, semiotics, production processes, nature, etc. The orientation of this design studio has yielded results with extraordinary potential for positive impact in our society, including the project "Waste Recovery System", a 2009 finalist in the prestigious Index Design Award [13].
- Course title: "Creativity and innovation graduate seminar" (MIG). Second-year seminar of the Master of Science (Manufacturing Systems). Students from multiple backgrounds converge in this course including Mechanical Engineering, Industrial Engineering, Industrial Design and the Master of Business Administration. This seminar seeks to promote reflection on the innovative potential of research projects and entrepreneurship initiatives. Teams of students develop a value proposal to an external client, addressing the clients' current problems and strategic planning. Students seek to introduce disruptive changes in their clients' practices rather than mere incremental improvements. The theoretical principles as well as their practical application deal with Systemic Complexity. Cases are analyzed and discussed in class, students write essays related to these themes, and the final project is evaluated by the client. As a result of this seminar in Fall 2009 one project was selected by the Business Incubator program and its business plan is currently under development.

The methods and tools used in design groups (DIU, MIG) are selected from the literature and from the authors' professional and teaching experience with the aim to enable and support systemic thinking. They include:

- Activity name: "The roots of the problem". Film screening of documentaries and movies dealing with social and economical complex problems as well as sustainable development. This material is selected thinking on the clear exposure of global problem roots. The objective is to move students from their comfort zone and trigger controversy for the debates following the screening. “Home” [14], “1984” [15], “Story of Stuff” [16], “An Inconvenient Truth” [17], "Hans Rosling TED talk" [18].
- Activity name: "Prosperity without growth". Class debates around the topics of how the current problems of social disintegration, lost of cultural heritage, economic gaps among social groups and nature depletion have reached their actual state. The relations between these problems are discussed, and the class identifies paradigms to be changed in order to achieve sustainability and social justice within global prosperity. Debates are open and the

objective is to help students reflect on these issues and their own personal and professional goals.

- Activity name: "Visualizing the system". System structure graphic visualization, this could be done physically or virtually in two-dimensional compositions, the objective is to visually understand the relation among the stakeholders and the exchanges they have, [19].
- Activity name: "User-centred Design". Surveys, interviews, behavioural mapping, camera journals and story telling; the main objective of using these tools is to understand as deep as possible the state of the system, develop stakeholder empathy, and elucidate their true needs, desires and expectations. Depending on the nature of the stakeholders (these could be any actor in the system with any type of exchange with others), students must select the apropiate tool and apply it to provide evidence of their understanding [10].
- Activity name: "Designing the change". Sketch, mind-mapping, and dirty prototypes are commonplace in all design studios, all these tools are implemented searching innovative ideas to be applied into the systems or to solve a particular aspect, like a specific product. The deliverables vary according to the project, from physical models, two-dimensional maps, photo-journals or drawings.
- Activity name: "Dancing with systems". This activity analyses the possible points of intervention in a system following a hierarchy of leverage points [3]. The objective is to create proposals of intervention in the semester project taking into consideration the consequences and the impacts throughout the system. Intervention proposals are analysed by an expert in each relevant area according to the project under development. Biologists, chemists, manufacturing engineers, biotechnologists, physicists, economists and lawyers are customarily consulted. The deliverable of this activity is a map of the system with the interventions and its new exchanges and expected consequences as advised by the experts.
- Activity name: "Complex problems may have simple, optional and unexpected solutions". This activity aims to introduce students to the idea that complex problems in large systems may be addressed by enabling counter-intuitive minimal changes that trigger positive effects. The three key issues in this approach are: to present the solution as an optional alternative in the system and not as a compulsory course of action, to focus on experimental evidence to select the smallest change (in cost, effort or time) with the largest returns, and to bet on counter-intuitive system dynamics. This activity is approached through the principle of "Nudge" by Cass Sunstein and Richard Thaler [20] where evidence from the literature and a range of methods are well documented. The deliverable of this activity is a one-week project where students design and document a 'nudge' that causes a behavioural change in their context. Pirnciples and examples of abductive reasoning are also useful for this activity.
- Activity name: "Identifying the growth and destruction of value in complex systems". The aim of this activity is to help students identify the values that the stakeholders of a complex system may perceive from its current state. Students realise that cycles of corruption and other negative behaviours often times respond to perceived values that reinforce negative outcomes. In design projects, this value-construction dimension of complex systems is best approached by learning the process of creative destruction in innovation [21], the dynamics of the Function-Behaviour-Structure framework [22], and the value of breakthrough products [23]. The deliverable of this activity is a team presentation where students seek and document examples of systems that yield undesired outcomes, and provide a value-based explanation of such outcomes.
- Activity name: "Life-Cycle Intelligence". This activity introduces students to decision-making processes based on a deep understanding of the life-cycle of a product or a service system, starting from the inputs, materials and supplies, throughout use and disposal. Simplified versions of LCA methods are used, such as the "Life Cycle Design tools" of the LeNS project [28]. Notions associated to "Ecological Intelligence" [24] provide an adequate starting point. The deliverable of this activity is to reveal, estimate and document the hidden costs of the team's main design project in the semester.

- Activity name: "Personal Sustainability Project". This activity provides students with first-person experience of changing deep-rooted habits in order to decrease their environmental footprint. Students use a number of online calculators to estimate their footprint and to identify the undesired consequences of their routine activities and everyday choices of transportation, food consumption, etc. The deliverable of this activity is a four-week journal where students record the challenges and milestones of their attempt to reduce their footprint. An essay is submitted by the end of this activity where students discuss the strategies that they would propose to help others implement this type of change.

	D/M disciplinary multi	I/N intervene non-interv	U/G undergrad graduate	Class size	Responses	Number of teams	Design (D)/ Engineering (E)/ Business (B)
DNU01	D	N	U	15	15	5	E
DNU02	D	N	U	25	5	3	D
DNU03	D	N	U	12	7	3	B
MNG	M	N	G	17	16	5	E/B
DIU	D	I	U	25	25	9	D
MIG	M	I	G	13	13	3	D/E/B

Table 1 Summary of all 28 teams included in this case study. 16 control teams (N) and 12 experimental teams (I); 20 are disciplinary (D) and 8 multi-disciplinary (M).

The case study

In our experiment we wrote a case study that deals with the problem of waste disposal and recycling in urban and suburban residential areas. Then we asked our student teams to provide a solution for this case. We created this case study based on exhaustive information from a consultation project developed for the Miguel Hidalgo local government in Mexico City in 2007. The case was jointly developed by the authors considering its suitability and relevance across all disciplines. The case of waste disposal and recycling was chosen because it provides high complexity and presents a significant challenge for the development of local solutions that add value to the economy, society and environment [25]. The time allocated for this work is three hours during the last session of the semester, and participation is voluntary and independent from the course grades.

Student teams in control groups are formed, given a design brief about residential waste disposal and allocated a two-hour session to analyse and discuss the problem and to formulate a sustainable strategy proposal. At the end of this session, teams are required to formulate a plan to address the problem specifying the resources required, expected results, etc. Two types of control groups are studied here: uni-disciplinary and n-disciplinary groups, the first refers to specialized teams of only business, design or engineering members while the second refer to teams that integrate these disciplines.

Experimental groups are also presented the same design brief and allocated a two-hour session under equivalent conditions, except that a summary of the topics and projects covered throughout the semester is presented highlighting the methods and techniques aimed at triggering change in complex systems. In a one-hour preliminary activity, students of these groups are reminded of the several methods covered throughout the semester. A set of qualitative research methods is used to assess both the process and the product of this short activity: questionnaires are applied to the team members immediately after their participation, sessions are recorded in video for further analysis and interpretation, and a panel of (independent experts) evaluates the potential of the proposals from a sustainability and innovation viewpoint.

The assessment tool

The assessment tool is divided in two parts; firstly, a one-page scenario provides information about the current situation including the agents involved in the collection, transportation and sorting of garbage. Statistics and the general flow and interactions between agents are included. The main challenges and conflicts of the system are summarised. Students analyse and discuss the current situation in order to collaboratively develop a solution strategy proposal. Teams are required to submit the following information at the end of the two-hour session: a one paragraph summary of the team's analysis of the current situation, a one-paragraph summary of the strategy that the team proposes in order to approach the problem, and a three-paragraph explanation and justification of the team's consensual ideas highlighting the main objectives, expected outcomes, and the creative value of their ideas.

These teams' responses are reviewed by the researchers in a double-blind process, yielding a classification of the solution strategies in SL, SM or SH according to the three-tier framework presented above in section 2. As a result, the solution strategies developed by teams are independently categorised by 'systemicity' and quality criteria including its creative potential to trigger paradigm changes. The distance between the distributions of SL, SM and SH in N and I groups is the vehicle to validate H1. The distance between the distributions of SL, SM and SH in D and M groups is the criterion to evaluate H2. Lastly, the distribution of quality and SH across all groups is the means to evaluate H3.

The second part of the case consists of a questionnaire that students respond individually after submitting the team's strategy proposal. This questionnaire is based on the strategies proposed by Meadows to intervene systems [3] and is used to compare the level of systemic thinking in individuals and teams.

Results

We categorized team’s responses according to the level of systemic thiking and computed a standardized systemic thinking score. We tested H1 and H2 using a two-group-mean comparison t-test. For H2 we run a simple linear regression, and also run a two-sample-mean comparison t-test. Our data provides support for H1 and H3, but not for H2. Tables 2, 3 and 4 show the statistical results for these hypotheses.

Variable	Mean of Intervened teams (N=12)	Std error Intervened teams (N=12)	Mean Non-Intervened teams (N=16)	Std error of Non-Intervened teams (N=16)	t-statistic of the mean difference	Statistical significance of diff. between groups (p-value, 1-tailed)
Systemic thinking score	1.99	0.11	1.60	0.10	2.56**	0.0083**
Solution quality	2.34	0.17	1.74	0.13	2.80**	0.0048**

Table 2 Difference between systemic level score and solution quality between intervened vs non-intervened teams. Note: ** significant level at 0.01 level

Figure1 illustrates the information about systemic thinking levels:

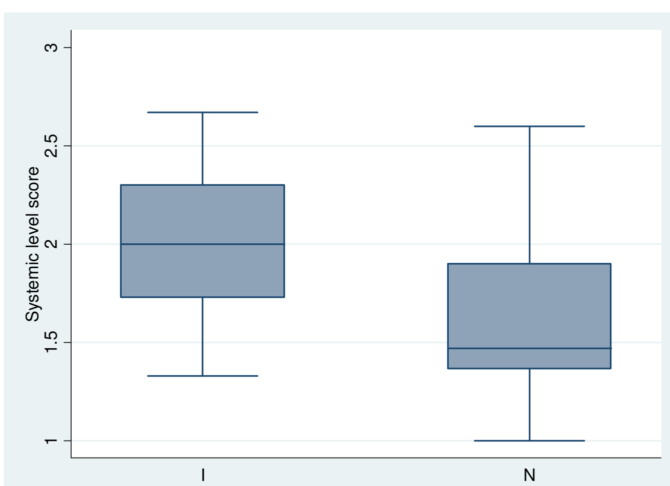


Figure 1 Box plot of the systemic level between Intervened (I) vs non-intervened (N) teams

As we can see from Table 2, there is significant difference between the level of systemic thinking between the intervened and the non-intervened teams. The intervened teams exhibit significantly higher level of systemic thinking compared with non-intervened teams (p-value=0.0083). If we can provide support to H3, then it would make sense to argue that intervened teams compared with non-intervened teams will experience a higher quality in their solution to the case. As we can see, we provide statistical evidence for this argument (p-value=0.0048). Therefore we provide strong statistical evidence for H1.

Variable	Mean of Multidisciplinary teams (N=8)	Std error of Multidisciplinary teams (N=8)	Mean of uni-disciplinary teams (N=20)	Std error of Non-Intervened teams (N=20)	t-statistic of the mean difference	Statistical significance of diff between groups (p-value, 1-tailed)
Systemic level score	1.71	0.13	1.79	0.13	0.42	0.33
Solution quality	2.00	0.21	2.00	0.14	0.00	0.50

Table 3 Difference between systemic level score and solution quality between intervened vs non-intervened teams.

There is not enough significant evidence to support H2. Multidisciplinary teams and uni-disciplinary teams do not show significant difference in their levels of systemic thiking. The difference between both groups' quality of solution is not statistically significant either. Therefore, H2 is not supported.

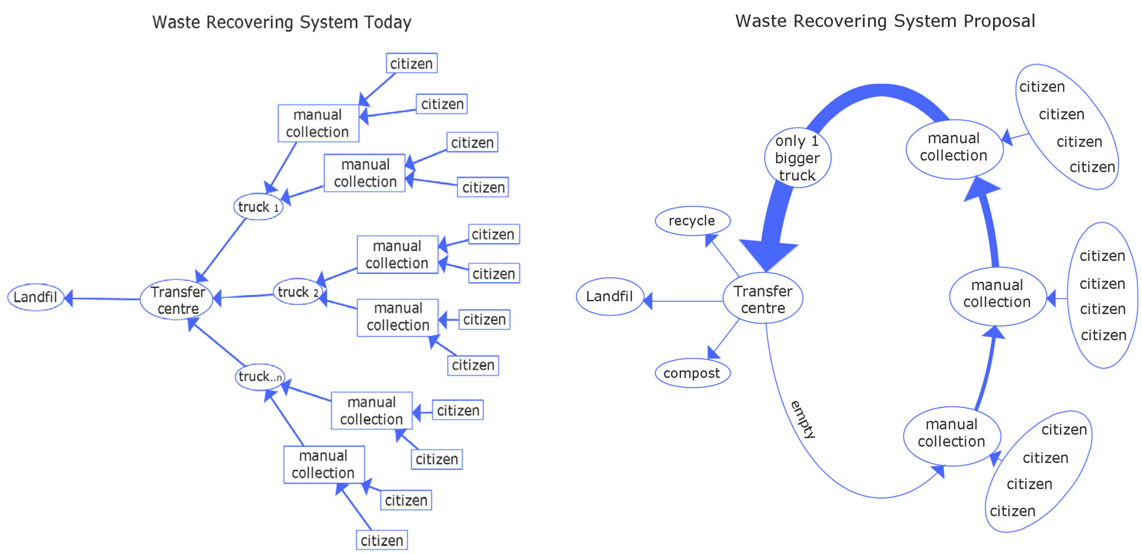
For H3, we run a simple linear regression using solution quality as dependent variable and the level of systemic thinking as independent variable. Regression results show that these two variables are positively correlated (correlation=0.31, and this correlation is marginally significant at the 0.055 level). We run an one-way ANOVA to see whether these three groups experience different levels of solution quality, finding significant difference between the groups (F=10.42, p-value=0.0005). After running Bonferroni comparisons, we found that SH teams receive a significant higher level of solution quality compared with SL teams (p-value=0.003). We also found significant difference in the level of solution quality between SL teams and SM teams (p-value=0.001). However, no significant difference between SM teams and SH teams was found. Considering these results we can say that H3 is supported.

To evaluate all three hypothesis at the same time, we run a multiple regression model with systemic thinking level as dependent variable and the dichotomous variables team type (Multi/ uni-disciplinary) and intervention variable (intervened/non-intervened) as independent variables (results are not shown in this paper due to space constraints). We also added as a control variable the academic level of the team (undergraduate/graduate). Interestingly, over and above all variables, the fact that the team is intervened was the only one significant in the model. We did a further analysis, regressing all these dichotomous variables and also the level of systemic thinking on the solution quality as dependent variable. For our surprise, the variable intervention explained most of the variance of the solution quality.

Besides these quantitative results, in the following section we present exemplary cases to illustrate the qualitative evaluations of the team’s proposals.

Exemplary systemic strategy proposals

Two strategy proposals developed by our students are documented in this paper as exemplary SL and SH responses. Team PLP of group DIU presented a majority of SM and SH responses, and received the highest quality score of all 28 teams. This team's main idea is to reorganise the network of garbage collection and waste recovery with the objective of minimising the number of trucks and optimising the manual collection process in the system. Rather than having half-empty trucks doing short trips from every existing small collection point to the transfer centre, PLP's strategy is to estimate the type of truck and route design that could traverse a number of larger collection points to deliver their contents in one longer trip into the transfer centre. Moreover, PLP's strategy includes a close monitoring program in every local collection point (citizen clusters) in order to capture information and learn the local patterns of waste disposal and separation, and customise the system accordingly. This paradigm change in the organisation of the network represents a creative breakthrough qualitatively different from the average strategy proposals; it is visually illustrated in Figure 2.



(a) (b)

Figure 2 A paradigm change from the system state today (a) to the new proposal (b) presented by team PLP in group DIU where the network of waste collection and recovery in the city is reorganised, transforming the values and dynamics of nodes, and enabling local customisation.s

In contrast, team LLJ of group DNU01 presented mostly SL ideas, and received a low quality score. This team's strategy includes the privatisation of the garbage collection process, salary raises for employees and subsidies for private companies with money from the recycling of materials. The strategy also incorporates an ambiguous system of garbage-management bonds that citizens earn as they comply with waste separation and disposal laws. While these ideas are not without good potential, they received SL tags because they address low-level leverage points of the system, and they earned low quality scores because they remain unconnected, ambiguous and lack details that demonstrate deep reasoning beyond trite stereotypes.

These two cases are exemplary of clear association of thinking style with quality of proposal, but in other cases this relation is not as straightforward, as discussed above.

Discussion

This study demonstrates that the set of methods and tools currently used in some of our courses are valuable tools for promoting systemic thinking in our students. These activities may vary in their objectives, scope, and implementation (as summarised in section 3.2.2), but they all address the deep understanding and purposeful intervention in highly complex systems. More precise studies are necessary to characterise the role of each activity type and their applicability in different disciplinary and teaching situations.

Evidence is also provided to suggest that regarding systemic reasoning, the distinctions between disciplinary and multi-disciplinary teamwork may be weaker than what was expected. No doubt, multi-disciplinary work has clear advantages and merits, but at least in the type of conditions and issues addressed here, its impact on high-order systemic thinking seems rather limited. This could mean that systemic thinking need not be constrained to multi-disciplinary settings, as intuitively assumed. An important implication of high-order systemic thinking as a cross-disciplinary skill, is that all disciplinary courses may be suitable for nurturing systemic thinking.

This somewhat unexpected outcome regarding multi-disciplinary teams may point towards other possible moderator variables at work. For instance, the creativeness and innovation of teamwork dynamics has been associated with the strength of social ties [26] and other variables related to culture [29, 30].

Furthermore, diagnosing systemic thinking in a team or a person would remain largely irrelevant if this type of reasoning failed to produce more creative and higher quality responses. Our study confirms the premise that teams with high-order systemic thinking consistently yield high-quality and original solutions. This is a promising outcome that validates this type of research initiatives, and motivates more specific questions for future work.

The research presented in this paper reinforces the claim that the design of sustainable products, services and systems could significantly benefit by the development and enactment of systemic thinking. This could be achieved by gearing teaching interventions across disciplines towards identifying, understanding and intervening complex systems. It is in this context that the buzzword 'design thinking' seems limited and inaccurate. What is necessary in design as in other disciplines, is 'to design our thinking' in a more systemic level.

Future steps

Further studies are required to characterise and develop 'systemic toolkits' to intervene courses across disciplines and at different scales: sessions, terms, semesters, etc. It is difficult to measure the potential of every learning intervention tool due to their varying nature, scope and time periods of applicability. However, such toolkits could provide cross-disciplinary teaching instruments to explore given the particular conditions at hand.

The assessment exercise presented here may require further exploration in terms of the topics covered, the length of activity, the team formation strategies used, and other potential moderator variables. The authors plan to replicate this study in future semesters in order to validate its predictive utility.

The analysis of the team responses could be revised and extended. The three-tier framework of systems thinking could be refined into more specific categories and responses could be contrasted against individual competencies before and after the test. The criteria of quality and originality could be validated against third-party evaluations by incorporating independent judging panels in the evaluation and categorisation of responses.

Finally, this work could lead to valuable input for curriculum design projects. Guidelines could be developed to incorporate teaching interventions throughout undergraduate and postgraduate programs across disciplines.

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The Value of Stimulated Dissatisfaction

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Abstract

"I'm not saying it's a good quality to have, but my observation is that good designers are never happy, they're never satisfied, never content" (Adrian Stokes, quoted in Spencer, 2008, p. 145).

It seems self-evident that designers, whose raison d'être is to initiate change in man-made things (Jones, 1970), devising courses of action aimed at changing existing situations into preferred ones (Simon, 1969), will be dissatisfied, at some level, with the way they experience the material world. However, recent research (Spencer, 2008) suggests that expert designers deliberately enhance the pressure and stress of the design situation – stimulating dissatisfaction. By stimulating the experience of dissatisfaction their imaginative and investigative action is given urgency, focus and purpose as they pursue excellence and attempt to unfold from their own view of the world to empathise with a broad project community.

This discursive paper highlights the need for a developed understanding of the reflective practitioner model to inform the post-rationalist generation of design methods. This paper: reviews critical literature about the experience of designing; discusses the role of dissatisfaction within the practise of design; and presents a research project that aims to evaluate the value of stimulated dissatisfaction for the purpose of supporting practitioners' empathic appreciation in early design direction generation. This paper argues that the reflective practitioner model of the designer must address the stimulation of dissatisfaction as a condition of creative and explorative design practice.

Keywords

Design Practice; Reflective Practice; Experience; Dissatisfaction.

Understanding design activity is an extremely complex task; particularly, if we accept that designers are intimate aspects of the very context dependent problems they aim to resolve (Schön, 1983; Lawson, 2006; and English, 2006) where bounded action encompasses all the various parts comprising human existence (Bousbaci, 2008). This paper aims to contribute to our understanding of design activity, specifically contributing to Design Epistemology (Cross, 2006), by focusing upon design practitioners' experience of practise (Spencer, 2008), reflecting upon the role of dissatisfaction, and presenting research that evaluates the benefit of stimulated dissatisfaction for supporting empathic appreciation in early design direction generation.

Theoretical Context

Based upon the 'generation game' (Cross, 1981), found within Design Methods, Bousbaci (2008), argues that each shift in the evolution of Design Thinking has been accompanied by a major shift in the implicit 'Model of Man', and, as a consequence, the implicit model of the designer (refer to Figure 1). Bousbaci states that, "each design theory, unless it puts forward its philosophical assumptions, assumes as well a particular view (i.e., a model of the designer)" (ibid, p. 39). Bousbaci describes Design Thinking's changing theoretical landscape:

- First-generation design methods shifted from the romantic, intuitive, and artistic model of the designer to embrace a very logical and rationalist view. The logical and rationalist model of the designer, which Alexander (1964) described well, has its philosophical roots in Descartes' (1637) mechanical world and investigative method.
- Second and Third-generation Design Methods – which delivered intellectual tools widely used in contemporary design discourses: wicked problems (Rittel, 1972); solution focused strategy (Lawson, 1980); design conjectures (Hillier, Musgrove & O'Sullivan, 1972); primary generator (Drake, 1979); ill-structured problems (Simon, 1969); and problem space and generative processes (Newell & Simon, 1972) – rested on the premise that design was a problem solving process and the model of the designer supporting these views was conceptualised by Simon as Bounded Rationality (1945).
- The reflective practitioner is a post-rationalist model of the designer and the 'reflective turn' that Schön's work provoked is the last paradigmatic shift in support of Design Thinking.

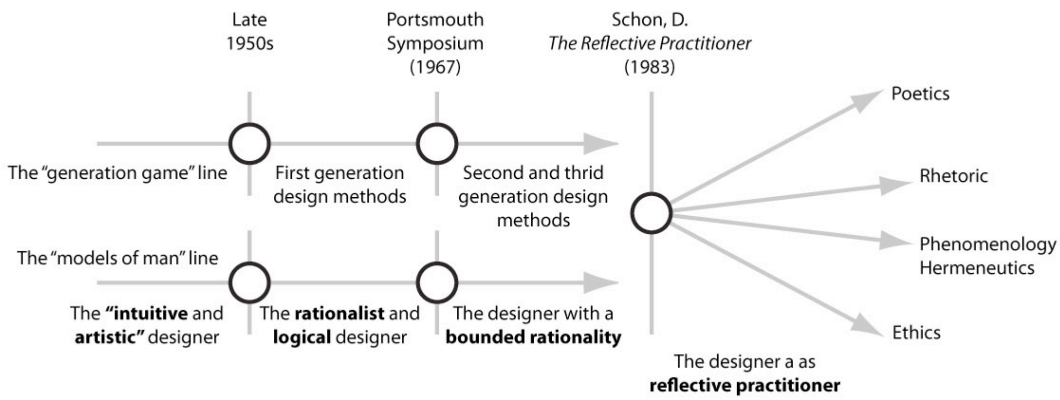

Figure 1 – 'Some landmarks in the evolution of design thinking', taken from Bousbaci (2008)

According to Bousbaci, Schön's reflective practitioner is:

> A post-rationalist model of the designer [that leads design theorists] to gradually abandon the very rationalist and logical concept of 'problem' (and the entire instrumental view of design as a 'problem-solving process') in order to adopt the more pragmatic and phenomenological concept of 'situation' (2008, p. 40).

The differences between the instrumental view of design, seminally illustrated by Simon (1969), and the constructionist view of design, as Schön described it, have been well discussed and dissected (Schön, 1983; Dorst, 1997; Spencer, 2008 & 2009). This paper is not concerned with debating the merits, contradictions, or paradoxes of these paradigms of design; it is concerned with examining the reflective practitioner model of the designer. If, as Bousbaci proposes, there is a causal relationship between Design Methods and models of a designer, then improving our understanding of the reflective practitioner model, furthering its detail and accuracy, should provide an improved theoretical foundation for developing fourth generation design methods.

In Schön's reflective practitioner model, designers are makers in the broader constructionist sense; using professionally and personally determined practices and competencies to impose coherence and order complex situations, converting indeterminate situations into determinate ones, bringing new things into being through their actions and inquiries. The reflective practitioner model describes the role and interaction of three different knowing modes: knowing-in-action, reflection-in-action and reflection-on-action. The knowing modes, knowing-in-action and reflection-in-action, are differentiated by the practitioner's ability to progress a task situation through action, and, reflection-in-action and reflection-on-action are differentiated by their relation, in time, to the task situation. The reflective practitioner model defines the pattern of inquiry (reflection-in-action) used when knowing-in-action is insufficient to proceed or when the situation falls outside the boundaries of 'normal' where knowing-in-action cannot be brought to bear. The pattern of inquiry, reflection-in-action, employed within an action present, is a process of: simplifying a situation's complexity (consciously or unconsciously naming the elements to be attended to); arriving at a standpoint about the situation, its problems and issues (framing); exploring the standpoint through action, experimentation and solution propositions (making moves); and considering implications and consequences in two directions, 1) forwards, to consider the value and consequences of the propositions and the barriers to successful implementation, and 2) backwards, to consider the restrictions and relevance of naming and framing and the appropriateness of the investigative actions (reflection).

For the reflective practitioner model of a designer there appear to be a number of factors that influence the effectiveness of an inquiry, they are:

a) The designer's ability to understand the design situation – the methods, tools, skills and cognitive capacity to identify issues and their consequences – i.e., appropriate naming.

b) The designer's ability to empathise with the project community – the creative capacity and knowledge to frame and reframe the design situation including personal empathy, commercial empathy and discipline empathy – i.e., appropriate framing.

c) The designer's ability to explore frames – the discipline skills and knowledge necessary to explore frames and solution opportunities, expose them to internal and external audiences for feedback and complete projects within specific design domains – i.e., appropriate move making.

d) The designer's ability to critically reflect – the sensitivity to recognise feedback from propositional explorations, the ability to recognise limitations with naming and framing actions, the ability to discover and see the implications of propositions – i.e., appropriate reflection.

e) The designer's ability to engage uncertainty and manage mental and emotional states – the confidence to feel the discomfort of uncertainty; and the willingness to repeatedly explore alternative frames and solutions and expose the coherence of the thinking structure to criticism (Spencer, 2009), time allowing, or to commit – i.e., appropriate application of the practitioner's mental and emotional resources.

Schön describes the good reflective practitioner as being willing to enter into new confusions and uncertainties, but does not provide a good account of states of confusion or the experience of uncertainty and how these affect reflective inquiries. The conversations that Schön presents (1983 & 1987), focus upon illustrating how naming, framing, making moves toward solutions and evaluating through reflection develop through dialogue, focusing upon design content and action (descriptions of solutions and frames; and explanations of moves and reflective behaviour). Schön does not highlight what it is like, experientially, to be in a reflection-in-action moment. Nor does Schön focus upon the affect a practitioner's mental and emotional state has upon their ability to have effective conversations. The role of a designer's mental and emotional conditions is a potentially fruitful area of investigation for informing the reflective practitioner model of the designer. In order to inform the reflective practitioner model of the designer, this paper: discuss findings about expert design practitioners' experience of practise; reflects upon the role of dissatisfaction within the practise of design; and presents preliminary research that aimed to test the value of using a Dissatisfaction Matrix to stimulate early stage design direction generation.

Investigating the Experience of Designing

Spencer (2008) conducted an investigation into the experience of designing. The research examined experiences of expert design practitioners' practise of reflective practice. His study was an embedded multiple-case study with multiple units of analysis, where qualitative data about the experience of designing were obtained from eight semi-structured interviews with expert designers.

Spencer's work suggested that design practitioners explore their design situations, through the propositional experimentation process suggested by reflective practice, intuiting the value of frames and solution propositions as a felt experience. It appears that dissatisfaction plays an important role as practitioner's continually strive for better personal and professional performance through their design inquiries, avoiding the extremes of conceit or stress induced inertia and avoiding habitualisation in preference to reflection-in-action. It is also suggested that in addition to developing self awareness of the personal and professional performance dissatisfactions, which can bring about changes in identity and expertise, there are also dissatisfactions with things beyond the person and the business, including: products, processes, services, communications, policies and politics. Each of these anticipated or experienced dissatisfactions become part of the context around which, and within which, the designers design. Dissatisfaction is therefore argued to be an integral part of motivation for change and motivation to design. Nevertheless, this does not mean that it is possible to use all dissatisfactions positively in a given context, for example dissatisfaction over price, when reducing price makes it ethically unacceptable; or dissatisfaction about diversity of choice, when the breadth of product range is already unsustainable in the marketplace. There is also a question as to whether the positive prompting of dissatisfactions can provide the same benefits throughout a design process; dissatisfactions at the ideation and brief development stage are anticipated to support in a different way, to dissatisfaction identification at design specification.

To illustrate the role of dissatisfaction that Spencer identified in the expert designers' experience, it is useful to present some of his research findings – descriptive statements about the experience of designing. Sample transcript excerpts, taken from his thesis's discourse analysis, follow the findings and a brief commentary is provided.

> Finding 1
>
> Expert designers are optimistic about their ability to resolve design problems, see problems as opportunities and begin their task with positive excitement (Spencer, 2008, p. 286).
>
> There's a sort of optimism that designers have to have, you have to be optimistic that you can solve the problem (Tim Brown, quoted in Spencer, 2008, p. 205).
>
> As a designer you need to be quite passionate about solving things and I think that most designers want to do things well, they want to create a better world, they

> want to do better things, they want stuff to be better (Mark Delany, quoted in Spencer, 2008, p. 206).

Cross (2006) stated that “the uncertainty of design is both the frustration and the joy that designers get from their activity” (2006, p. 54). Spencer refutes that claim: “it is not the uncertainty of design that expert designers enjoy, rather it is the potential and pregnant opportunity that uncertainty represents, it is the fear that is generated as the designer experiences uncertainty that is enjoyed” (Spencer, 2008, p. 242).

The excitement a designer feels at the start of a project appears to be a consequence of the opportunities they see in the design challenge. Spencer’s data suggests that the uncertainty, inherent in the design situation, provides perceived opportunities to make positive contributions to society through the activities of design and to achieve positive re-enforcement of the designer’s professional identity. The dissatisfactions implicit in Finding 1 are: a) the belief that society and material culture is not as satisfactory as it could be and can be improved by deliberate and organised action (design); and b) that one’s own practice can be further improved and refined and hence has not yet fully met self-imposed standards.

> Finding 2
>
> As expert designers engage with a professional context that is uncertain, ill structured and ambiguous they personally experience uncertainty. As the uncertainty of the challenge is grasped, fear develops about their ability to resolve the design problem’s issues and exploit its opportunities (Spencer, 2008, p. 285).
>
> Often the first month or so you’re kind of stabbing away and it’s all a bit hazy and you’re a bit worried you’re going in the wrong direction, […] there’s always that uncertainty at the start of a project ‘*Are we going to be able to pull it out of the bag this time*’ (Kevin McCullagh, quoted in Spencer, 2008, p. 208).
>
> Even now, after God knows how long that you’re doing it, whenever you get a project in there’s still a little bit of panic at the start of it, ‘*Shit, I don’t know what I am going to do, I don’t know what the answer is*’, and that fear is quite enjoyable. I think the moment I lose that fear is the time that it’s like time to give up! (Mark Delany, quoted in Spencer, 2008, p. 208).

The situation, and phenomenological state, that Finding 2 describes, is presented as central to practitioners’ reflective inquiry. The design situation in itself is dissatisfactory and it is the designer’s role to produce solution propositions for satisfying the issues, contradictions and conflicting commercial demands. As described by reflective practice theory and by the design expertise literature (Lawson, 1994, 2003 & 2004; Dorst, 2003; and Lawson & Dorst, 2009), the form of inquiry dominant in design practice requires practitioners’ intimate engagement and personal investment. The initial engagement with an ill-structured design situation is complex. In addition to external ambiguous conditions and criteria there is the designer’s experience of this situation, as Spencer highlighted:

> Expert designers, in addition to imposing order upon their situation of practice and developing solution propositions, must cope with their personal response to the experience of uncertainty and its discomfort and their personal doubts and insecurities that are given focus as they engage with challenging design problems (Spencer, 2008, p. 242).

Spencer’s data illustrates that designers experience the situation’s uncertainty without necessarily being immediately able to unpick and cognize the strands of doubt that create it. This phenomenological state seems crucial, and Spencer suggests that designed outputs can be viewed as a result of coping with, and attempting to resolve, this state of uncertainty and stress; therefore, reflective practice is a series of attempts to escape from the unsatisfactory experience of uncertainty, creating conceptual certainty and coherence by employing imaginative and investigative action.

Finding 3

Iterative attempts to develop solutions can lead to frustration as the expert designer assesses his/her propositions as inadequate for resolving the design challenge. Over time, if solution propositions continue to be assessed as inadequate, dread is experienced as the expert designer questions his/her ability to resolve the design challenge. Mental paralysis can occur after this stage where the expert designer is unable to further explore the design situation (Spencer, 2008, p. 285).

Coming up with ideas is pretty easy; making them reach the other end of the net is not easy. Ideas are two a penny at one level, even though people say, '*How do you have ideas*', ideas is not the problem, making them the right ideas, better ideas is a problem and you can only do that if you have reference points to judge better-ness against and then successful exploit them (Steven Kyffin, quoted in Spencer, 2008, p. 210).

There is a huge amount of worry to turn that [creative] moment into a finished product. Without that moment there would be no successful products and without that worry there would be no successful products. There are all these opportunities to ruin that moment (Adrian Stokes, quoted in Spencer, 2008, p. 210).

I think designers are inspired by quite negative emotions, you know you're really frustrated with something and you want to design it better, or you're just frustrated with the way things are going and you need to solve it, you cannot let it go until you solve it, you know I think any creative act involves a bit of pain, you've got to give a bit (Mark Delany, quoted in Spencer, 2008, p. 211).

I think there's something about the creative process that requires your brain to work pretty hard and it has to be open to certain things and so you can't be scared and frightened. If you're scared and frightened you can't design, you can't be in too much of a hurry all of the time or you can't design and you need to be fit, mentally fit and physically fit […]. So there is something in being in a good state of mind and state of body that does help you be creative. I mean you see it in people who have been working too hard for too long they just stop having good ideas (Tim Brown, quoted in Spencer, 2008, p. 212).

It's amazing how confidence can desert you; emotions are very fickle, lifting your mood sky high or just shutting you down. At those moments you never look at the bigger picture, 30 years of achievement for example, you always just think, '*Oh God, I'm in trouble*' (Adrian Stokes, quoted in Spencer, 2008, p. 214).

Finding 3 describes ongoing proposition experimentation and the emotional states that can occur if solution propositions are assessed as inadequate. This finding highlights an interesting area for further research: what influence does the experience of stress and uncertainty have upon a designer's assessment of their solution propositions. An ideal-type designer would be one that has developed tactics and gambits to help manage the effect that strong and/or sustained levels of anxiety have upon their practise of design while maximising their motivational benefits positively – they would be effective in the appropriate application of their mental and emotional resources.

Discussing the Experience of Designing

Spencer's research explores the application of practitioners' mental and emotional resources as they practise design. His investigation, however, is not intended to be, nor claimed to be, a complete picture. The methodology and cases studied shape the scope of the research and its limitations provide avenues for further inquiries. However, Spencer's thesis is useful in developing our understanding of the reflective practitioner model of the designer; it highlights that reflective practice has a significant phenomenological dimension to it beyond the action-orientated theory of Schön. Spencer's (2008) findings deal with aspects of experiencing dissatisfaction, but do not address the role of dissatisfaction and relate it with stages of the design process, nor does his work address the significance that dissatisfaction has upon a practitioner's practice over time. The Dissatisfaction Matrix project described in this paper outlines an experiment that is an attempt towards evaluating the role of dissatisfaction in Opportunity Identification (Hilton, 2002).

The generation of the experience of uncertainty and its discomfort is evident in Cross and Clayburn Cross's (1996) study of Gordon Murray. In a description of his situation of practice Murray is quoted as saying, "the pressure then to come up with something new becomes intense, and the responsibility is all yours, and you get sort of panicky" (op. cit.). Cross and Clayburn Cross suggest that innovative designers frame or reframe the design situation in a way that creates significant challenge. Davies and Talbot (1987) stated that although ideas can occur at any time they seem "most likely to occur when the person has to cope with significant life events, and/or a particularly knotty design problem" (1987, p. 23). Spencer suggested that, expert designers stimulate their experience of uncertainty and inquisitive discontent: "engaging with design problems of increasing complexity appears to ensure that expert designers' experience of their design challenge is at the edge of what they are able to cope with" (2008, p. 282). Perhaps, taking on problems of increasing complexity and framing a problem so that it is seemingly impossible are tactics designers use to enhance the pressure and stress of the design situation, creating the unsatisfactory experience of uncertainty and discomfort from which they attempt to escape through their professional activities. If this is the case, it appears that the reflective practitioner model of the designer must address the stimulation of dissatisfaction as a condition of creative and explorative design practice. Also, if this is the case, then designers may manipulate their awareness, and perception of project progress, in order to improve creative engagement and performance. This control of stimulation may in part relate to the balance of Boredom and Anxiety for Flow experiences (Csikszentmihalyi, 1975 & 1992).

There appear to be sets of interesting relationships between the balance of dissatisfaction/satisfaction and ambiguity/clarity for our understanding of Design Expertise and designers' personal development. The point at which an individual design practitioner experiences enough satisfaction with their approach to designing to be uncritical about the way they design is interesting. It perhaps signifies the point where competency and confidence has allowed a practitioner to deploy their critical attention to a different area or set of concerns regarding their profession. However, it may also signify the point where a practitioner believes that they no longer need to deploy the extra effort to critique their practices, as they are sufficient to do the job. It may also be the case that a practitioner may not know how to do things differently without potentially sacrificing quality. Spencer's (2008) data highlights that a lack of curiosity, or the early satisfaction of curiosity, is an issue that becomes a point of friction between designers:

> This is a bit of a personal bug bear; when people just want to slip into a pattern that they're familiar with, '*So we did this with the last project let's do that*', rather than go, '*Well what's actually the right thing to do on this project*' (McCullagh, K., quoted in Spencer, 2008, p. 223).

> I think that there are some designers, quite a lot of designers that are insufficiently curious or critical about what they are doing on the other hand they have job and a mortgage and have to pay off their credit card bills, like along with many other people they don't make life complicated they just do their job (Thackara, J., quoted in Spencer, 2008, p. 223).

In Spencer (2008) Stokes, A., suggests with astonishment, that the majority of designers that he has trained or known do not develop because they are too easily pleased with themselves and too smug (ibid, p. 145), he states: "they became complacent, lazy designers and lazy people who took things for granted and were more interested in going out to the pub at 5.30 than they were about their work and the world around them" (Stokes, A., quoted in Spencer, 2008, p. 149). As a designer develops solutions that provide greater clarity of a concept, they become more satisfied with the concept's development and so continue to move towards the specification phase. However, it has proposed that ambiguity is a resource for design (Gaver, Beaver, and Benford, 2003), in that it allows for more open association and intuitive leaps to take place, and therefore the feelings, if satisfaction is arrived at too early in the process, could reduce beneficial engagement with creative thinking, and the project may therefore conclude with less value added.

Dissatisfaction Matrix

Inspired by the research into the value of stimulated dissatisfaction, and in an attempt to further understanding of this area of research, a Dissatisfaction Matrix was developed by the authors as a tool to test if dissatisfaction could be prompted to support creative engagement with ambiguities. The Dissatisfaction Matrix was intended to offer designers a multi-perspective association approach to inspiring Opportunity Identification (Hilton, 2002) at the ideation and brief development stage. This proposition was a further development of work using 'personas' for design critiquing (Hilton and Henderson, 2008), where here, the matrix was to prompt using characteristics, a selection of which might make up a full persona's concerns. Using the Dissatisfaction Matrix requires that the designer/design team imagine and consider dissatisfactions for specific characteristics in specific contexts, providing a structure to empathic appreciation, and informing their understanding of the project community's design challenge. The characteristics of dissatisfaction, which populated the prototype matrix, were identified through a session that involved naming product and service related dissatisfactions and later categorising them. This list was not exhaustive or intended to be in any way definitive, it served to create a reasonable test framework. Lists should always be viewed as 'live' not 'set', able to be questioned and added to, or made more specific, to be appropriate to the design task.

The research method required that the design-teams, each made up of three 2nd year industrial design undergraduate students, imagine and list on post-it notes either dissatisfactions or ideas for each of the characteristics against each context. In each case, the 5 teams of 3 students were briefed and given two hours to generate as many responses as possible. In addition to the verbal briefing session, each team was provided with written details of the task and efforts were made to ensure that each design team carried out the two hours task in separated workspaces free from distractions.

This project involved an iron and a kettle, in two separate sessions, so that participants had opportunity to compare experiences of using the Dissatisfaction Matrix, to list dissatisfactions, against traditional brainstorming (Dominguez, 2008) or the Dissatisfaction Matrix used to list ideas. This enabled the investigation of differences in dissatisfaction/idea-fluency between a traditional brainstorming format, and two applications of the matrix, one for dissatisfactions the other for idea generation.

The results showed a greater fluency of responses where ideas were required. When ideas were required it was noted that 1-5% of the post-its listed dissatisfactions, whereas when dissatisfactions were required it was noted that 20-85% of the post-it notes listed ideas. There was an obvious slew towards the habitualised ideation process, possibly in part due to lack of practice with the dissatisfaction matrix, possibly in the way responses were framed as ideas even if they originated as feelings of dissatisfaction.

The participants found the Dissatisfaction Matrix to be engaging and proved to be a good way of ensuring that a large number of associations were considered. The Matrix therefore functions in a more prescriptive fashion than the theme prompting of idea flow experienced in a traditional Brainstorm.

The nature of the matrix approach, requiring a fast response in order to complete within a two-hour period, was reported to be exhausting. This reported exhaustion, is believed, by the authors, to be because there were a greater number of matrix associations, than there were brainstorm themes, making the experience much more one of thinking against the clock. Although it was reported to be more challenging to list dissatisfactions, a number of participants did describe feeling that the dissatisfactions would provide more concrete direction for concept development than many of the ideas. This conjecture would have to be investigated with future research using listed dissatisfaction for concept development and design, as a comparative study with concept development and design using listed ideas. It would also be of value for future research to investigate the design practices of critically reviewing and selecting noted dissatisfactions to progress, in comparison to what would occur with noted ideas, and then seeing how the selections influenced the quality of design process and creative output. It is expected that experienced practitioners may generally have become more critical, more dissatisfied, though some may have become somewhat apathetic. This leads to further research and raises the question of Design Apathy and whether there is any evidence of it.

Conclusions

It has been argued that expert designers stimulate their experience of dissatisfaction to create the phenomenological conditions for their imaginative and investigative actions to be given urgency, focus and purpose as they pursue excellence and attempt to unfold from their own view of the world to empathise with a broad project community. As such the reflective practitioner model of the designer must address the stimulation of dissatisfaction as a condition of creative and explorative design practice. Further research could explore designers' variety of responses to design-situation induced anxiety and discomfort and how this influences design decision-making and reflection.

The value of stimulated dissatisfaction within design practice and to the practise of the design practitioner, as an alternative approach to idea generation, would appear to be the heightened awareness of needs for improvement, as opposed to wants or hopes. This would make it more useful in certain cases where a more critically developed brief is required for example, possibly prior to a more divergent traditional brainstorm session being run. Choosing dissatisfaction assessment appears to bring a more critical view of needs, helping to address any possible over-optimism or motivational bias to reflecting upon, and working with, what works well.

The value of stimulated dissatisfaction, for the design practitioner, appears twofold: 1) it helps form phenomenological conditions that a designer attempts to resolve through the use of their creative cognitive capacities, i.e., it helps to keep a designer designing; and 2) it helps to keep the design situation at the boundaries of a designer's capacities; it ensures reflection-in-action, i.e., it helps to keep a designer designing. The descriptions, in this paper, have illustrated the use of stimulated dissatisfaction as a positive resource for creativity and design. How defined the balance is between healthy and positive usage of stimulated dissatisfaction and unhealthy and destructive usage is unknown and a source of further research.

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Understanding the complexity of the multicultural design work team dynamics.

First author[1], affiliation
Second author[2], affiliation

Abstract

Designing digital artifacts for a culturally diverse market implies the thorough understanding of the psychological mechanisms derived from the social and environmental context. The next article introduces a research that investigates the relevance of cognitive and identity diversity (Page, 2007) in the working groups that have as a task the design of interactive services for digital environments. The argument of the article does not focus on the positive aspects of the heterogeneous quality of the group, but simply aims to understand how the diversity of the design group could help improve the nature of the interactive services designed for a multicultural market. Considering the craft of a virtual environment in terms of interaction metaphors that have to be understood by the end users, the step prior to the design of the above-mentioned environment is to be taken into consideration. Two pedagogical experiments placed in two different cultural contexts, Italy and China will be presented in order to exemplify the prior findings of the research inquiry. First the common ground creation in the context of multicultural workgroups will be analyzed, and second how the internal dynamic of the group reflects in the creation of the digital working model will be shown. Taking into account all the above, the question asked is: what methods and tools can be used to support an internal communication language of the working team and how the developed skills could then be applied to the process of designing digital interactive artifacts.

Keywords
Communication design, work group dynamics, collaborative projects, cultural diversity, interactive digital media.

What connections could be made between two different groups of students placed in different cultural contexts? In the next chapters it will be shown how apparent cultural differences in the design teams could be mitigated through a constructed disciplinary language, and how eventually this experience could bring more insight to the overall quality of the project. Although the final outcome of the experiments to be presented concretized into a digital artifact, the study of the diverse group dynamics could inform other disciplines of design as well.

1.Concept design for mobile communication

The above-mentioned experiments have involved two groups of students in Italy and China and have been organized to share the same brief. The brief asked the students to generate collaborative service ideas for mobile communication that will help social aggregation and promote a sustainable lifestyle.

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[1] First author wrote

[2] Second author wrote

More specifically the Chinese project came as an iteration of the Italian one and was intended to test and refine a previously defined teaching structure. Both groups had a similar no. of master degree level students (22-27) with an industrial design background and were asked to design digital intangible artifacts using a methodology specific to service design (Gong et al., 2008). It is interesting to note the same type of first view reluctance in dealing with service. The correct appropriateness of words such as interaction, service, system, scenario, prototype and simulation had to be stressed out and supported with comparisons between industrial and interaction design. In other words the input lectures given by the professors and technological partners had to be explained in the group revisions and "translated" almost into a vocabulary of concepts already used by the students in their previous learning experiences. In the same time the students had a much better ability to use the digital technology, being part of the digital native generation (Prensky, 2001). Both courses underlined the need for two ways of learning to design for mobile communication: one by using the physical and digital interfaces actively, and another by applying an awareness strategy to the acquired knowledge. From pedagogical point of view the role of the professor has to be seen not as an authoritarian presence that imposes a set of methods and tools, but as an active participant in qualifying the tacit knowledge (Polany,1966) gained through the shared experience.

1.1 Laboratorio di sintesi finale, Italy

The course followed a predetermined sequence such as case study collection, concept generation, concept development – which included service and interaction design, followed by the financial analysis of the project, service simulation and communication design. After the projects' completion the students had to prepare a presentation for the sponsoring partners in a public venue and for an extended audience. The activities that took place during the course were of three types and involved three distinct groups. An organizing group of tutors and professors from the university, an external group of experts and the group of second year masters degree students. The input lectures, and revisions given by the teachers and expert teams were followed by progress presentation offered by the students.

The team of professors had to adjust from the beginning with each other's disciplinary language even before proceeding to develop the content of the course. The definition of notions and terms, which have a different understanding for the different disciplines, were subject of an ongoing negotiation process. Even more when the area of application dealt with the new and continuously evolving mobile communication systems, the above mentioned process had to be acknowledged and purposefully evaluated. The common ground creation effort was consequently reflected in the course material.

1.2 Workshop, China

Following the experience in Italy, the Chinese course was organized as an iteration of the Italian one and shared the same brief. The intention of the workshop was to test the same didactical structure following the same logical steps, but evaluate and review the methods used in the first place. This is in part due to the analysis of the students' response embodied in the projects that have been developed and the working flow observed in the class activities. Other important factors were the different geographical location as well as the ethno-cultural differences. In the same time the lecturer team was aware that given the circumstances the students' behavior and most of all their understanding of apparently obvious content, could not be fully anticipated this is why the pace of the lectures had to be tuned according to the reaction of the students. From this point of view the pre-established sequence that worked well in the first case had to be reviewed and adjusted to meet the students' needs and bridge a common ground between the two groups. In the next chapter it will be discussed how the above-mentioned differences could be mitigated and channeled into a creative environment that leads to effective problem solving.

2.Cognitive and ethnic diversity

2.1 Personal relationships and student-professor interaction

After having seen how the cultural differences could modify the structure of a pre-defined teaching structure, we will now discuss the distinction between the cognitive or disciplinary differences and the ethnic ones. The Italian example offered a lesson on how teachers from the same university, therefore sharing the cultural base for a fruitful discussion, had to acquire certain awareness and construct an interdisciplinary bridge of understanding. The engagement in a conversational relationship had to balance the inner mental representations of possible outer circumstances (Shotter 2000) of four academics and professionals coming from service design, interaction design, architecture and management in one coherent chorus capable of developing a specific educational content. The difficulty in that situation was to correlate the construction of the particular representations. In this case the apriori explanation of the commonly shared terms and notions was necessary in order to avoid subsequent misunderstandings. Analyzing the initial phase of the content development, it is important to underline that this kind of negotiation has to occur at the beginning of the conversation otherwise the consequences will cost the participants a loss of time and an increased level of frustration. Good communication within the group could maintain open the flow channels (Csikszentmihalyi…) therefore be enriching, because all the participants have gained a new understanding of there own perspectives, beneficial because the collaboration had an optimal result, and rewarding because the overall experience was positive and not frustratingly tiresome.

The result of the conversational effort being, in this specific case the content of the course dealing with digital services for mobile communication the next important step to be discussed is how the students reacted to the content. Here it is important to stress out the presence of the generational gap. In his seminal work *Digital Natives Digital Immigrants* (Prensky 2001), Mark Prensky shows the ways in which the younger generation that grew up with the digital technologies thinks and learns in alternative ways and how this contradicts the traditional methodology of teaching. In fact he argues that the role of the professor is shifting from the authoritarian status to a peer status (Prensky 2007). Although the course at the Italian university had an ex-cathedra setting and an hierarchical organization, the information was exchanged in a peer to peer situation not only from the professors to the students but also from the students to the professors.

The experience and knowledge gathered from teaching the course was then reviewed and adjusted for the Chinese workshop. Here the already consolidated group of lecturers had to deal with the ethnic differences. Aside from the language barriers, the way in which the Chinese group of students assigned meaning and importance to the taught content made the lecturer group to change the way in which the lessons were taught. In this sense the theoretical lectures had to be supported by intensive mentoring sessions with the students in which the appropriation of the concepts took place from both sides. The conversation in this case had to be supported by hand drawn visual representation and the use of commonly shared metaphoric comparisons. If in the beginning there were two distinct groups foreign to each other, the common effort in developing a mutually accepted communication language helped establishing a cohesive collaboration group.

2.2 Interacting with the mobile technology

If the previous chapters have explained the cultural context in which the two courses were placed and the pedagogical structure they followed, in the next part it will be explained how the students interpreted the brief and in particular in which way they have chosen to use the mobile technology.

As mentioned before both groups worked on how the mobile communication could help the social cohesion and lead towards a more sustainable lifestyle. In the Italian case having as a partner a major communication company, the group has received a very strong technological input on how the avant-garde technologies work. Perhaps this is one of the reasons for which the outcomes tackled the requirements of the brief from a technological point of view, suggesting rather futuristic solutions. In the same time the students successfully identified the critical moments in which the mobile technology could be successfully be employed without being intrusive (Ling 2004; Fortunati 2003). In this respect a good example is the project La Maglia -The Patchwork (fig.1), in which the service proposed acted upon the underused or “wasted” moments (Perry et al., 2001) imbedding them with a new meaningful activity. More specifically the project analyzed the behavior of a very specific group, a women’s community center on the outskirts of Milan, in the time span of a working day. The delay moments, such as the waiting time at a bus stop, at the dentist or the hairdresser were qualified by getting in touch with a friend which happen to be nearby. The technology proposed the use of GPRS - general packet radio service, SMS –short message service, pc server, and smart phones.

fig.1

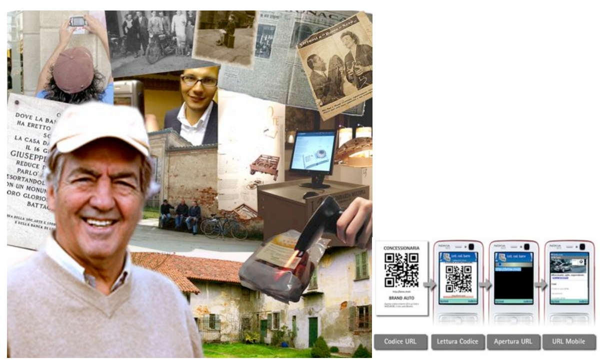

fig.2

The re-interpretation of public/and private space it is another issue that emerged in the usage of mobile telephony. In this sense the awkward situations are encountered every day insofar that they became an embarrassing but inevitable reality. The loud voiced conversation of a neighbor sharing the public transportation could irritate if not even annoy the others. The misuse of public space is in the eye of the beholder. If one party asserts his rights too boldly, the other side will feel that his or her status is being affronted (Ling 2004, pg.127).

Acknowledging this critical point in the user behavior the Cantastorie- Storyteller (fig.2) project proposes an alternative perspective raising the awareness and eventually re-

defining the public realm. Using the semantic code technology the lost story of the place is being remembered. Placed in the Comune di Opera, the service aims to preserve the memory of the different sites. Even if most of the physical traces of the history of the place have disappeared the stories told by the older generation create an alternative topology made out of pieces of memories, waiting to be shared with the younger.
The workshop in China offered the opportunity to test not only the revised teaching methodology but also the different perspectives on the same brief. Presented with a similar structure and input lectures the Chinese students have chosen to base their concepts in the ethnographic insights provided by the field trips. More important almost all projects presented strong reactions to the changes in the social structure, and the events experienced through personal involvement. In this sense a good example is the Pride House (fig.3) concept, which focused on the migrant workers issues and their insecure status with respect to the local communities in the locations they are employed. The project proposed the use of GPRS and MMS technologies.

fig. 3

A particularly interesting example is Yesterday Once More (fig.4), because the target and starting idea of the concept are somehow similar to the Cantastorie project developed in the service design course in Italy. The initial idea is based on the same critical observation of the continuous change of the public space; only in this case the landscape is modified literally over night. Although the message is supposed to be positive the project conceals certain nostalgia for the traditional landscape and the traditions imbedded in it. The ethnographic research reveals stunning images of the demolition process in a low-income environment in contrast with the hi-rise concrete buildings that will replace the houses. With the help of MMS and SMS technology the memories of the community could be shared and the richness of the personal relationships revived.

fig.4

The examples shown above provided a thorough inside on the complexity of factors to be considered when approaching the same design brief requirements in two different cultural contexts. Moreover the understanding of the mobile technology and the project concepts developed by the students, expressed the richness of applications for which the mobile technology could be used. It is a matter of conscious choice to employ the digital tools in a meaningful way, addressing the social and environmental issues relevant for each culture.

3.Research Methodology: analyzing the iteration process using action research methods

The complexity of the subject matter in the design teaching activities, calls for an ongoing appropriation of the research methods from other scientific disciplines; moreover when, most of the times, the person carrying on the pedagogical tasks is also a practicing designer. This is why the engagement in collaborative conversations (Feldman 1999) qualifies as a valuable inquiry tool belonging to the action research methodology. Action Research is a way of learning from and through one's practice by working through a set of reflective stages that helps a person develop a form of "adaptive" expertise (Riel, 2007). In fact in the passage from the first iteration to the second one the lecturer team engaged in several sessions of reflective conversations, which led to the evaluation of the accomplished experience and the craft of the following iteration. The conversations were synchronous or asynchronous and involved the different group members either as a full group or in separates sessions. The main subjects of the discussion were:

-what the team will do and the expected outcome, the evidence to be collected – in this case related in some respect to the kind of material the students had to prepare in their deliverables.

-the evaluation of our collective action that in the specific case of the design workshop involved not only the team but also external advisors.

-finally reflecting on the action taken and understanding the critical points, the knowledge created and outlining next possible directions of action.

The level of complexity in the second case presented shifted from the interdisciplinary lecturer team that had to achieve a level of common understanding of the emergent issues to the cross-cultural lecturer-student relation that had to be constructed through shared perspectives on the subject matter of the brief.

In the examples described before the outcome of the conversations was not only the improvement of the course structure and teaching practice but also an introspective journey into the creation of common ground in a interdisciplinary and multicultural situation. The iterative process provided a reflective inquiry into the professional action of the group and the initiation of an ongoing process of adjustments. The result was the acknowledgement of the need of change in the role of the academic from teacher-researcher to teacher-learner (Noffke, 1997)

Conclusion and future work

The qualities of a digital artifact conceal the laborious effort of multicultural teams and a fair amount of negotiation within the group. Having to face a fast pace in the changes that occur in the social context and in the technological field, the question is what kind of formation could prepare the next generation of designers to face increasingly complexity of the design projects. The paper presented intended to offer a view on the educational process and the complex issues that emerge in the development and teaching of the didactical content. Using the example of the two concept design experiments situated in two different geographic locations, the paper analyzed the multiple facets of the cultural differences. If the understanding of the notion of “culture” is commonly assimilated with ethnicity at a closer look the fine layers in cultural differences include discipline, age as well as gender or religion. In the case studies presented we tackled the intricacies of the interdisciplinary conversations and the need for a mutually agreed vocabulary. It was shown how the experience gathered in the process helped the professors deal with the generational gap and the different perspectives brought by the young students that grew up in the digital era. It was shown how the learning paradigm changes from an hierarchical structure to a peer to peer one, and how the classroom becomes a physical space for exchanging ideas. Moving to the second iteration of the same brief part of the lecturer team had to confront the complexity of multiethnic communication and face the radical view change brought by the social context. The results of the both courses have shown how the above-mentioned differences reflected in the final outcome.

To draw a conclusion, it stays in the teacher's ability to properly articulate the requirements of the didactical content and to encourage the students' progress in a collaborative manner. This is particularly important when the young generation has to be prepared to do the same under the pressure in a work environment. Especially in the specialized area of digital services, in order to achieve this goal the teacher has to be ready to adopt the alternative ways of transmitting the knowledge and be prepared to adjust these methods according to the cultural component of the student group.

Insofar the experiments presented have dealt with internally homogeneous student groups coming from different ethnic contexts but sharing the same disciplinary language. For a thorough understanding of the multicultural issues, the future work should employ a similar teaching structure involving this time both ethnically and disciplinary diverse students and teachers.

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Implications of Spatial Abilities on Design Thinking

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Abstract
The relationships between various cognitive characteristics and design creativity provide the necessity for consideration for design education. It can be argued that constructive perception ability that combines perception and conception and basic ability in visual reasoning composed of visual analysis, synthesis and representation in iterative nature are equally related with creative design ability. This paper reports findings of the application of a Spatial Ability measurement tool to first year design students and considers the results across three parameters, gender, University entrance Score and students' achievement in a first year Graphics course.

Keywords
Cognition, cross/trans/inter,multi, disciplinarity, Architecture, Learning

This paper reports on the application of a Spatial Ability test to first year design students in the School of Architecture and Built Environment at the University of Newcastle. The evaluation of the results gained from the 170 students provided some interesting considerations where the students' performance relative to their University Entrance Score, their performance in a Graphics based course and the performance based on gender. Firstly the paper will consider the role of spatial ability in the design activity as document in current literature.

The Relationship of Spatial Ability and Design

Design is a natural human activity present in many professions (such as engineering, industrial design and architecture). The design activity when utilised by the design professions provides a significant force for innovation and change in our societies. Despite the fact that the activity of design and the activity of science are tightly linked, design can be contrasted to science in that it is considered to be about imagining and synthesising new realities, rather than analysing and describing existing ones. Design can also be contrasted to art as it is essentially guided by human purposes and is directed towards the fulfillment of intended functions (Alexioua, et al. 2009). The distinctive nature of the design activity as illustrated by this emphasis on novelty and usefulness makes design fundamental to modern society.

Although design is customarily taken to be a high level cognitive ability, and many empirical and computational studies are focused on design cognition (Alexioua, Zamenopoulosa et al. 2009), there is to date very little research that touches on the biological or neurological basis of design (e.g. Cross, 1984, 1990; Goel and Grafman, 2000; Vartanian and Goel, 2005). On the other hand, there are many neurological studies that focus on creativity and aesthetics in art (e.g. Zeki, 1999; Martindale et al., 2007).Lloyd *et al.* (2007) argues that a major problem with a lot of research in this field is the poorly defined relationship between theory and empirical evidence. There is a sense of disconnect between the world of what design researchers talk about and the world of design activity itself. In addition, studies often come from a wide range of analytical approaches, including psychology, sociology, anthropology, grounded theory, and management studies. This diversity enriches the empirical-based study of designing but at the same time points to the absence of an agreed research methodology for design studies.

Definitions of design usually refer to the importance of "constructive forethought", or as Gregory (1987) states: "Design generally implies the action of intentional intelligence." A few common themes have emerged around the ways in which designers work and what designers do. Designers are said to (1) produce novel and unexpected solutions; (2) tolerate uncertainty and work with incomplete information; (3) apply imagination and constructive forethought to practical problems; and, (4) use drawings and other modeling media as a means of problem solving.

These themes provide us with an understanding of what designers do, however they do not inform us about the *Design Thinking* which underpins such design practice. Cross (1995, 2006) suggests that design aptitude consist of several key components including the ability to resolve ill-defined problems, adopt solution-focused strategies, employ abductive, productive and appositionial thinking, and use nonverbal, graphic/spatial modeling media.

This definition of design cognition acknowledges the particular ways that designers think, work and know. It separates designers' behavioral and cognitive processes from scientific and artistic forms of knowledge, both of which have tended to engulf design within their own epistemological and pedagogical frameworks. The unique nature of design processes suggest that there is a need to establish a distinct language and research of design, though care needs to be taken so that design is not reduced to static cognitive and behavioral categories for the sake of it (Allison 2008; see also Snodgrass and Coyne 1992).

Considering the crucial components of the design process, Kim and Maher (2008) defined the process of designing as a cognitive activity that involves the production of sequential representations of an artifact, both mental and external. Although further research is required on this matter, it can be argued that viewing design as a form of intelligence is productive; it focuses attention on design as a cognitive activity, it helps to identify and clarify features of design ability, and it offers a framework for developing further knowledge of the case for 'designerly' ways of knowing, thinking and acting.

Defining spatial ability

One of the more important cognitive components for designers is spatial ability. The concept of spatial ability refers to a complex process that designers utilize extensively in their design activity. Spatial ability has been defined as:

- the performance on tasks that require mental rotation of objects, the ability to understand how objects appear at different angles, and the ability to understand how objects relate to each other in space (Sutton & Williams 2007);
- "… the ability to mentally manipulate, rotate, twist, or invert pictorially presented stimulus objects" (McGee, 1979, p. 893);
- "… visual skills, spatial manipulation, recognizing the similarity of visual images, and imagining how visuals might appear in other orientations'' (Jonassen & Grabowski, 1993, p. 64);
- "… the ability to generate, retain, and manipulate abstract visual images (Lohman, 1979, p 188)";
- the ability to conceptualise links between reality and abstract; and
- the aptitude needed to mentally process three-dimensional images of objects (Fleisig *et al.* 2004).

Considered in their most basic form, spatial abilities form part of the visual thinking used in everyday life. Common activities, such as maneuvering a car along an unfamiliar road or rearranging furniture, require visual thinking. Spatial ability requirements escalate when higher order skills are needed as, for example, in the interpretation of technical drawings such as in building plans and in the process of translating these plans into buildings (McKim, 1980; Lajoie 2003). High spatial ability is therefore a requirement for design related activities where it is related to successful performance in real-world occupations such as architecture and engineering (Cronbach, 1970; Smith, 1964).

Spatial Ability and Design Learning

Spatial ability in the domain of design is essential for both learning and problem-solving, even when a problem is not specifically spatial (Alias et al. 2002; Roberts et al. 1997). From this it can be easily deduced that spatial ability plays an important role in design education and for the learning experiences of design students. There is a body of research (Sutton & Williams 2007; Sorby 2005; Potter & van de Merwe 2001) that indicates the importance of spatial ability in graphics-based courses and the implication of poor skills on success rates and career choices. However, despite there being a vast amount of research on spatial ability, there is very little known about the effects of spatial ability on design thinking and how it is developed through appropriate education programs. Furthermore, previous research on spatial ability tends to focus on one or two test types and neglects test types that specifically target spatial cognition relevant to disciplines such as design (Allahyar & Hunt, 2003).

Spatial ability has in the past been considered an innate ability. Recent research conducted at the University of Newcastle (Sutton & Williams, 2007) has, however, started to increase our understanding of spatial ability as well as of the effect it can have on students' performance in design related courses. A substantial part of spatial ability is 3D understanding; that is, the ability to extract information about 3D properties from two-dimensional (2D) representations (Sutton, Heathcote, & Bore, 2005). For the purpose of interpreting 2D drawings that are based on a notational system, design students require the ability to think and reason in 3D. By adopting the 3D Ability Test (3DAT), the projects reported here aimed to measure the spatial ability of students.

The studies on which this paper reports were conducted under laboratory conditions and in accordance with established psychological methodology protocols. Data were analysed using standard and appropriate statistical procedures. The underlying hypothesis was that no one spatial task is ideal when measuring the spatial performance of designers but that multiple subtests are required in order to gain a measure spatial performance. The studies used a range of paper ability tests that measures accuracy on a set of test items within a set time frame, and they assessed the validity and reliability of the 3DAT by comparing performance of the unskilled and skilled groups on both the 3DAT and the paper ability tests. This paper only reports the results of the 3DAT. In what follows, we present the approach used to investigate students' spatial ability and report on the results of statistical procedures.

Testing Spatial Ability

3DAT is a computer-based instrument that measures choice accuracy and response time. In its present form, the 3DAT consists of 12 subtests. Each subtest aims to measure separate factors of spatial ability, often referred to as elements or spatial skills. There is disagreement in the literature about the number of spatial skills that make up spatial ability.

The 3DAT is delivered on a computer using psychological experimental research software (SuperLab Pro). It consists of 72 items that are divided into the 12 subtests mentioned above. The items are all made up of straight lines and flat planes, but they vary in form and are novel in design. They were created using a CAD package (AutoCAD) and saved in bitmap format to suit the experimental software. Below is a description of the broad areas that make up the subtests:

- 2D3D Recognition: Objects are presented as orthographic and isometric projections. Participants select which type of two alternatives match a standard of the other type (Cooper 1990; Bertoline & Miller 1990). Subtests use either (A) an orthographic standard or (B) an isometric standard.
- Correct Fold: Objects are presented as an isometric projection or as an unfolded view. Participants select which type of two alternatives match a standard of the other type (cf. Blasko et al. 2004). Subtests use either (A) an isometric standard or (B) an unfolded standard.
- True Length Recognition: Objects are presented as isometric and orthographic projections (Sutton et al. in press). In one subtest, participants decide which view in a set of orthographic projections shows the true length of a labelled edge in an isometric projection (True Length Recognition A). In a second subtest, participants decide which of three isometric projections shows the true length of a labelled edge in a set of orthographic projections (True length Recognition B).
- Mental Rotation: Participants decide if a rotated isometric projection of an object matches the isometric projection of a standard or its mirror image (Metzler & Shepard 1988). The object on the left is always in the same position and is the referent. The object

on the right can be the same or the mirror image of the referent and its orientation in the XY plane can be different.

- Object Decision: Participants decide if an isometric projection can represent a 3D object (Schacter & Cooper 1990). The objects can be one of two types: the first (possible) is one where the projection can reasonably represent a true object. The second (impossible) displays some visual feature that cannot reasonably represent an aspect of a true object.
- Dot Coordinate: Participants are shown an isometric projection of a 3D Cartesian coordinate system and a text description of the position of a point in that system (Bore & Munro 2002). From four orthogonal projections, participants choose the projection that corresponds to the description.
- The tests cover a comprehensive range of different components of spatial ability and provide a detailed understanding of the spatial ability of the participants. A range of the examples of these can be seen in Appendix 1.

Results

The study, of design students spatial ability attributes has yielded a range of interesting and, in some cases significant, results. There are three areas aspects of the results that stand out, namely:

- the disparity between gender when considering spatial abilities;
- the relationship between high university entry scores and spatial ability; and
- the relationship between spatial ability and success in university design courses.

Gender

The test results show a significant difference in the performance of male and female students in relation to different aspects of spatial ability. As illustrated in Figure 1, which shows the level of performance by gender, female students did not perform to the same level as their male peers.

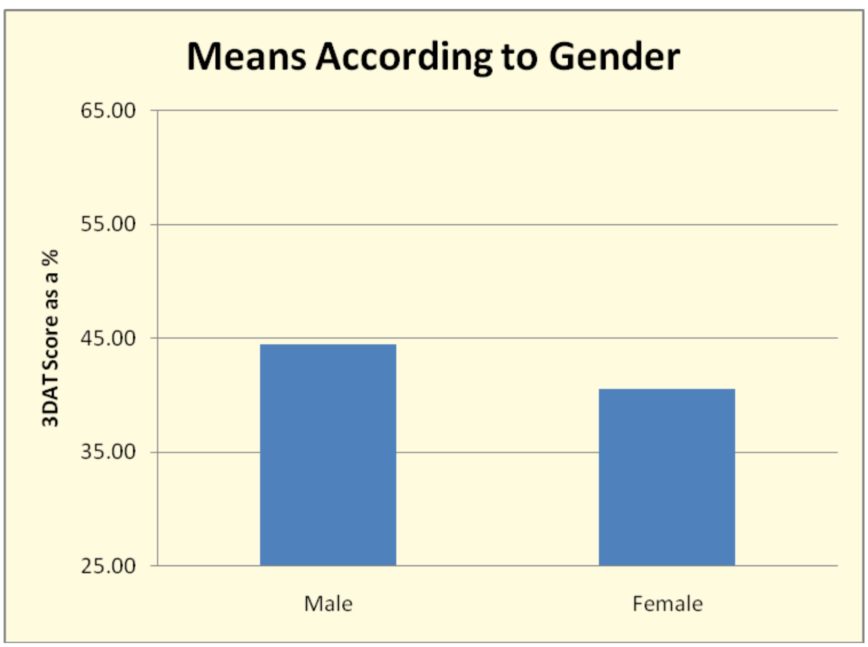

Figure 1 : Outcomes for Gender

The 12 subtests combined attained an overall mean score of 42.5%, with the males having a mean of 44.5% and females a mean of 40.5%. The female design students did not perform as well as their male counterparts on any of the singular subtests. Figure 2 illustrates the significant difference between male and female students on the 12 different subtests. This breakdown of the results makes the impact of gender even more apparent.

The performance of females across these fields is significantly lower than the males showing that females would find concepts that require such cognitive processes would not be able to function at the same level.

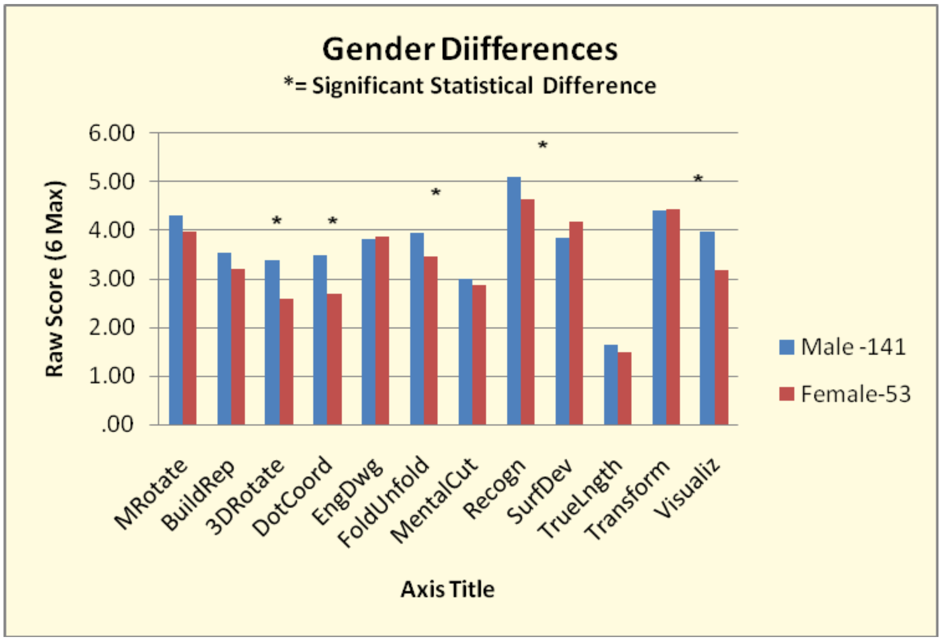

Figure 2: Performance of genders across the range of subtests

More research on this matter is required, and studies that will include other design discipline and other institutions are in planning. The results indicate that females experience more difficulty than their male peers when dealing with spatial problems and female students are likely to face greater difficulties with subjects that involve spatial ability aspects. The significant difference between male and female students across all the 12 tests raises a range of issues. It highlights the importance of preparing females for work in areas that require spatial abilities and consideration for educators as to how this divergence can best be addressed. The desire for increased female participation in the range of design disciplines at universities and in the work force accentuates the need to address this issue.

The preparation of students for university courses that require and utilise spatial ability needs to be a consideration of the secondary and perhaps even the primary school sector. Indications are that if exposed to appropriate experiences already at an early age, females are able to improve their abilities in this area.

Universities need to consider the abilities of female students when they enter design based courses or courses which would require application of spatial abilities. Curricula need to include experiences for females to that they are able to participate fully in subjects involving design or drawing and problem solving that requires spatial abilities.

The Relationship of Spatial Ability to UAI

One of the long held beliefs of universities is that high entry scores will ensure the quality of the students. Accordingly, it may be anticipated that there is a correlation between the novice designers' scores in spatial ability and their university entrance score. This assumption has a historical link with the inclusion of spatial ability type problems in traditional IQ tests. It is, however, evident from the results presented in Figure 3 that there is negligible correlation between university entry scores and spatial ability.

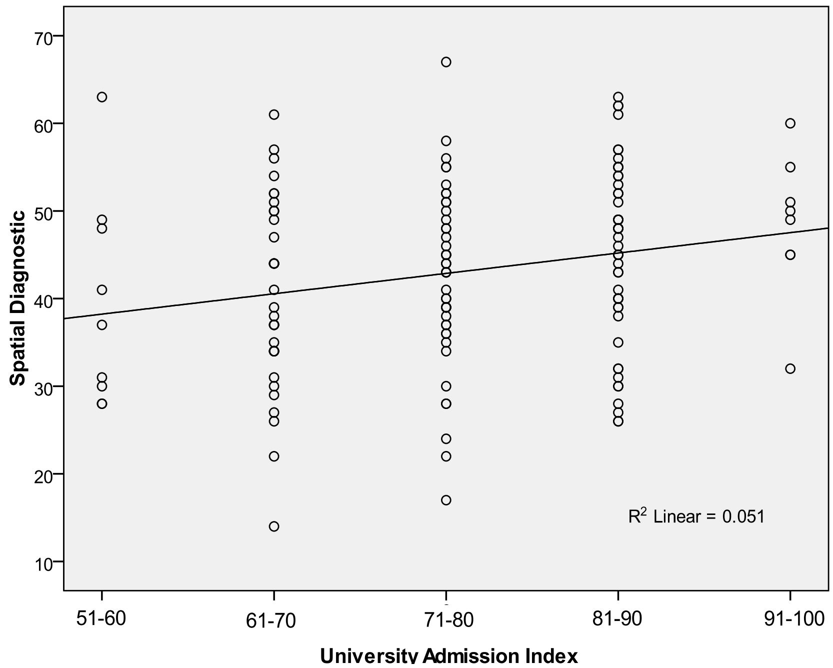

Figure 3: The relationship of the Course Score to the Student UAI

What is evidenced is that the students with higher UAI scores did score higher in the 3DAT when it is looked upon as a mean or average. But what this does not indicate is the range of the results in each grouping. This is evident where the spread of the results show that there is just as significant range of results in each university entry score deciles.

The relationship of UAI to performance in spatial ability provided some interesting outcomes. The project team expected a high positive relationship between the UAI performance and the spatial ability results. This was not confirmed by the results, which instead showed a low to medium positive relationship between these variables. This result suggests the need to consider the potential problems that students who enter university with a high UAI might have in subjects utilizing spatial abilities. Drawing and CAD courses are often part of the early curriculum structure of design programmes, requiring pre-existing spatial ability skills. Such skills are, however, not necessarily reflected in the UAI of the students. Obviously further study is required in this domain but, with such consistent results, the question must be asked about preparedness for study in some types of subjects. One factor that may impact on this situation is the experience level of the students undertaking the tests.

The material reported here suggests that students with high UAI do not perform as well as could be expected across the range of spatial ability tests. This implies that, firstly these students may not relate well to subjects that utilise spatial ability, and, secondly, that it is not possible to consider UAI as an indicator of expected performance when dealing with spatial ability problems.

The Relationship between Spatial Ability and Results in a University Course

This study investigated the relationship between course marks attained in a university undergraduate first year graphical communication course and the 3DAT to determine if the 3DAT could be used as a reasonable predictor of success in certain graphics based courses. Deno (1995) points to a deficiency in visualization skills as a reason for many design students withdrawing from graphics courses very early in their careers and considers addressing shortcomings would improve retention rates. In one detailed study (Blasko, Holliday-Darr, Mace, & Blasko-Drabik, 2004), a number of variables such as academic background, motivation, parental persuasion, verbal skills and spatial ability were tested to determine what might impact on student retention rates the most. The researchers found that scores on basic tests of spatial ability (e.g., mental rotation) were the best predictors of retention.

	BuildRep	DotCoord	EngDwg	FoldUnfold	Recogn	SurfDev	Visualiz	3DAT
Course Mark	.18*	.17*	.34**	.21**	.24**	.29**	.23**	.3**

*p is significant at the .05 level. **p is significant at the .01 level. Sample (n = 179).

Table 1: Correlation Between Arbe1100 Marks and the 3DAT and Subtests Scores

Correlation coefficients (r) for the Graphics course marks and the 3DAT and selected subtests are shown in Table 1. Correlations were statistically significant for 7 out of the 12 subtests and these are the subtests listed in Table 1. For effect size, r = .10 is considered to be low, r = .30 is considered to be medium and r = .50 is considered to be high (Cohen, 1992). Effect size is also termed practical significance and it is a measure of the extent of a relationship between two variables (e.g., Arbe versus 3DAT). Using this scale, the relationship between course marks and the 3DAT and each of its subtests shown in Table XX is in the low to medium range. Although the correlations are significant, the correlations are not strong. Using the 3DAT in its existing format at the time provides a modest predictor of success in a graphical communication course such as Arbe1100. However, the 3DAT has undergone a number of reviews and modifications in accordance with psychometric standards for test development since the testing with the participants reported in this study. These standards include item analysis, validity assessment and measures of internal consistency (reliability) of the test items in each subtest. We have confidence that the 3DAT is a more effective instrument in its current form and further testing is planned in 2010.

Conclusion

The 3DAT test for Spatial ability has now been evaluated and refined over a four year period and the statistical results gained from its use across a range of disciplines and levels in both Design disciplines and non-design disciplines has proved fruitful data but also a validation of the test. The result of the First Year Design Students doing a course in the School of Architecture and Built Environment School showed a range of interesting results across the three areas reported in this paper. Results indicate a statistically significant difference between male and female spatial performance, favouring males, and overall spatial performance showed only a marginal correlation with university entrance scores but the range of scores at any level was very broad with students at the top end of the UAI scoring very low results in the 3DAT test, inferring that the higher UAI students may not have high Spatial Skills and visa versa. Spatial performances were also compared with course results and indicate that spatial ability can be used as a moderate predictor of success in graphics based courses.

Further refinement will be undertaken of the test but more importantly the project now moves into a phase of resource development to develop online resource packages aimed at enhancing students' spatial ability and using the 3DAT as a self diagnostic stool.

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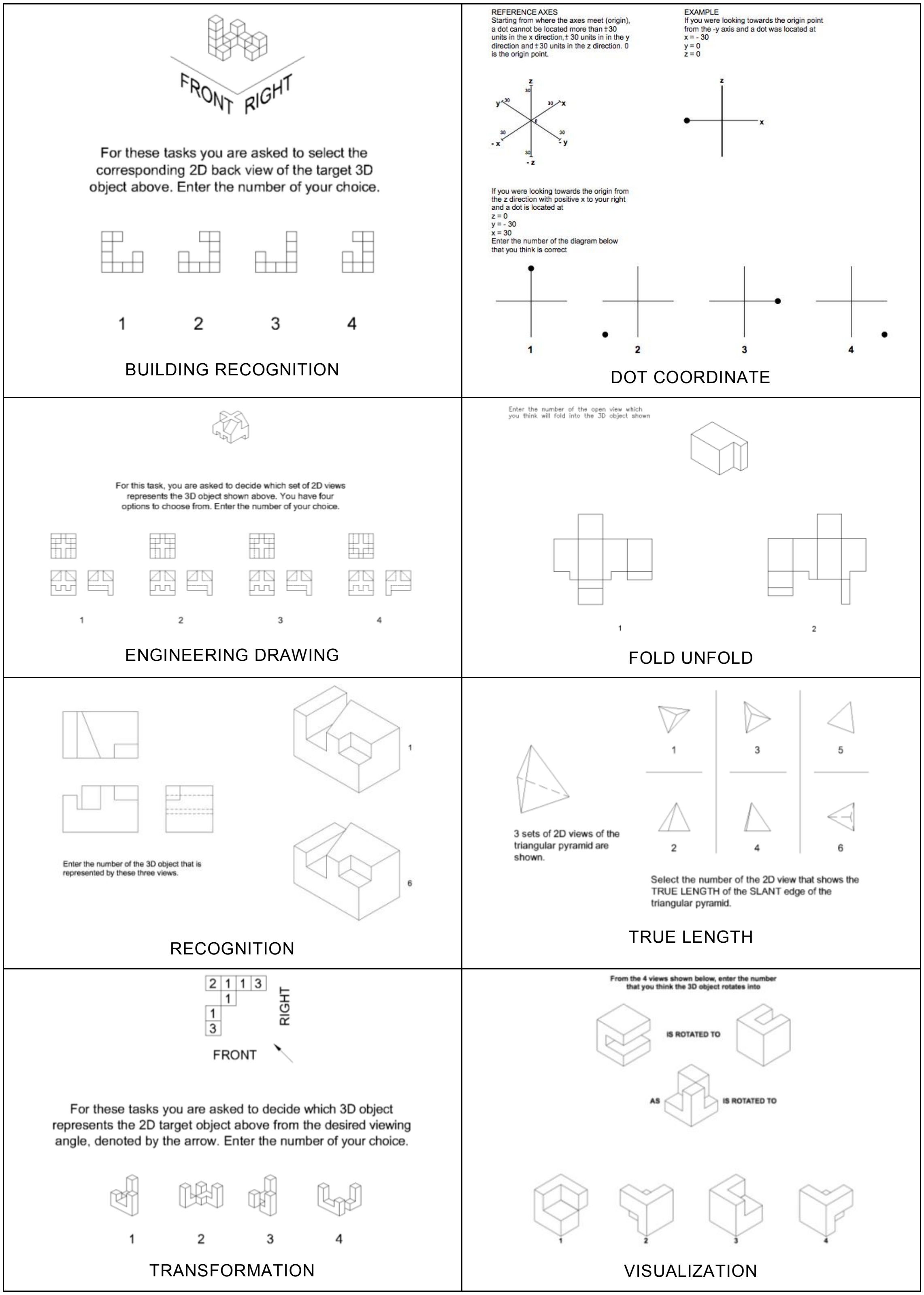
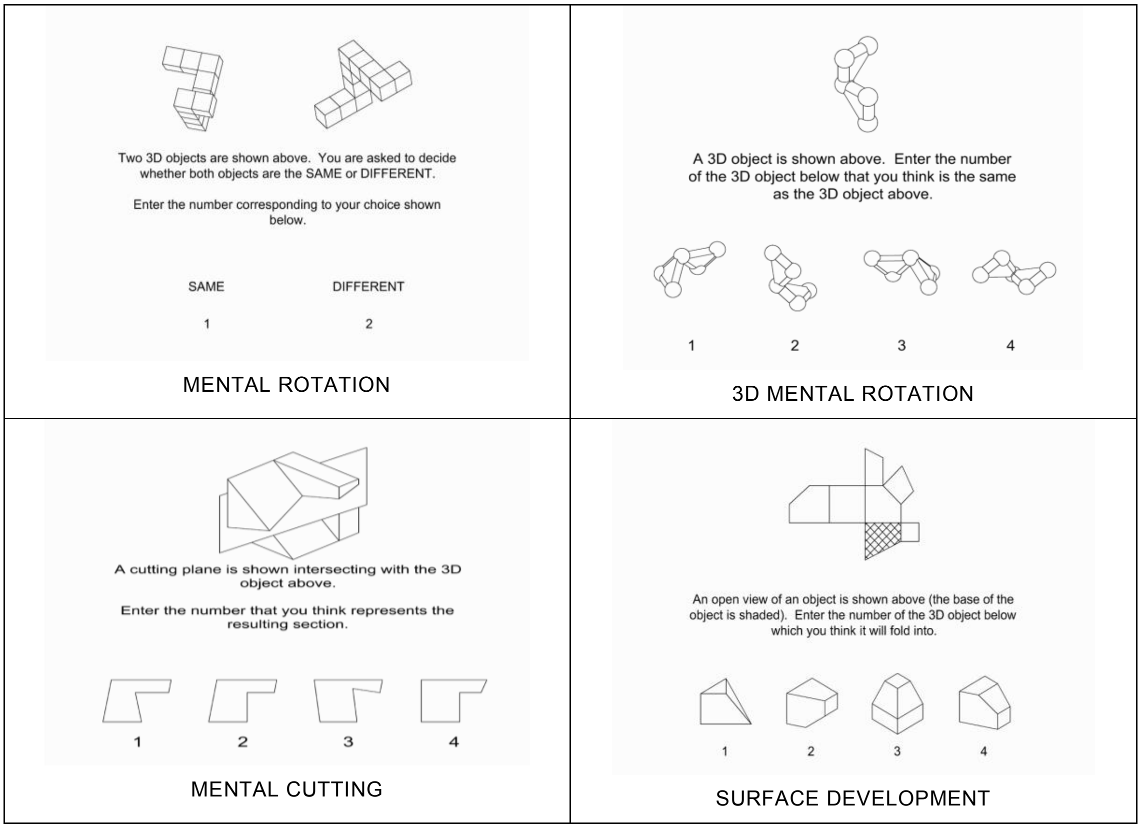
Appendix 1: Examples of Test Items





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Engaging complexity through collaborative brand design

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Abstract

In this research we used inductive reasoning through design to understand how stakeholders in the Waterfall Way (New South Wales, Australia) perceive the relationships between themselves and the place they live in. This paper describes a collaborative design methodology used to release information about local identities, which guided the regional brand exercise. The methodology is explicit about the uncertainties and complexities of the design process and of its reception system. As such, it aims to engage with local stakeholders and experts in order to help elicit tacit knowledge and identify system patterns and trends that would possibly not be visible if a top-down expert-based process was used. Through collective design, local people were drawn together in search for a symbol to represent the meaning attached to their places/region in relation to sustainable tourism activity.

Keywords

Collaboration; complexity; identity; place branding; tourism; design and society

This paper describes how collaborative design can be used as a tool to acknowledge and engage the complexities of place branding for tourism destinations. In this research, we used inductive reasoning through a collaborative design methodology to help release information about local identities, perceptions and expectations of stakeholders in relation to tourism and how it should be promoted. In the approach we describe below we are explicit about the uncertainties included in the design process (e.g. uncertainty about a client's cognitive model to successfully brand a product) and also about the complexities of the design process and of its reception system, i.e. conflicting interests about what should tourism should bring to the places as well as the numerous relationships between the branding process and how potential visitors perceive it and choose a destination based on it. It seems to us that a methodology that aims to engage graphic designers with stakeholders and experts involved in branding destinations, hosting tourists and tourist activities can provide advances in design research. We argue that our methodology provides results that would possibly not be visible if a top-down expert-based process was used.

The main challenge of creating a brand for the Waterfall Way lied in harnessing an identity to represent a destination that does not naturally sees itself as one. The sole creation of a symbol would not necessarily help bring this identity to surface, hence the need to engage locals in thinking about their places, perceptions and expectations, and about how their lives are connected to the others (peoples and localities) along the region. We believe that the active involvement of locals into the brand design process allowed the elicitation of a regional identity that is grounded into actions and interactions, rather than simply dependant on an isolated symbol to represent them to the outside world, as suggested by Anholt (2008).

Thus, the objective of this paper is to describe a collaborative methodology that is focused on active stakeholder engagement in the design process. We also discuss the methodology in terms of the local knowledge and the conceptual regional identity it helped release. To do this we first sketch the geographical and historical conditions of the Waterfall Way in order to contextualise prospects on how the collaborative design approach was applied. Then we present the theoretical background, followed by the description of the design process, the results it produced, and a reflection about the advantages and limits of our methodology. It is outside the scope of this study to analyse the design outcomes in relation to the efficiency of their application. Further research is needed in order to survey and evaluate the current situation of the tourism activity in the Waterfall Way region, and how it is related to the collaborative brand design work.

Geographical and Historical Setting

The Waterfall Way is located between the New England Tablelands and the Mid-North Coast of New South Wales, Australia (Figure 1). It is known for its variety of landscapes set in a relatively short distance (approximately 250 km), showcasing significant diversity in climate, wildlife and culture. In addition, the region is privileged with rich stories concerning indigenous culture and pioneering history, as well as collections and festivals of art and music reflecting the painters, poets and scientists who have frequented the region over almost two centuries (Atkinson, Ryan, & Davidson, 2006; Hassall, 2008; Haworth, 2006; Kane, 2007; O'Loughlin, van der Lee, & Gill, 2003a, 2003b; Pigram & King, 1977).

The area is called “Waterfall Way” due to the pre-existing name of the road that links the Bellinger Hinterland, up the mountain through to the University town of Armidale, administrative capital of the Tablelands. Numerous waterfalls pour over the escarpment and run down the deep gorges through which the rivers reach the sea creating the so-called ‘falls country’ which has long been a scenic tourist attraction. While tourism activity exists in the area, it has always been scattered and disparate, with the places along the corridor usually competing for visitors and business (O'Loughlin, et al., 2003a, 2003b; Pigram & King, 1977).

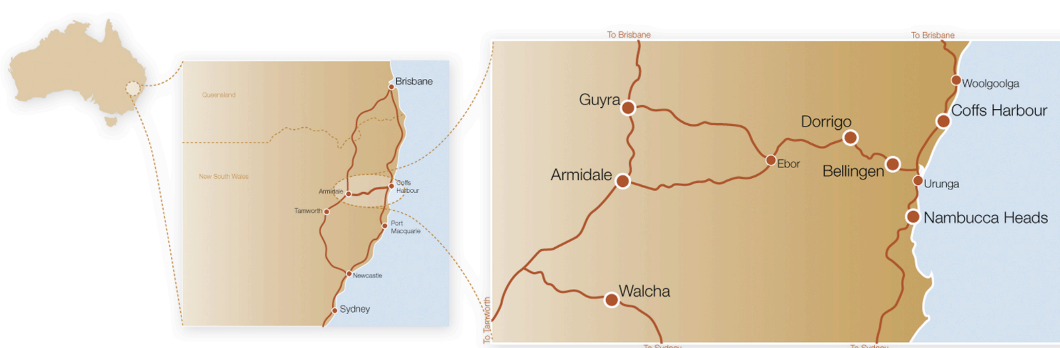

Figure 1 – Location map of the Waterfall Way, NSW, Australia (Taboada, 2009).

Local initiatives have emerged along the years envisioning an increase in tourism activity that could bring new economic possibilities to the communities in the area. In 2002 an initiative to build a long distance walking track along the Waterfall Way was identified as a way of unleashing the tourism potential of the region. In response to this initiative, a Concept Plan and Feasibility Study were developed at the time in a partnership between the New England Ecotourism Society and the University of New England. Among other strategic recommendations, these studies pointed out the need to create a shared regional destination brand to represent and promote the whole region as one, instead of promoting parts of it as it has been traditionally done (O'Loughlin, et al., 2003a, 2003b; O'Loughlin, van der Lee, & Gill, 2004).

Branding a destination is more than simply creating an image for a product (Anholt, 2008; Anholt & Hildreth, 2005; Marzano, 2006; Morgan, Pritchard, & Piggott, 2002, 2003; Pike, 2005). It involves a process of creating meaning for the place/places being branded; meaning that will impinge on the place not only through the new tourist activity that it may bring, but also on the way local people act and see themselves and their places (Hough, 1990; Taboada, 2009; Taboada, Haworth, & Spence, 2008). A new symbol alone for the Waterfall Way is not able to change its reputation. It requires, proper institutions, policies and collective actions to create a new place image in the minds of the outsiders (Anholt, 2008).

Therefore, in accordance with Morgan (2002, 2003), Pike (2005) and Marzano (2006), destination brands should start from inside out, rather than the opposite. Local people should be the drivers and owners of the strategic solutions created during the process so that the new “brand” can be in line with and support their actions and ways of living, resulting in collective will to change actions and ways of living in order to support the newly created brand.

Theoretical Background

What Morgan et al. (2002) describe as the challenges of branding places (multiple stakeholders, little management control and destinations being normally under-developed identities) can, in fact, be seen as points of advantage if we understand places/destinations as complex emergent systems with flow-on effects on the governance systems of the region. Through this perspective, the multiplicity and diversity of stakeholders can enhance the capacity of interpretation and understanding about the place; “little management control” may open doors for self-organising actions to emerge, and “underdeveloped identities” can be a good blank canvas to bring people together around catalysing a latent regional identity.

The background theories we use in this research are complex emergence (Holland, 1998; Johnson, 2004; Nova Science Now, 2007) and systems thinking (Ackoff, 1960; Angyal, 1941; Capra, 1982; Checkland, 1999; Jackson, 2003; Senge, 1990; Stacey, 1993) where a “system” is defined as a complex whole that emerges from interactions between its parts through networks of relationships.

The theory of complex emergent systems can be used to explore the dynamics of place and to describe the growth, development and change cycles of towns, cities, or regions. Systems tools can be applied to develop planning/designing methodologies that consider the local identity system as a whole, reflect this identity, and draw upon the self-organising characteristics of the place to implement small changes that can have broad, long-term positive impacts (Innes & Booher, 1999; Johnson, 2004; O'Loughlin, Taboada, & Gill, 2006).

Complex emergence and systems thinking approaches emphasise that actions within a system are not necessarily coordinated by a leader or leadership group (transformational leaders may be key factors in catalysing emergence). Rather, they unfold from the actions of individuals who follow certain system embedded rules of behaviour, normally defined by survival / instinctive needs (physical or social). “Individuals and like communities observe, inform each other and develop adaptive responses; they swarm, re-think and cluster”, to form their own individual identities (O'Loughlin, et al., 2006). These identities will reflect on the system behaviour as a whole and will determine the kind of interactions the system will attract as well as its evolutionary pathway.

Additionally, complexity theory is concerned with uncertainties rather than certainties in the systems’ behaviour. These views engage with our postmodernist approach where we acknowledge that there are multiple interpretations of the world and that not much can be predicted in the long-term (Capra, 2002; Castells, 1997; Crotty, 1998; Gadamer, 2004; Healey, 1997; Searle, 2005).

Designers create and deliver their designs into this complex setting. Destination branding, the focus of this paper, has specific demands and challenges that differ from branding other kinds of products, and that reinforces its complex character. (Anholt, 2008; Morgan, et al., 2002, 2003; Taboada, 2009). It deals directly with the systems’ physical and social structures, and with the interactions within the place being branded. Efforts have been made to accommodate the complexities of places into destination brand design (Marzano, 2006; Morgan, et al., 2002, 2003; O'Loughlin, et al., 2006; Pigram & King, 1977; Taboada, 2007; Taboada, et al., 2008). Most of which involve broadening the participation of local stakeholders into the branding process.

This study understands places and tourism as complex systems that involve a broad range of agents and meanings attached to them, deeply interacting with each other to create tourism experiences (Bosselman, Peterson, & McCarthy, 1999; Burns & Novelli, 2007; Jafari, 2000; Pigram & King, 1977; Robinson, 1999; Shaw & Williams, 2004). Thus, the process for developing a promotional image for a destination should take into consideration these critical interactions. Figure 2 depicts the dynamics of destination branding, showing the interactions between the hosts (who live at the place and deal with the positive and negative impacts of tourism, and build the reputation of the place) and the visitors (who are attracted by what the place communicates, and create images of their own about what it really is).

It is important to acknowledge the multiple interactions of tourism destination and the impacts its communication system has upon the host communities. These dynamics will determine if the messages released from the place genuinely reflect local values, vision, and parts of the place identity that the locals wish to reveal to visitors. At the same time, through acknowledging the complexities of place it is more likely that the actions of hosts will support and reinforce the brand messages, helping to construct a reputation for the place, rather than having businesses just applying (sometimes struggling to apply) an “empty” new symbol (Anholt, 2008, Pike, 2005 #308).

Figure 2 – The dynamics of destination branding. From (Taboada, et al., 2008).

The role of inductive reasoning in our methodology

The methodology described in this paper used design as a tool to stimulate inductive reasoning to conjecture how stakeholders perceive their place system individually and collectively. Inductive reasoning means that when we, humans, face complex problems, rather than looking for solutions that thoroughly consider all the possibilities in the system, we deal with these overwhelming amounts of information by intuitively simplifying the problem. We naturally search for patterns and “we simplify the problem by using these to construct temporary internal models or hypotheses or schemata [that are simple enough] to work with” (Arthur, 1994). We then use these internal conjectures to “fill in the gaps” of knowledge we don’t have or things we don’t understand about the problem. Subsequently, we try to find a solution based on the information we can recognise or induce from what we can observe.

In other words, instead of creating and thoroughly testing all possible variable of a hypothesis, and then generalising the answers, through inductive reasoning we unconsciously observe the world and consider what patterns emerge from those observed situations, and how can specific solutions be found. Therefore, inductive reasoning is highly context dependant and considers the fact that we never understand each and every aspect of a certain problem, but what we can do is deal with the parts, interactions and patterns we are able to reason.

This may seem contradictory to the systems approach that suggest that problems should be tackled holistically rather than through dividing it into parts. However, the individual maps we collected from participants enabled us to create a broader (and more holistic) map that can provide a better representation of the system (Özesmi & Özesmi, 2004). Mapping individual perceptions of patterns and interactions can help us deal with the overwhelming feeling of the whole at the same time as it makes us acknowledge the unknown.

In our methodology the design process was used as an instrument to help find patterns that are easier to identify and tackle strategically. In other words, the action of designing the strategy and the visual communication material for the Waterfall Way brand helped simplify the broader complex problem of understanding the region's identity. It worked as a "translation" tool that helped stakeholders make sense of their thoughts and feelings about the place system.

In the next session we briefly explain the methodology, show some of the achieved results and interpretations of patterns and interactions in relation to the places identities and to the final brand and visual communication concepts.

The collaborative design process

The branding of the Waterfall Way involved seven local shires and consisted of public workshops, one-to-one interviews, and collaborative design workshops where participants were invited to share local stories, personal views and opinions as well as to actively contribute to the brand design itself. The process can be explained in three stages: the elicitation of the local identities, the conceptualisation of the regional brand, and the delivery / implementation of the created strategies.

Eliciting local identities

This phase consisted of public workshops and one-to-one interviews. The workshops aimed to collect market information in relation to the local tourism opportunities, existing businesses and gaps. Approximately one hundred and fifty people attended the workshops and all of them were invited to take part in the branding process through the one-to-one interviews. A total of fifty-nine people from across the area were interviewed.

The interviews were unstructured (and we refer to them as 'conversations' in the remainder of the manuscript) and the starting point was the open question: 'What is special about your place?'. This question led the conversations into other reflections and considerations about the places, especially in relation to tourism activity and the positive and negative impacts it may bring to the region.

The conversations were conceptually mapped in a way that themes, ideas, opinions and the links between them were registered as they were mentioned. For each locality, the conversation maps were conflated according to common key ideas and themes and a new map was created that represented elements of the identity of each place according to the conversations. Figure 3 depicts one of these place identity maps.

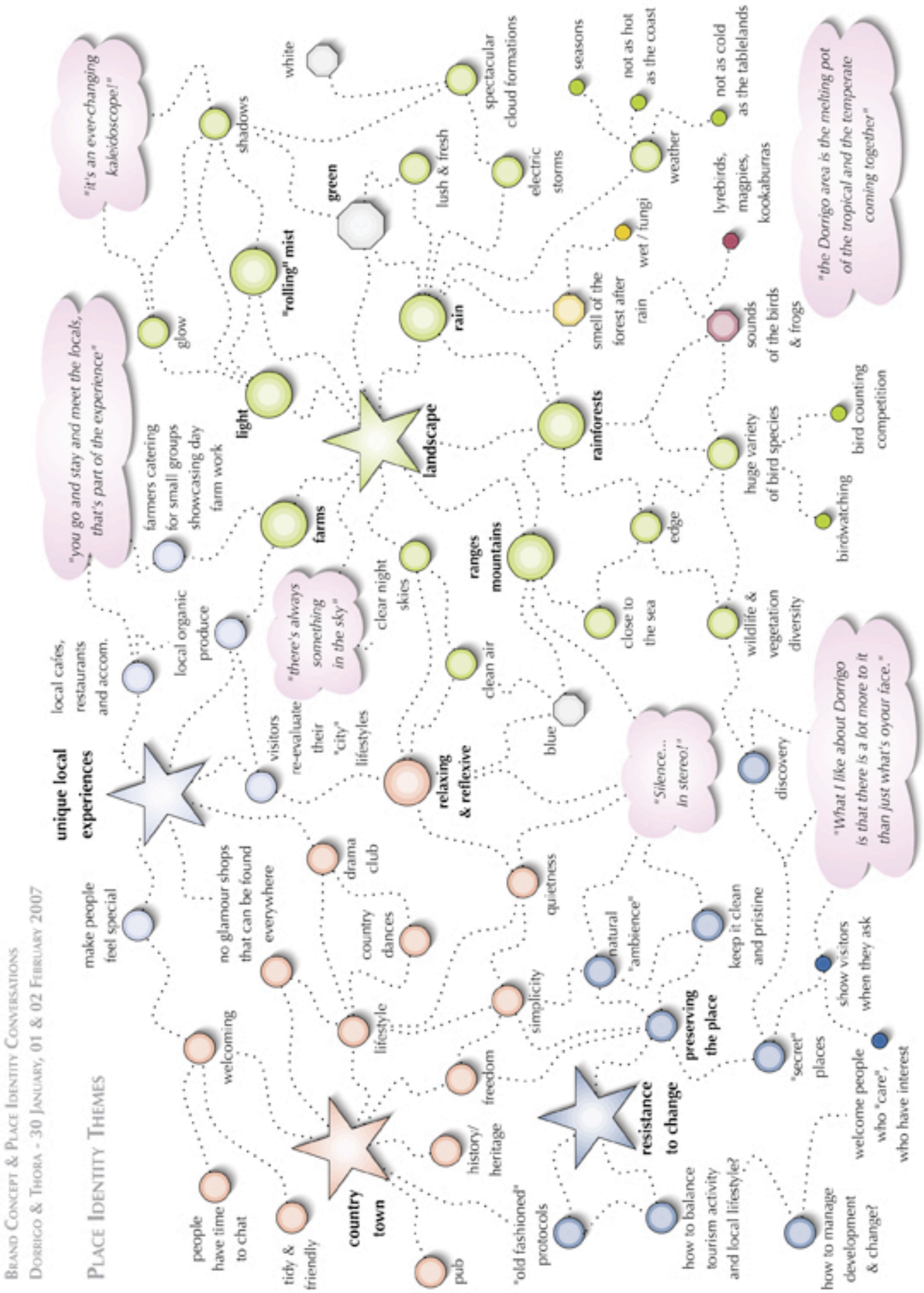

Figure 3 – Place Identity concept map created for Dorrigo, based on eleven one-to-one conversations with local farmers, dwellers and business owners.

Concept mapping was used to reason the information collected during the conversations. The maps were used as a model for tackling the complexities of local identities by representing ideas on the same ‘plan’ (a board or piece of paper). As such the insights from different people are seen equally and the interconnections between them become clear. Additionally, through visually mapping the conversations using a phenomenological approach, the feelings and impressions expressed during the interview were captured in a richer systems map, showing the interactions between concepts and the emergence of certain key themes.

At the end of the one-to-one interviews, Place Identity Reports based on the concept maps were produced and sent back to stakeholders for feedback.

Identifying a Regional Brand Concept

Nineteen people from the broader group of stakeholders were selected to participate in a two-day workshop for the consolidation of the regional identity concept. Participants were community members, tourism business owners, government representatives, academics, as well as design and marketing experts. The aim of the workshop was to collaboratively design the brand concept for the region, to create the visual communication tools for the brand (name, slogan, logo, etc.), and to outline the brand principles, ethos, and management strategies.

Despite the strong presence and informative collaboration of the experts in the workshop, their opinions concerning the creation of the brand had the same weight as the ones from all other participants. Experts and lay participants had to express their opinions in a way that all could understand, thus promoting clear and open discussions. Along with brainstorming and group concept mapping, the following approach was used to elicit information in regards to how the region looks and feels like:

A broad collection of existing publications and promotional materials of different styles, formats and colours was presented to the group in order to engage them in thinking visually about the message that needed to be conveyed for the region. They were asked to choose the items they believed would be most suitable to represent the Waterfall Way. One by one, the participants presented and justified their choices. In so doing they were indirectly telling the team which elements – type, colours, style, texture, imagery – they thought would be appropriate to carry the message of the Waterfall Way as an eco- and nature-based tourism destination. Each idea was discussed and registered on the white board, so the group could visualise the full picture of the message they were collectively designing through the exercise.

This exercise helped participants visualise and express abstract ideas and concepts that they were not used to verbalise. It allowed for them to use different channels to communicate their ideas, which were compared to inputs brought in by the broader group of stakeholders through the previous interactions with the researchers.

Later, the group engaged on the discussions around the brand principles, the regional charter that would inform the management of the brand, and some rules of behaviour for local tourism operators and visitors. The same group involved in the creation of the shared brand concept designed the brand principles and management strategies. During this part of the work the participants drafted a document describing the shared agreement on brand principles, a proposed governance structure and some management strategies.

The one-to-one conversations and workshops made it possible to collect information about people's perception of the area. At the same time, it stimulated reflection upon what is special about the places, thus reinforcing a sense of belonging. Feedback and communications between the smaller working team and the broader stakeholder group were constant and remained an essential element of trust among the participants (Figure 4). The collective process helped elicit tacit knowledge (similarly to findings from (Dray, Perez, LePage, d'Aquino, & White, 2006; Polanyi, 1967; Rust, 2004a, 2004b; Senker, 1995)), in relation to communication design and promotional strategies, from people who would not normally be involved in these practices.

Figure 4 – Scheme of public participation and communication flow during the Waterfall Way collaborative brand design process.

The collective work undertaken during the workshop helped reinforce the identity concepts initiated during the conversations by locking into a communication strategy that intends to synthesise the essence of the destination system as a whole. Table 1 outlines a summary of concepts and ideas, and how they developed from the initial conversations to the final brand concept and visual apparatus. This demonstrates the inductive reasoning in relation to the elicitation of the regional identity.

Key ideas from conversations (identity concepts)	Brand concepts from co-design workshop (image / promise)	Translation into "tangible" aesthetic elements (communication)
Diversity	**Connection**	
Diversity of landscapes	Connection with changing landscapes and environments	Contrasting combination of colours and type
Distinctive local cultures	Connection with local people,	Welcoming, familiar tone

	cultures and arts Receiving visitors as friends	Stories and quotes from locals Poetic language
The “small town” atmosphere and natural beauty of the region works as an antidote to everyday city life	Connection with nature and self, through the journey	‘Hand made’ tracing style Recycled paper, matt, soft, natural feel Use of white space
	Travelling slowly, journeying	
	“Waterfall Way: a new journey, a new story”	

Table 1 – A synthesis of the collective reasoning process: from broad identity concepts to tangible communication elements.

Implementing the brand strategies

After the strategies and visual elements of the brand were finalised, the Waterfall Way brand was presented to the public on 8 February 2008, in a specially organised event in Dorrigo. After the launch, public workshops were organised across the region in order to present the brand and all the prepared material to the local people, tourism operators and business owners who would be interested in joining the Waterfall Way sustainable tourism network. At the workshops the brand was presented and explained in detail, including its features, possibilities and rules of use. A promotional pack was given to the attendees, which contained promotional material and the Waterfall Way Sustainable Tourism Toolbox (consisting of three booklets with support information about business development, marketing, communication activities, and the specifications of use of the Waterfall Way brand. Toolkits can be accessed via the Waterfall Way Operators Website: http://www.waterfallwaytourism.com).

Discussion

This study shows that a focus shift in brand development from an external perspective to an internal perspective is possible, and that, consequently, it requires not only the traditional market knowledge regarding consumers niche markets and what goes on the minds and hearts of potential visitors, but also the knowledge of the destination itself, its attractions and sensibilities, and its peoples’ cultures, hopes and expectations in relation to tourism activity and to the visitors that are coming to their places.

The impact of the collaborative methodology in the construction of a new region and in the decision-making process

The collaborative design methodology helped initiate thinking, among locals, of how multiple places along the Waterfall Way area can be understood as one. Through acknowledging the complexities of the task, the collaborative approach encouraged the shared construction of meaning in relation to the places and stimulated the rise of one potential single identity for the region. The use of our methodology enabled the creation of opportunities for stakeholders to reconcile information, expectations and place identity issues among themselves, confirming that place identity is socially created through conversation (Dixon & Durrheim, 2000).

Engaging multiple stakeholders in the creation of knowledge – the actual development of the visual and strategic components of the brand – with sometimes divergent points of view enriches and consolidates a regional identity that becomes more coherent in relation to expectations from hosts as well as tourists. Our research was effective to better understand people's perceptions about their places, about the possible unified tourist destination, and about the role of tourism in the region. Therefore, we opine that the act of collectively designing worked well as a tool to engage the complexities of place branding and of combining diverse people, backgrounds and expectations into one potential regional vision. An applied outcome of our research was the regional brand itself.

This kind of process can be a good alternative for planning in rather complex transdisciplinary areas, such as tourism, as it allows for different views to be acknowledged, perceived and taken into consideration. Our research also reinforced the fact that not all information can be known, and that, as humans, we naturally simplify, organise and recognise patterns of behaviour. In the end decisions are made based on what we know about the system as well as on the regional social networks where information flows. Through engaging multiple stakeholders from diverse backgrounds, we increase the chances knowing more about the system, building more interactions and creative connections, and therefore, being able to make better informed decisions. Including interested parties also promotes ownership and helps spread the information around the region. This is probably a useful way to catalyse emergence about solutions to issues related to tourism and regional planning.

On another perspective, the search for a symbol naturally engages one in reflection about self, or about what that symbol is to represent. Collectively searching for a symbol to represent their social group induces people into reflective conversations about who they are, what matters, what they want to communicate about themselves, and what are their roles in building the identity of the group they are in. These reflections are an expression of inductive reasoning in relation to your own “complex” self, or, place, as is the focus of our study.

During the work, participants learned by doing. Learning happened at a reflective and reflexive level. Reflection means that participants learned from each other, acquiring information and experience from outside. Being reflexive means that they learned from themselves by becoming conscious of knowledge they did not realise they had, while trying to express and explain them to the others. Experts and researchers learned about the places and the participants during the workshops and interviews. This dynamics helped create a level of tolerance that allowed for informed decisions to be made based on agreement and shared understanding, rather than consensus.

The collaborative design process also originated some challenges such as the change of roles of the designers, and the dealing with multiple mental models involved in the decision-making process. The role of the brand specialist and graphic designers changed significantly as most of the decisions were to be made by the group instead of an expert (e.g. graphic designers, planners). Consequently, leaders and experts became catalysers, interpreters and/or facilitators, rather than making the final decisions as is usually expected from them. This turned out to be one of the main challenges in applying the collaborative design methodology, as the graphic design team was disempowered to a certain degree.

If on the one hand some power was taken from the designers, on the other hand the close interactions with stakeholders gave another dimension to their work. Instead of designing the brand for the locals, the team designed the brand with them. As expressed by Rust (2004a), this kind of direct hands-on research allows users to “feed directly into designers' thinking and feed their tacit understanding of the people they are designing for". The change of roles helped the designers explore a more holistic view of the effects of their work on the region and its people.

Another challenge encountered during the application of the methodology was the fact that, in order for the collaborative approach to flow genuinely, the management of the design process needed to rely less on control, and more on facilitating the emergence of multiple local leaders. As a consequence, the process of making decisions changed: instead of having a single person or expert group deciding on design solutions, there was a large group of empowered stakeholders making decisions.

Our methodology was effective in understanding how participants perceived the Waterfall Way as a regional tourist destination at the same time as showing what the important links are to make it work according to tourist hosts' expectations. The design of the regional brand was a consequence of this understanding and an applied outcome of our research. The openness and flexibility of our approach comes at the expense of long periods of training to draw the concept maps during the conversations and subjective interpretations of the interviewer about how the interviewee's cognitions are perceived. Other approaches, such as the use of multi-step fuzzy cognitive mapping (Özesmi & Özesmi, 2004), qualitative modelling (Dambacher, Luh, HW, & Rossignol, 2003; Levins, 1974, 1988; Puccia & Levins, 1985) may be used along with our approach, in future research where they can all be combined and compared.

Conclusions

The main conclusions of our research are summarised as follows:

Collaborative design proved to be efficient and to facilitate real solutions in terms of the brand concept design. It is an example of inductive reasoning being used through design to tackle the issues of planning for sustainable tourism. Furthermore, by understanding destinations as complex emergent systems, we acknowledge that there are uncertainties in the "picture" provided by the conceptual identity design, and that decisions need to be made based on what we know and are able to understand about the system under a certain context.

Involving stakeholders in the design processes is not an easy task. It is time-consuming, hard to manage and highly context dependent. However, the power of this kind of collaborative process applied to brand design is the collaboration between lay people and experts in the design and decision-making processes. This collaboration led to reflections upon their own roles in the process of creating and marketing a tourist destination. The impact from this kind of collective work can be perceived on the final product as well as on the realities of people involved in the process.

Future work is needed to evaluate the brand in terms of its acceptance, recognition and usage by all concerned. The methodology can be further refined and may be applied in other areas of social research, in order to continue testing the efficacy of collaborative design as a tool to help engage complexity in constructing social identity and meaning.

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The Design and Development of Microcab

Michael Tovey, CEPAD, Coventry University, UK

Abstract

The combination of the global economic crisis and the issues associated with reducing our carbon consumption has made the Microcab project both timely and relevant. The company is essentially a spin-out from Coventry University's design expertise. The project has been to design, develop and test a sequence of vehicles for urban transport using low carbon hydrogen fuel cell technology. The key process issue is whether a relatively straight forward and familiar design process can be followed up successfully by a design product evolution and testing programme which is complex. Its complexity is in its dependence on various funding sources, in its engagement with a changing array of development partners, and in its relationship to a number of public sector programmes.

Keywords

Industrial design, Eco-design, Sustainable design

The Microcab project is led by John Jostins who is located in the Centre of Excellence for Product and Automotive (CEPAD) at Coventry University. Established as the result of a successful bid to HEFCE's Centres of Excellence for Teaching and Learning initiative in 2005, CEPAD now has an expanded remit. It encompasses both pedagogic development and applied research, seeing these activities as mutually reinforcing. The author, as Director of CEPAD, has taken a direct role in managing and ensuring an appropriate context for the Microcab project.

The Microcab Project

The intention in the Microcab project has evolved during its development. When it was initiated in 1996 the vehicle concept was considerably further from the mainstream than it is now (in 2010). It can be summarised for the current phase of work as:

- To design and develop a vehicle for urban transport using low carbon, hydrogen fuel cell technology.
- To manufacture and test a number of vehicles

The design concept is a vehicle with good environmental characteristics. It incorporates a powertrain architecture which is modular and full optimisation of systems and components has not been attempted. Technology and component choices have been dominated by considerations of availability, practicality, robustness, affordability, and avoidance of the risks associated with emerging exotic technologies. The original inspiration for this extended piece of work came about as a response to urban congestion problems, particularly in large cities. The intention has been to design and prototype vehicles employing lightweight structures powered by means other than the internal combustion engine. A range of electric drive systems has been adopted for propulsion, initially using battery and solar power, but subsequently adopting hydrogen fuel cells.

Whole vehicle design has always been at the heart of the project, with specific purposes and users in mind (eg. taxis). This has allowed all aspects of the vehicle to be re-evaluated including developing a more sustainable drivetrain. There are two aspects to the current approach:

1) Low carbon footprint designs for vehicles can be different from those currently in use. Patterns of usage will probably change and this is an ideal time to offer up alternatives.

2) New drive systems offer new ways of packaging components in and around vehicles and therefore offer potential for better use of the space.

The project has grown steadily in scale allowing a range of experiments with alternative vehicles, fuels and drive systems. As global environmental concerns are being taken extremely seriously by governments and industry leaders, the future of individualised transport products is likely to be in the integration of engineering and design innovation. From that, new products could emerge for mass use.

Approach Used

As the Microcab project has developed, numerous partnerships with academic institutions, companies and other organisations have been formed to create a network of support structures to test particular concepts. Throughout its development the project has been led by John Jostins, who divides his time between running the Microcab company and as a professor at Coventry University. He has a background in motorsport and special effects for film and television. His original motivation to develop what became microcab was a very personal response to the frustration of experiencing the difficulties of urban travel.

John Jostin's role throughout, has been as:

- Project Owner
- Concept Designer
- Project Manager

For the intial design work John was joined by Mark Dickins (a Transport Design graduate) who did the concept design styling drawings. He produced design sketches under John's direction, acted as a sounding board, visualiser and then model-maker. This core staffing of two produced a 1/4 scale chassis model, followed by a full size automotive clay model, from which a grp shell was taken.

The earliest physical model (1/4 scale) on show at the Oxo Tower, South Bank, London. It was intended to be a pedal/electric hybrid.

The original concept was of a pedicab type trike. This was a pedal-electric hybrid which weighed 150 kilograms. Jostins was able to secure private investment of £20k which was sufficient to pay for the construction of a prototype. By August 1999 a full sized working vehicle which was half pedal-powered and half electric had been produced. To do this Jostins used industry contacts and called in favours from the cycling industry and others. Honda for example provided the electric motors. The prototype design was exhibited at Interlaken in Switzerland.

Interlaken, Switzerland for the European Velomobile Symposium - the first full size working prototype. Battery electric with pedal assist.

Experiments were carried out with three different drive trains and eventually single motor system was chosen. The tiny battery pack weighing 28kg was not very effective and hydrogen fuel cells were examined as an alternative as they are lighter and better for re-fuelling.

In order to be able to apply for public sector funding to develop the vehicle a project team was created. Zytech had worked in Coventry with LTI and added necessary fuel cell expertise. John Piper was a former colleague of John Jostins from the Williams F1 team, who brought chassis design expertise. The team was thus expanded to:

- Microcab
- Zytech Power
- Piper Design

This enabled an approach to be made to the UK Government for funding. The basis was a claim that at a weight of 180kg for the revised design the vehicle had an extremely light chassis which provided the appropriate framework for developing hydrogen fuel cell hybrid propulsion. The application to the DTI (Department of Trade and Industry) in 2002 for a SMART innovation award was successful.

The first prototype was reworked with a new, lighter, moulded carbon sub-frame, and a single motor geared up and driven through a differential shaft.

Development was still a little precarious and uncertain as Zytech went bankrupt and had to be replaced by Intelligent Energy to sustain the fuel cell expertise within the team. In order to provide greater stability Coventry University became an equity partner in the company, and provided development and funding support.

2003, working in the new Bugatti building facilities at Coventry University, a styling exercise, led by Geoff Matthews, looked at a possible new four wheeled Microcab design.

This stage in the development of Mircocab was based on 4 core partners:

Microcab Industries Ltd.,

Coventry University,

Piper Design,

Intelligent Energy

In 2004 this partnership provided the basis for an application to the DTI for a Research and Development grant. £145,000 was awarded to develop the principles of the previous prototype. Now numbered H4 the project commenced in April, 2004 lasting for 15 months, completed in July 2005. As with the preceding design, the H4 was an urban, ultralight, city speed, 'short hop' taxi or freight vehicle. One important consideration in the design was that vehicle should be able to carry a wheelchair-bound occupant.

Context for the development

Since the initial idea for Microcab the context for its development has been one in which it has moved closer to mainstream concerns. This has included the developing body of published advice and opinion which was considering alternative energy sources for vehicles, and various configurations and drive trains. Samples of such developments give an indication of the direction they have taken.

In 2002 Jeong et al proposed that the most promising vehicle engine that could overcome the problem of present internal combustion is the hydrogen fuel cell. Fuel Cells are devices that change chemical energy into electrical energy without combustion. Pure fuel cell vehicles and fuel cell hybrid vehicles (Fuel cell + battery) studies indicate that hybrids which can capture regenerative braking energy look most promising. Hybrid vehicles are superior to their non-hybrid counterparts (Jeong, K.S., and Oh, B.S. 2002). Hybridizing a fuel cell system with an energy storage system offers an opportunity to improve the fuel economy of the vehicle through regenerative braking and possibly to increase the specific power, and decrease the cost of combined energy conversion and storage systems (Ahluwalia, R. K. and Wang, X., 2005).

Fuel Cell vehicles will be quieter and will have lower non-GHG tailpipe emissions, but will be more expensive and will require new infrastructure for vehicle manufacturing and maintenance, and for producing and distributing hydrogen fuel- thus making rapid acceptance and market penetration more difficult (Weiss, M.A., et al 2003). Automotive manufacturers and suppliers are investing heavily in the development of fuel cell systems as potential power sources for light duty vehicles. At this point fuel cell vehicles promise to be far more efficient, clean and truly zero emission with the only by-product being water (Lee, H. S., et al 2003). Reports on trials with Scania Hybrid PEM Fuel Cell Concept Bus, using hydrogen stored in cylinders on the roof concluded that such vehicles have big potential, but that there are issue to be considered, relating to durability, lifetime, costs, vehicle and system optimisation and subsystem design (Folkesson, A., et al 2003).

Battery and hybrid vehicles are seen as today's sustainable mobility solutions, preparing a future shared with a hydrogen economy. The summary report of the EU High Level Group for Hydrogen and Fuel Cells, presented in June 2003, developed a vision of the contribution that hydrogen and fuel cells could make to the realization of sustainable energy systems in the future. However as a long term vision (2000-2050), there is a need to take a strong action in the short and medium term to address current environmental and energy concerns (Mierlo, J. V., Maggetto, G 2005). Because of their high efficiency and low emission potential, fuel cell vehicles are undergoing extensive research and development. However several major barriers need to be overcome to enable a hydrogen economy. Because fuel cell vehicles remain expensive, very few fuelling stations are being built. To try to accelerate the development of a hydrogen economy, the auto manufacturers are developing a hydrogen fuelled internal combustion engine as an intermediate step (Kwon, J., et al 2006).

The hydrogen era is foreseen following the European research programme in a time horizon of 2020-2040. There will clearly be a choice between the electron economy using directly produced electricity, and the so-called hydrogen economy, which leads to the introduction of intermediate hydrogen production, transport and distribution. For passenger transport/ delivery vans there is a big time gap between the looming oil shortage and 2020-2040 for the hydrogen economy. Hybrids and electrics are needed to fill the gap and the better they perform the more questions there are over hydrogen fuel cell vehicles (Mierlo, J. V., et al 2006).

Fuel cells are projected to have energy efficiency twice that of internal combustion engines. They can start in freezing conditions without significant deterioration. Hydrogen storage systems for vehicles are inadequate to meet customer driving range expectations without being intrusive. The transition to hydrogen-powered fuel cell vehicle is projected to occur over the next 10-15 years. In the interim fossil fuel consumption will be reduced by increased use of battery gasoline hybrids (Chalk, S. G., and Miller, J. F., 2006).

Various fuel cell vehicles have been designed and prototyped by a number of companies - according to one source some 40 vehicles by 16 companies (TUV SUD). These vehicles have not become available for evaluative scrutiny and are not available at an affordable cost for public sector testing.

In this context the argument for the design, development and testing of vehicles employing fuel cell technology, and available for public sector scrutiny in universities and government agencies, becomes fairly compelling. There was a need to respond to this requirement, which the Microcab group endeavoured to meet.

Design Development of Microcab

For the current version of Microcab the overall vehicle design was developed under John Jostin's leadership. For the vehicle re-design Jostins engaged Automotive

Design graduates Adam Fairless and Alan Barrett as concept design/stylists. They were responsible for:

- Design: styling sketches
- CAD
- Ergonomics rig
- Full size styling buck

The full size styling model was sculpted and milled in Coventry University's Bugatti automotive design studio. It was used to facilitate design approval sign-off.

This new vehicle design was exhibited at the Grove Fuel Cell Symposium in London in October 2005 (Jostins J., 2007)

The next stage in the development of Microcab was concerned with addressing the engineering and operational requirements of the design. The need was to move from a concept design with a good external appearance and sound spatial ergonomics which was functioning as a rolling prototype, to a vehicle design with proven technical capability. This required considerable development. The UK National Engineering Laboratory in East Kilbride needed a test vehicle to sustain their programme in 2006, and Microcab was able to fill the gap. Their test results confirmed the viability of the design, and clarified the direction for future technical development.

However depending on the serendipity which had made available the East Kilbride facility was not a very secure strategy. There was a need for a greater focus on making the company viable, and on collaborative arrangements to sustain intellectual and financial investment. At this point Mike Wade joined as an equity partner bringing expertise in small manufacturing company start-ups, and investments.

The necessity for this was made apparent with the loss of Piper Design from the group due to bankruptcy. As a number of Piper's engineers then moved to Delta Motorsport Ltd, it was appropriate for Delta to replace Piper in the core consortium. This meant that individual contacts could be maintained.

The key to the next stage in Microcab's development was Wade's bringing a second University into the programme. His approach was to the Chemical Engineering Department of the University of Birmingham. In a programme of research led by Professor Kevin Kendall the department was already investigating CHP (combined heat and power) and canal boat propulsion using hydrogen fuel cells. They were quite amenable to extending their activities to encompass Microcab. However for this to be feasible a further funding source was necessary.

Design: technical details

What was needed for Microcab was that its technical details be developed and tested through running protypes. Its technical package consisted of its powertrain and the vehicle structure.

The powertrain is a fuel cell series hybrid, with a relatively small battery pack to deal with power transients and provide for short periods of operation on stored energy. (Tovey, M. 2009). This enables adequate performance with minimal fuel cell power output, giving benefits in cost and simplicity. If fuelled with hydrogen generated from renewable sources, this gives a truly zero-emissions fuel cycle. Current vehicles, designed for limited low-speed operations only, use the following components:

- Dynetek carbon-composite cylinder storing 0.63 kg hydrogen at 350 Bar
- Ballard Nexa fuel cell system, producing ca 1.5 kW at 24 V, with DC/DC converter
- Sealed lead-acid batteries 48V, approximately 35 Ah

- GE motor (wound, 48V DC, brushed, separately excited) rated at 4 kW continuous, 11 kW peak
- GE electronic drive, including simple regenerative braking (rear wheels only)

The vehicle structure has been designed with a frame holding lightweight GRP panels and vacuum formed plastic parts. The intention is to minimize weight with a target of 450kg. The current test vehicles have steel chassis components partly in order to allow modifications as required, and as a consequence are heavier. It has been necessary to use standard parts from production vehicles for reasons of availability and cost. The chassis has a sandwich structure with the steel frame assembled around it to contain the fuel cell, motor and hydrogen tank.

The original intention to use regenerative braking has not been retained in the current prototypes. The intention was to recover power from deceleration but this proved to be unsatisfactory in practice. This was because short pulses of high current generated on deceleration could not be absorbed by the batteries.

As anticipated, issues related to hydrogen safety required considerable attention to design details. There is a requirement for leak testing and monitoring, for avoidance of any accumulation of gas, and for other measures to comply with the draft European safety standard for hydrogen vehicles.

Fuel economy and range of existing vehicles are compromised by low efficiency of the mature, off-the-shelf fuel cell, the extra power converters, and the motor. However general performance has been fully satisfactory for trial purposes.

The limited budget, requiring maximum use of standard components and the prohibitive costs of carbon fibre, engineering and tooling have required major compromise on weight, with vehicles weighing approximately 650 kg against the original design target of 450 kg. The effort required for electrical integration of the fuel cell and other vehicle systems was underestimated and a wide range of electrical system revisions has taken place. Overall packaging was relatively straightforward, because the vehicle design is spacious, the all-electric powertrain facilitates a modular approach, and the low energy requirement results in small sizes of fuel cell and batteries (Tovey, M., 2009).

Birmingham University Project

The Birmingham Science City Project is part of the UK Government's Hydrogen, Fuel Cells and Carbon Abatement Technologies (HFCCAT) Demonstration Scheme. The scheme is designed to address key energy priorities of cost competitive carbon emission reductions and increased security of supply. A number of projects are being funded throughout the country. The Birmingham scheme is also supported by the regional development agency, Advantage West Midlands (AWM).

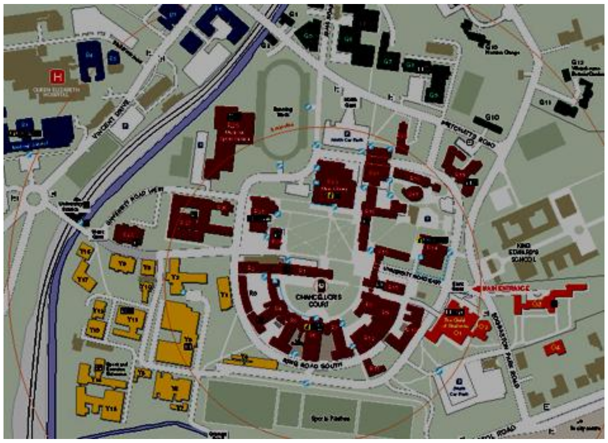
HFCAT project proposal created with funding support from three sources;

Science City (pays for vehicles)

AWM: hydrogen fuel station.

DTI: project funding.

The Birmingham project includes commissioning Microcab to supply and operate 5 of its vehicles on the Birmingham University Campus. It provides a good test arena for evaluating the vehicles on real roads where there is mixed use, but off the public highway. Part of the facility is a dedicated hydrogen fuel station



the fleet of five vehicles at the University of Birmingham

The project began in November 2007. The plan has been to investigate the use of the vehicles through various cycles of operation. A number of tasks have been trialled including postal and food deliveries, taxi services for visitors and estate duties. The intention has been to produce results which would allow comparison with the types of standard diesel vehicles currently used for such operations.

The filling station which has been installed contains hydrogen at 400bar. The filling operation was planned to take 4 minutes to pump 0.6kg of hydrogen into the carbon fibre/aluminum core composite storage tank at 350bar. The hydrogen is fed to the 1.2kWe Ballard Nexa PEMFC system which provides current direct to the motor and/or recharges the batteries to give a predicted 100 mile range. On campus that should be sufficient for 5 days of operation, making refuelling a weekly task.

The project which is now 50% completed involves 23 separate work packages, delivered by 8 separate organisations:

1. Microcab Industries Ltd
2. RDM Ltd — microcab consortium.
3. Delta Motorsport Ltd
4. The University of Birmingham – demonstration site.

5. Coventry University
6. Westfield Sportscars Ltd
7. Potenza Technology Ltd
8. Tempus Developments Ltd

The early work was reported on by Kendall, Pollet and Jostins (Kendall, K., et al 2008). They identified the basis in the development of hybrid fuel cells in previous work (Kim, M. J., and Peng, H., 2007), (Schell, A., et al 2005), (Lin, C., et al 2006), (Vahidi, A., et al, 2006).

In a recent technical paper Kendall et al described the Microcab test fleet test as the largest such trial in England to date. Their conclusion was that the hydrogen filling of the vehicles with green hydrogen could operate successfully on the university campus. Vehicle performance was good in terms of acceleration, cruise speed and range, satisfying the campus drive cycles. However the regenerative braking system was not adequate and needed improvement. Further optimization in terms of efficiency and reliability was required and a more powerful hybrid drive train would be needed for the ECE15 urban drive cycle (Kendall, K., et al 2010) and (Kendall, K., 2009).

Further Projects

There is regional support for further development work on the vehicle design through the regional development agency Advantage West Midlands. It is funding a research and development programme for small companies who are involved in the development and manufacture of vehicles and members of its Niche Vehicles Partnership. Microcab is a member. It is managed and led by CENEX, the Centre of Excellence for LowCarbon and Fuel Cell Technology, and supported by Coventry University, which both hosts the project and delivers the programme.

The Niche Vehicle Network consists of some 37 organizations. Microcab's development programme involves 3 of them in collaboration, along similar lines to the Birmingham project.

Microcab

RDM Automotive

Delta Motorsport

Further, through the Technology Strategy Board, the UK Government has announced that it is supporting CABLED (Coventry and Birmingham Low Emissions Demonstrators), as part of its Low Carbon Vehicle Demonstrator Programme. This will be delivered as 8 projects nationwide featuring 340 vehicles showcasing a range of technologies. About a third of these will demonstrated in CABLED and Microcab has been asked to provide 10 fuel cell vehicles for the trial, the only hydrogen vehicles in the scheme. This builds directly on the Hydrogen Fuel Cell and Carbon Abatement Technologies (HFCCAT) project at UB and extends the reach of it to Coventry.

Conclusions

The initial design process for Microcab has been successful. The complex design development programme has clearly had some success. However it is incomplete and there is a difference between the successful completion of its various programmes, and the overall achievement of a successful and proven product.

A key characteristic of the project has been its dependence on public sector funding. Its being timely and contributing to longer term future rather than short term economic returns has been an important component in arguing for such support.

The organizational components which have been crucial to its survival are probably twofold:

- The role of John Jostins as the project manager has been essential.
- Maintaining a small core of collaborating companies to design and make the vehicles has ensured a manageable approach.

The medium term future for Microcab will depend these elements being maintained.

Michael Tovey

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Author Biography

Professor Michael Tovey

A graduate of the RCA, Professor Mike Tovey was in industrial design practice prior to entering education. In 1973 he joined the institution which was to become Coventry University, as a lecturer in industrial design. He was appointed to Head of Industrial Design in 1985 and in 1989 was made Dean of the Coventry School of Art and Design. In 2007, he changed position to take on the University-wide post of Director for Design. Professor Tovey is responsible for developing courses and applied research in design across the University and is Director of the Centre of Excellence in Product and Automotive Design (CEPAD).

Developing a Pedagogic Framework for Product and Automotive Design

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Abstract

An approach to industrial design education based on 'transformative practice', which has the ambition of equipping students with a passport to enter the community of professional design practice, is described. This is mapped onto a version of the designerly way knowing which is illustrated as an analysis-synthesis model involving a conversation between the two cognitive modes, which are emphasised in various teaching activities. The uncertainty threshold, which is inherent in this, is both essential and routine, but can present problems for some students. The development of a re-designed course programme devised with a more flexible project delivery arrangement to accommodate these issues is briefly described. Its effectiveness is assessed through focus groups and feedback from early results is giving a broadly positive response to the new scheme.

Keywords

Project-grounded research, design process, industrial design, creativity, design practice, learning, reflective practices, pedagogy.

This paper outlines a particular strand of pedagogic research undertaken by the Centre of Excellence for Product and Automotive Design (CEPAD) at Coventry University. Established as the result of a successful bid to HEFCE's Centres of Excellence for Teaching and Learning initiative in 2005, CEPAD initiated several strands of pedagogic research, all of which are underpinned by Wenger's community of practice theory. Specifically the research focused on the journey of industrial design students towards successful entry to their professional community of practice. From this starting point, research was undertaken into identifying threshold concepts in design – those crucial transformations that turn students into designers equipped to engage with their professional community. This identification was then used to develop a pedagogic framework for product and automotive design. Also linked to the research are issues concerning how to foster students' visual creativity and these are discussed in a separate paper to be presented at this conference (see Tovey & Bull, 2010).

Community of practice theory

The CEPAD research is underpinned by community of practice theory (Lave and Wenger 1991). A community of practice typically comprises a group of professionally qualified people in the same discipline, all of whom negotiates with and participate in a mutually understood discourse. This discourse is both explicit and, very often, tacit and the signs of membership are usually unmistakable. (Osmond, 2010)

Lave and Wenger also highlight a theory of learning as being our 'lived experience of participation in the world' (Lave and Wenger 1991, Wenger 2007): that is, our learning takes place through a

[1] Centre of Excellence for Product and Automotive Design

deepening process of participation within a community of practice, and even our identities are formed from this participation. Wenger defines the major principles of a community of practice in three separate, but related quotes:

> *Communities of practice are groups of people who share a concern or a passion for something they do and who interact regularly to learn how to do it better.*

> *A community of practice is not merely a community of interest – people who like certain kinds of movies, for instance. Members of a community of practice are practitioners. They develop a shared repertoire of resources: experiences, stories, tools, ways of addressing recurring problems – in short, a shared practice.*

> *In pursuing their interest in their domain, members engage in joint activities and discussions, help each other, and share information. They build relationships that enable them to learn from each other.*

Thus within a community of practice learning can be seen as an experience of identity formation: it is not just an accumulation of skills and information, but also a process of becoming – in this case a certain kind of creative and critically minded design practitioner. (Osmond, et al 2007) It is through this “transformative practice”, as Wenger calls it, within a professional community of creative design practitioners that learning can become a source of motivation, meaningfulness and personal and social energy.

Design Communities

Designers come in many types, for example architects, industrial designers, design engineers, graphic designers, interaction designers, fashion designers, interior designers, craft designers, furniture designers and jewellery designers. Each of these represents a significant group of practitioners and each one can be regarded as a community of practice. Some of the categories are sufficiently large that they subdivide into groups of more specialist designers, for example graphic designers might distinguish between those concentrating on corporate identity, media graphics, or information design. Similarly industrial design contains the large sub-categories of product design and automotive design, and smaller groups such as boat designers.

For key groups there are formal bodies to which entry is by examination – for example, in relation to architects there is the Royal Institute of British Architects in the UK, and the Society of American Architects and the American Institute of Architects in the USA. For a wide range of design professions in the UK there is the Chartered Society of Designers and in the USA the Industrial Design Society of America. Most such societies are national and tend to have national membership, but less formal groupings can be international in scope and a powerful example of this is the community of practice of automotive designers.

The International Community of Practice of Automotive Designers

There are car design studios in all of the major industrial countries of the world, and in most of the world's continents. The designers who work in these studios typically share their passion for automobiles and each time a new vehicle concept is revealed by one studio it causes interest and excitement in others. Although during the development of a new design there is usually great secrecy in the company concerned, a great deal of information is shared throughout the industry, and companies often move in similar directions, responding to common pressures from the market and governments (Tovey and Owen, 2006).

For an international community to function it is important that there is communication between its members. For automotive designers this is supplemented by online resources such as the Car Design News (CDN) website. This was created by three car designers from both the USA and the UK and contains news from a designer's perspective of developments in car design, with in-depth reviews and an extensive on-line gallery from all of the major car shows. CDN also features student exhibitions and competitions, discussion forums, resources and job listings, a large on-line collection of car designer portfolios, (paid for) members editorial and a car design taxonomy. With over a million hits a year CDN is a highly effective device for facilitating the community of practice.

Designerly ways of knowing

A working assumption in CEPAD is that - within the design community of practice - designing ability can be described in terms of both generic capabilities and specialist capabilities. The generic capabilities are those that are shared by designers across a wide range of specialisms and the specialist are those areas of domain-related knowledge that distinguish designers in particular areas.

In the practice-based approach to design education we suggest that the intention could be seen as one of combining the generic capability with domain related specialised knowledge, to produce a level of capability sufficient to gain entry to the relevant community of design practice. The portfolio of work could then be characterised as the passport to enter that community (figure 1).

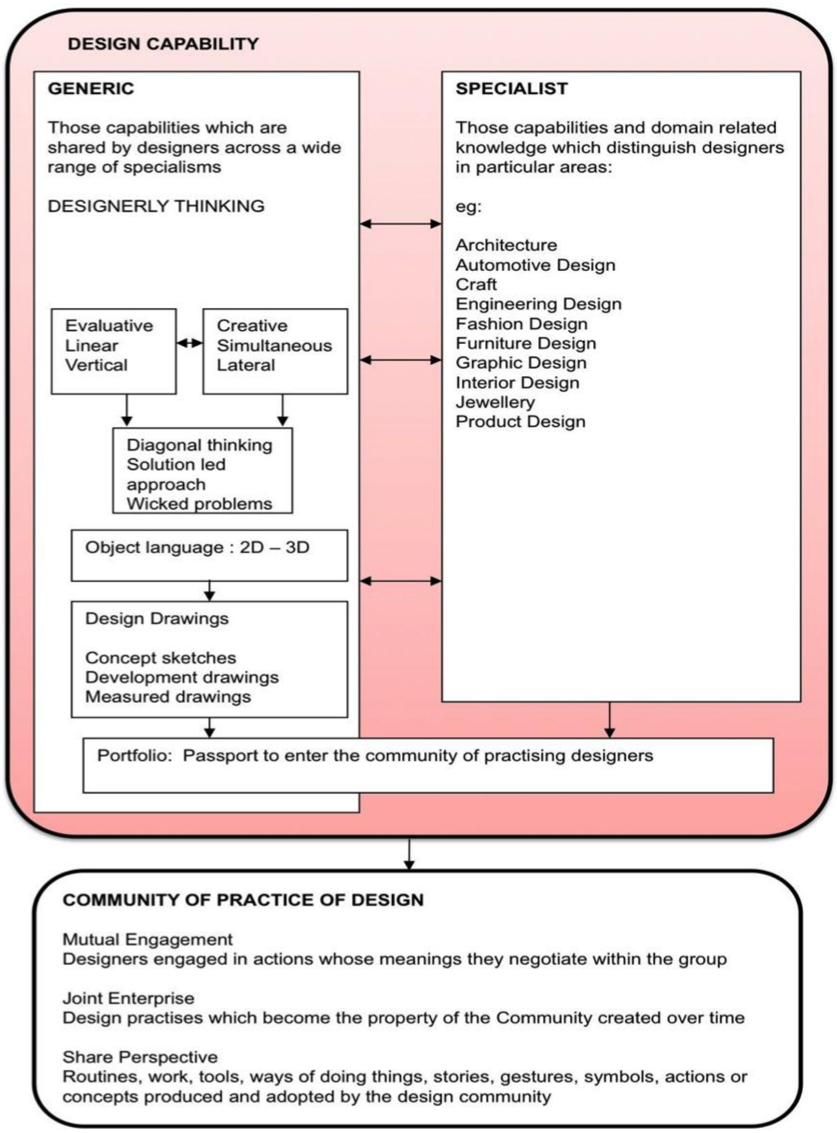

Figure 1 Design Capability Model

In order to develop this 'passport' there is a long tradition of teaching design through 'transformative practice' in which students' educational experience is centred on tackling design problems that become progressively complex. This practice-focused education is reinforced by real world design experience and CEPAD's engagement with this community has been developed and evaluated through industry involvement in course work, placements and internships and university-based consultancy. From this professional engagement comes the picture of designing ability described in terms of both generic and specialist capabilities.

However, although there are specific skills and areas of specialist information that mark out product design, graphic design or architecture for example, there are also important commonalities. One of the most important – generic design thinking capability – has been labelled by Cross (2006) as 'The Designerly Way of Knowing'.

Cross describes this capability has containing five aspects:

- Designers tackle ill-defined problems
- Their mode of problem solving is solution focused.
- Their mode of thinking is constructive
- They use codes that translate abstract requirements into concrete objects.
- They use these codes to both read and write in the object languages.

It is in the character of design problems that they tend to be ill-defined, ill-structured, or 'wicked' (Buchanan 1992) and designers may not have all the information necessary to solve them. To cope with this lack of information, experience indicates that the quick production of a draft solution will allow a definition of the limits of the problem and the provision of a basis for developing an idea or ideas further. To quote Cross (2006)

> *In order to cope with ill-defined problems, the designer has to learn to have the self confidence to define, redefine and change the problem-as-given in the light of the problem that emerges from his mind and hand. People who seek the certainty of externally structured, well defined problems will never appreciate the delight of being a designer…*

The production of a solution conjecture at an early stage in the process could be said to facilitate the re-examination of the problem by providing the spectacles through which to look at it. The designer is able to tell where she or he needs more data because without it the design cannot move forward. In some areas of design this solution-focussed strategy is fully formalised in the way in which the design activity is managed, for example at an early stage in the process there will be a requirement for a 'Concept Design' which is the designers' attempt to provide a sketchy representation of what the finished design might be, or might look like. If the designer or design manager sees the concept as providing a basis for proceeding then the structure of the rest of the process falls into place. This is the solution-led approach, which has, at its core, the process of moving from an abstract statement to a visual object. The designer learns to think in a sketch-like form, in which the abstract patterns of user requirements are turned into the concrete patterns of an actual object. Thus the designer uses a code to effect this translation from individual, organisational and social needs to physical artefacts. This is the use of the visual language of designing, employing its translation codes, and is the match of the analytical (left hemisphere) statement to the holistic (right hemisphere) solution. The manifestation of this outcome will be a visual representation, a drawing, a 3D or virtual model.

Developing a Pedagogic Framework

The Analysis-Synthesis Model

This picture of the thinking processes involved in designing corresponds with the classic analysis-synthesis description of the design process. Such a dualistic characterisation corresponds with the view of brain function which orders cognitive activity to align it with the different characteristics of the two halves of the brain, or cerebral laterality. In the substantial work on this many researchers in this field have characterised the two parts of the brain as separate information processors and encoders. There is strong evidence for the view that underlying the left hemisphere's dominance for expressive speech and the right hemisphere's dominance for manipulospatial activities are different processing modes. Typically the modes are characterised as analytic-synthetic, linear-holistic, serial-parallel or focal-diffuse for the left and right halves of the brain, respectively. This dichotomy is attractive as it seems to correspond with the different types of cognitive style identified by psychologists in problem-solving procedures.

It is clear that for anything other than very simple mental operations, both halves of the brain are involved, as has been shown in EEG maps of cerebral activity during experimental tasks. It would seem that the two processing modes are typically employed at the same time and interactively, and that a more complete understanding of any particular problem arises from the matching of initially separate simultaneous mental operations.

It is possible that design thinking may be organised in a similar way, with two simultaneous interacting cognitive styles being employed. Thus it would be expected that an analytic, linear strategy would be at work in the process of data generation and organisation to yield a design specification, and also in the evaluation of design proposals. In parallel with this a synthetic-holistic strategy, used in the generation of solution conjectures, would be the integration of visual relationships and the physical representation of the design as drawings or 3D models.

These two interacting lateralised mental operations can be used to map out design thinking and help understand it. Tovey (1984) has called this the dual processing model of the design process. In it there is the assumption that the two halves of the brain will both be involved in solving the design problem, each half working in its own preferred information processing mode, each tending towards its favoured modelling language, the left in words and symbols, the right in drawings and 3D models.

In order to offer a way of characterising some of the key areas identified in our investigations into design pedagogic process Figure 2 maps the industrial design programme activities onto the dual processing model.

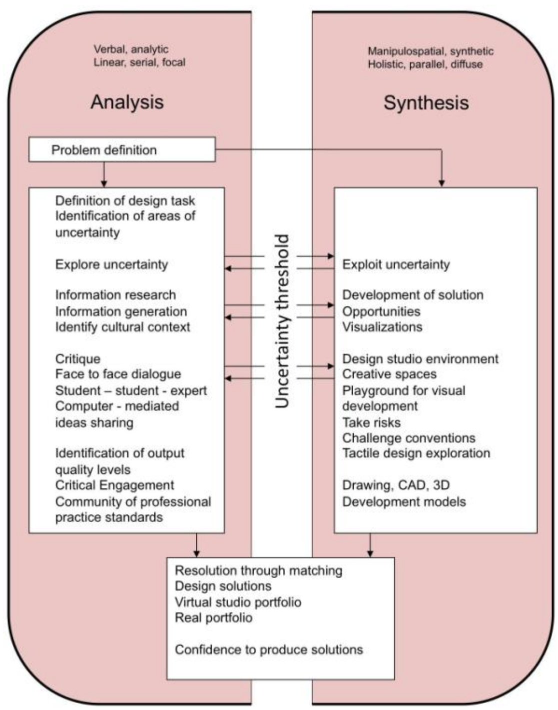

Figure 2 Analyses – Synthesis Modes

Identifying threshold concepts in design

As outlined above, this ‘dual processing’ strategy is routinely employed by designers, involving a ‘conversation’ taking place between the left-brain (convergent, reflective, field dependent, serialistic) and the right-brain (divergent, impulsive, field independent, holistic). The result of this 'conversation', in what Tovey describes as an 'incubation period', enables a designer to arrive at a 'solution':

It is possible that the incubation periods, that time of apparent inactivity during which the designer's brain furiously grapples with the problem, is simply the period during which the two halves of the brain are out of touch or unable to agree. But contrast the moment when they do suddenly come into alignment would be the classic 'eureka' point.' (1984: 226)

However, qualitative data from the CEPAD longitudinal study into identifying threshold concepts in design with a cohort of industrial design students from entry (2005) to graduation (2009) showed that some students, presented with typical 'wicked' design problems may get stuck in this 'conversation'. Often students are trying to satisfy what they think tutors want rather than trusting their creative abilities and those who do not get beyond this lack of trust can remain in what Meyer and Land describe as a 'liminal state'. In this context a liminal state relates to the notion of a threshold concept, which Meyer and Land define as:

> *… akin to a portal, opening up a new and previously inaccessible way of thinking about something. It represents a transformed way of understanding, or interpreting, or viewing something without which the learner cannot progress. (2003:1)*

As such then students can be stranded within a liminal space while they struggle for understanding and this struggle can involve identity shifts and 'troublesome, unsafe journeys' (Cousin 2006:5); in other words they will experience a period of intense uncertainty. As reported in Osmond et al, 2010, a threshold concept also features other characteristics: it is *transformative* in that it involves a personal and a conceptual change; *irreversible* in that it will not be easily forgotten; *integrative* in that it allows hitherto unrelated knowledge to 'slot into place', and *troublesome* in that it appears 'appears counter-intuitive, alien…or seemingly incoherent' (Perkins 1999 in Meyer and Land 2003:7).

In order for students who are 'stuck' to move beyond a liminal state they need to experience a unforgettable, integrative and troublesome transformation - almost a leap of faith - to navigate this uncertainty, and if they do not, they are unlikely to possess the confidence to challenge design conventions, produce solutions and thus innovative designs. However it looks as if once students accept that each time they approach a design brief they will experience this uncertainty they can then use the tools and methods inculcated within their programme to harness their thoughts and ideas and begin designing. In essence, the research identified a threshold concept, which CEPAD has labelled as 'the toleration of design uncertainty', defined as:

> *…the moment when a student recognises that the uncertainty present when approaching a design brief is an <u>essential</u>, but at the same time <u>routine</u>, part of the design process.*

From this analysis the notion of providing a safe 'creative space' in which the students could experiment and experience intense uncertainty within a supportive environment emerged. Indeed it was considered that this represented a key change for the curriculum and that the design programme should be revised to incorporate both scheduled time and physical space to allow it to happen.

The revised design programme

In 2009 the creative space idea was incorporated into a course review process for the industrial design programme, which resulted in the introduction of a new and fundamentally revised curriculum design for the academic year 2009-2010. This new scheme also capitalised on the analysis of data gathered from student course consultative committee meetings, special focus groups with external examiners, leaders in the School, and designers in professional design studios.

In particular, major changes were introduced that addressed the modular structure of year 1 and year 2 of the course in that the existing eight-module provision was replaced with an arrangement incorporating one quadruple practice module, which spanned the whole year. In keeping with this, the assessment requirements for the new module now take the form of staged gateways, attached to a number of briefs associated with a range of key 'drivers of design' such as branding, sustainability, historical context, user needs, technical advances and cultural differences. Some briefs have been designed to be 'tight' and others to be 'open'; the latter designed to encourage and develop students' creative abilities. To this end, the weightings given for marks in each assessment have also been staged and graduated to encourage a 'creative' journey, with the first assessment attracting only 10% of the mark for the year, the second only 15% and the final 75%. The aim is to allow the students space to experiment with their designs and then put forward their 'best' work for the final 75% assessment. In addition year 1 and year 2 students are given a specific studio space to work within and colonise as their own.

Student feedback

In December 2009, a series of focus groups and one-to-one qualitative interviews were carried out with eight year 1 and six year 2 students in order to capture their experiences of the new curriculum design. Open-ended questions were used around the themes of assessment, feedback and the new 'creative space'.

The findings showed that the first year students were, on the whole, enjoying the creative space and freedom they had been given:

> *I have to say I do like it – I like the relaxed style of teaching it makes you feel more comfortable and it feels like you can express yourself a lot more and the course is designed around you instead of a specific standard that is supposed to fit every kind of ideal person.*

At the point at which the focus group took place, the students had yet to receive a summative assessment mark (although they had received two instances of formative assessment), which was in contrast to some of the students' previous educational experiences, which could be characterised as very structured:

> *In the beginning [of the BTEC] we got a list – and the criteria of what gets merit, what gets distinction and if you do all of them, you get the grade basically*

This change was reflected in their current experience, which is very far from 'trying to tick boxes':

> *It is not a case of just trying to tick the boxes - which they keep drumming into us - you are not going to tick the box you are going to develop your own ideas.*

The students were asked if they found the increased independence they were experiencing caused uncertainty in tackling design briefs, and one did feel that this could be problematic as 'you don't know where you stand', but another, whilst acknowledging this, felt 'it was good because it drives you on.' Another pointed out that their tutor had gone to great lengths to make sure not only that they understood the brief, but also to make sure that they related to the brief in terms of their own ideas and thus gained 'ownership' of their designs.

The second focus group, which took place much closer to the first formative assessment gateway, did result in some anxiety being evidenced by the students about the vagueness of the briefs, although some students thought that the briefs were 'deliberately vague':

> *I think also that the way they have structured it with the freedom, because if they drilled it into us you have got to do this, this and this, I don't think it would give us the chance to develop our own style as much, so with the freedom we can have a chance to work on that a lot more*

Again, some of the students put the ability to embrace the freedom down to previous educational background, with some having experienced the same kind of freedom in 6th form college, and others working to a tick box system:

> *There are a couple of people that I have heard that do want to be spoon fed and have come straight out and said tell me what to do and I will meet the criteria if you tell me what to do, but from day one I know that it has been drilled into us that they are not going to tell us what to do, they are expecting us to get pro-active with it*

One student did recognise that the transition from student to designer took place when ‘you have got past that bit where you want to just fill in tick-boxes’ but again another pointed out that, depending on previous experiences, some students might need more help:

> *I think you have to appreciate at the same time, everyone has different levels of stages where they can just go and do that, some people who do need that support more than others*

Overall though, despite some anxiety being expressed about the freedom of the new style curriculum, the first year students appeared to be enjoying the creative space they had been given. However, as the focus groups took place at the end of the first term of the new curriculum and before the first summative assessment we can only speculate that this would continue. Having said this, the comparison with the responses of the 2005 cohort during their first interview is quite striking. Most of those responses concerned meeting deadlines, and as their first year progressed, a particular task entitled the ‘thought receptacle’ proved troublesome for the students. As reported in Osmond (2007) the task was designed to foster creativity and encourage the students to experiment with ideas. However, several students failed this task and comments in relation to staff feedback included: ‘I really thought I had understood [the thought receptacle] – but from the feedback I hadn’t. Apparently it was too planned’. Another reflected that: ‘[the thought receptacle] should reflect your personality and music I liked and sometimes poems and wrote down a lot of … but it wasn’t much so then later on [the lecturer] said relate to design as well…the creative thing wasn’t really set in.’. This was echoed by staff comments in relation to this assessment, which identified a ‘limited sense of personal point of view, …distance from being a designer, lack of confidence.’ and ‘not much personal stuff coming through.’

For the year 2 students interviewed, it appeared that the new curriculum had already made an impact in that they had just completed their first piece work and that attracted a summative mark of only 10% of the total for the year. Firstly, several of the students had experimented with designing different vehicles in order to improve the variety of their portfolios, with one stating that ‘if it had been a higher percentage I would have thought of sticking to what I know.’ Another found that because the mark was such a small percentage that he could spend time on sketching, which allowed him to ‘get better at the design process’:

> *I had a sketch book and I was constantly sketching, sketching and I noticed that my sketching did improve from the beginning to the… at the very beginning I was quite scared and drawing very neatly oh no i don’t want to make a mistake but later on got more free and didn’t really care and that is when I got my best bits when I was – there was a point where I was really angry I just couldn’t get a design and really angry and scribbled and oh actually that’s quite good…*

Secondly, for another student who felt he had performed poorly at this task, the 10% mark was a relief because he could use the feedback he received in a constructive manner for his next assignment.

> *In a way I am glad because I don’t think I did very well…I think if I ever did something like that again, I would probably have a better stab at it…*

In addition to this marking system, a new ‘buddy’ assessment method was introduced where students who were not presenting their work were asked to write down feedback given to the student presenter; this would allow the tutors to enter into a conversation with the students about their work without also having to write down every comment. Also, the summative mark for the assessment was not given until a week after the presentations.

The students felt that this system was excellent as they not only received good quality feedback, they also had a record of it and got to see feedback given to other students which allowed them to ‘see where you are at and where your peers are at and whether you are doing good or not so good – and if they are doing better, you want to do better’.

This is in contrast to the 2005 cohort responses during their first interview during their second year where some students had problems with understanding the brief that was set:

> *My main problem - especially the ones that I only just passed they said I didn’t understand the brief - I had obviously read it and gone out and done my own thing and*

completely forgotten about it and not stuck to the brief at all - that was the main problem

Finally, some of the students could not see the 'join' where all the modules intersected within the previous curriculum design and thus found it difficult to design 'holistically':

I don't really like the idea of splitting things up…I don't really like the way some of the modules are done this year…because they are splitting up disparate parts of the design process and they are not bringing them together at the moment.

In summary, the qualitative research with the first and second year students showed that they were enjoying the new creative space afforded by the newly designed curriculum evidenced by the lack of 'deadline panic' that was apparent in previous years and by a willingness to experiment when faced with a design brief. However there are indications that some students are finding the provision of such an 'open' space difficult and this may well be linked to previous educational background. However the study sample was a small percentage of the total number of students, and the data gathering took place at the end of the first term, so cannot be seen to be representative of the experience of all Year 1 and Year 2 students or representative of a complete study year experience. To address this, more data is to be gathered at the end of Term 2 and Term 3.

Conclusion

It seems that part of the mutually understood discourse of the professional design community of practice is what Cross aptly calls 'The Designerly Way of Knowing': the recognition that design problems will always be 'wicked' and therefore problematic, and possession of this knowledge is a passport to the professional design community of practice. In more detail, Tovey posits that the thinking process that underpins this 'knowing' involves 'dual processing', where two parts of the brain have a 'conversation' with each other, which then produces a quick solution that can be built upon and expanded.

However, the CEPAD research found that some students get stuck in the 'conversation' between the cognitive modes associated with the two halves of the brain and consequently cannot move quickly towards a draft solution. This may be because they are trying to divine what the tutors want or because they do not trust their creative abilities enough to recognise that the conversation and draft solution is an essential part of the design process. From this the identification of the 'toleration of design uncertainty' as a threshold concept was made in order to provide a benchmarked portal for students to pass through on their journey towards becoming a designer. In other words, once the students recognise that the conversation and the process of drafting a solution involves experiencing design uncertainty and that this is an essential but routine part of the design process, they then can move on towards experimenting, innovating and playing around with design conventions. In recognition of this a new design programme was introduced for the students, which was designed to encourage creativity, and early indications are that the new 'creative space' is indeed fostering the students' creativity. However, there are also some indications that students from a 'rigid' or 'tick-box' educational background may experience difficulty with such a creative space and more research is needed in this area.

Overall the CEPAD research has enabled an essential threshold concept to be identified and explicitly surfaced within the curriculum and a pedagogic framework developed in order to support student designers on their journey to assuming the identity of professional designers. The ability to work with the toleration of design uncertainty is a quality exhibited by established designers, and is part of what is shared within the community of practice. The intention is to research further the utility and impact of the new programme design on students' creative confidence and on the extent to which it develops capabilities which are in line with the aspiration to achieve entry to the community of professional practice. It is anticipated that this will involve a process of adjustment and fine-tuning.

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Author Biographies

Professor Michael Tovey

A graduate of the RCA, Professor Mike Tovey was in industrial design practice prior to entering education. In 1973 he joined the institution which was to become Coventry University, as a lecturer in industrial design. He was appointed to Head of Industrial Design in 1985 and in 1989 was made Dean of the Coventry School of Art and Design. In 2007, he changed position to take on the University-wide post of Director for Design. Professor Tovey is responsible for developing courses and applied research in design across the University and is Director of the Centre of Excellence in Product and Automotive Design (CEPAD).

Dr Karen Bull

Dr Karen Bull is Deputy Director, Centre of Excellence in Product and Automotive Design at Coventry University. This centre focuses on evaluating spatial design understanding and identifying the transformative threshold concepts associated with students entering the Global community of practice for industrial design. Her expertise is in industrial design theory, design analysis and design context. Her background is in product design and her PhD is titled Advanced Personal Telecommunications Products and Industrial Design'. She has continued to research pedagogy in relation Art and Design and is especially interested in the area of critical and reflective learning, e-teaching and learning and e-portfolio.

Jane Osmond

Jane Osmond is Senior Research Assistant for the Centre of Excellence for Product and Automotive Design (CEPAD), Coventry University and is researching students' spatial awareness skills, threshold concepts in design and internationalisation of the curriculum. Jane is undertaking a PhD by research in this area, and has published several papers on threshold concepts including: Osmond, J., et al (2009) 'The Threshold Concept Journey: from identification to application'. *From theory to practice*. Sense Publishers. Rotterdam [in publication]; Osmond, J. et al (2008) 'Measuring the creative baseline in transport design education.' In Rust., C. (ed) *Improving Student Learning – For What?* OCSLD. Oxford; Osmond, J. et al (2007) 'Threshold Concepts and Spatial Awareness in Automotive Design.' Land, R., & Meyer, JHF. (eds) *Threshold Concepts within the Disciplines*. Sense Publishers. Rotterdam. Previous projects include: 'Improving Retention, Supporting Students'; 'Mapping Equality & Diversity Initiatives in HE' and 'Meeting the Challenge: Managing Equality & Diversity in HE.

Craft as a Form of Mindful Inquiry

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Abstract

In this research project 'Communication of Craft Practice' is the subject and the problem is one of transparency of the intellectual act and accessibility to the embodied knowledge. Why? The skill of coherently expressing the intellectual and personal voice within the development of craft practice is usually missing. There is a gap in our knowledge.

The methodological framework is *Mindful Inquiry* which is a synthesis of critical social science, hermeneutics, phenomenology and Buddhism (Bentz and Shapiro, 1998).The research involves working directly with professional practitioners to embark on a series of creative journeys from which craft as an experience, process, product and service could be observed and evaluated. The practitioners included a 3-D metal designer, curator, interactive jeweller, product artist and woven textile designer.

The aim is to reassess the term craft practice as a means of understanding the impact of social, political and technological change by documenting the practitioner's thinking processes throughout a period of practice. It is to consider combining visual and written outputs as means of supporting the identification of the new knowledge gained through practice, and how this knowledge is used cumulatively to develop craft. The objective is to nurture a dialogue with practice and to document the process of thinking and making associated with craft.

This paper provides the context and framework for research as well as presenting the findings from it. It exposes the methods and the accompanying rational for using them in relation to mindful inquiry, and it presents a new perspective from which to view and discuss craft practice. The argument is concerned with articulating the relevance of mindful inquiry as a methodology for critiquing and supporting the development of craft thereby supporting the contextual understanding and meaning of the research findings and procedures when they are presented. It is also to offer new craft knowledge in terms of the phrase 'practice'.

Keywords

craft practice, mindful inquiry, visual language, communication, methodology

Introduction

Mindful Inquiry is a synthesis of critical social science, hermeneutics, phenomenology and Buddhism. At the heart of this methodology is the concept of 'change' where perpetual activity is its inherent characteristic, both within the research context and of the subject under consideration, because the human condition is at the centre of investigation (Bentz and Shapiro, 1998).

Buddhism permeates *Mindful Inquiry* through the philosophy of mindfulness which is an awareness and understanding of one's own mind and how it influences one's perceptions and actions. The process and product of the discipline of mindfulness is inextricably interwoven: it is both a means and an end – a philosophy and a method (Valentine, 2003; Valentine and Ivey, 2009). The concept of 'postmodern chaos' and its presence in our everyday existence is a key reason for selecting *Mindful Inquiry* as an appropriate methodological framework to investigate contemporary notions of craft practice. The consequences of interdisciplinarity to the field of craft or the implications of modern high technology to methods and their associated aesthetics, for example, gives rise to a situation whereby traditional static frameworks for analysing and evaluating the applied arts can provide a distorted view of the realities of being a creative practitioner.

The person is placed at the centre of the process of inquiry in both a psychological sense (for example, my personality style can shape my research method) and a philosophical sense (in that research is viewed as an embodied programme of activity, a way in which I engage with the world). The premise of Bentz and Shapiro's concept of *Mindful Inquiry* is the idea that research is intimately linked with the researcher's awareness of his/her life and his/her lifeworld.[1] They advocate that 'awareness and reflection on your world and the intellectual awareness and reflection that are woven into your research affect – or should affect – one another' (Bentz and Shapiro, 1998:5). *Mindful Inquiry* is a reciprocal system: quality research contributes to personal development as a mindful practitioner and personal development, in terms of awareness and reflection, embodies the research. It sits within the realm of 'reflective practitioners' where the researchers do not adopt a detached and impersonal approach rather they have direct engagement and involvement. In this investigation 'Communication of Craft Practice' is the research subject and the problem is one of transparency of the intellectual act and accessibility to the embodied knowledge. Why? The skill of coherently expressing the intellectual and personal voice within the development of craft practice is usually missing. There is a gap in our knowledge.[2]

On reflection of the intellectual and social meanings of craft practice, craft is often misunderstood as skilful making. The notion of craft as a concern for innovation, individual vision and future cultural concerns: a fusion of art, science, engineering, and technology, is uncommon. The misconception of 'craft as skilful making' fails to address the maker's capacity to synthesise and integrate information. While recent texts (for example the work of Glenn Adamson, Howard Risatti and Richard Sennett [3,4,5]) have gone some way to redress the imbalance in understanding the intellectual value of craft, the plethora of literature which services crafts as a hobbyist pursuit remains uppermost in the minds of popular culture.

In *Mindful Inquiry,* the researcher's ways of engaging with ideas, data, methodologies and decisions are a critical consideration and as such, it is pertinent to pause and present what they are to this study. My environment for learning is design and I[6] understand design as a dialogue,

> an activity that requires a freedom to explore, to allow imagination and creativity to range widely and bring knowledge and expertise alive in a

> wild uninhibited dance. It is a process that involves looking, listening and thinking, allowing collective thoughts to levitate: to sit suspended in the mind and to be given space, through time, to develop as the process of creation unfolds (Valentine, 2004:15).

This suspension of thought allows a pattern to evolve, providing an individual with a picture, which depicts the interrelationship(s) between different and often contrasting elements of an idea. Subsequently, the lens with which I view *Mindful Inquiry* is design and the context for developing design is *Mindful Inquiry*.

Adopting *Mindful Inquiry* for this investigation is used as a means of generating and contributing to social knowledge of craft practice, thereby complementing the existing cultural, material, product and technical knowledge. *Mindful Inquiry* was used to embark upon a journey into the context and culture of contemporary practice. The journey asks questions of how the mind's eye synthesises visual, oral, sensory and written information, and the process by which ideas are transposed into an individual's personal philosophy.

Mindful Learning

The cognitive aspects of mindfulness, as adopted by Hanh (1991), Kabat-Zinn (1994), Langer (1989, 1997) and, Bentz and Shapiro (1998) are that it is a way of seeing which causes and maintains inter-connections. It is an approach to inquiry that draws a person's attention and awareness to the impermanence and uncertainty surrounding a problem. Much of the learning associated with Mindful Inquiry is social learning; learning about language and social convention rather than methods, and it is a requirement of the inquirer to become socialised into a community. The inquirer's remit includes learning where the action is and becoming an active member of the community (Bentz and Shapiro, 1998).

This process of socialisation and familiarisation for this study of craft took place throughout the research but was intensively invested in within the first two years (of the five year project), attending national exhibitions, museums and trade fairs, meetings with national agencies and champions of craft within Scotland, England and Ireland[7,8,9]. In-depth conversations about craft as a practice and methodology were held at regular intervals with the jeweller Georgina Follett.[10] The process also took the form of an international conference and exhibition entitled 'New Craft: Future Voices'[11] and 'Future Voices: Celebrating Diversity' organised by the authors.

The process and output of these events were a fundamental aspect of the social learning perspective. Taking place over an 18-month period (including pre and post event responsibilities), it offered the researcher deep insight into the intellectual dialogues that go with craft practice; the multiple forms of craft; the range of traditional and digital methods currently being employed; awareness of the material, technological and cultural aesthetics of craft practice; the alternative ways of approaching collaborative and interdisciplinary frameworks; the various ways people discuss and emphasise craft and, the visual impact of craft research as a new form of craft practice.

The ‘Future Voices: Celebrating Diversity’ exhibition provided the opportunity to view a broad range of craft practice from different cultures (in terms of academic cultures of inquiry or research frameworks and, cultures associated with native or societal heritage *eg* Australasian, Canadian, Nordic). The exhibition also offered the opportunity to view craft practice across a bandwidth of material specialisms (*eg* ceramics, jewellery, interactive jewellery, metalwork, printed textiles, woven textiles). It presented a visual discourse and offered a way of distinguishing between traditional and non-traditional forms and, historical and contemporary aesthetics. For example, the work of Carol Epp (Figure 1) exposed a traditional perspective in terms of the form and aesthetic, while the work of Sarah Kettley (Figure 2) presented a non-traditional example of form and aesthetic. Epp’s work is concerned with refining the form and function through subtle shifts in technique and, the concept underpinning the work (*ie* that of a vessel) is in the tradition of ceramics. Kettley’s work on the other hand, is a non-traditional form of jewellery and as such, challenges the traditional concept of jewellery. While the conceptual underpinning of her work is very good (*ie* wearable computing infused with soundscapes), the relation between final form and concept is oblique.

Figure 1: The ceramic work of Canadian craft practitioner Carol Epp

Figure 2: The interactive jewellery of Scottish craft practitioner researcher Sarah Kettley

The collection of exhibits facilitated understanding of a subtle but important delineation, in that a traditional form (for example, a ring or neckpiece in the context of jewellery) does not indicate a lack of innovation in terms of concept and aesthetic. And, that a historical or cultural aesthetic within a traditional form does not indicate there is no radical thinking underpinning the craft. For example, in the work of Barbara Jardine (Figure 3) whose jewellery exposes a strong Trinidadian cultural aesthetic through a traditional form, the intellect is found through the interrelation between the material elements of metal, stones, amber, black coral, ivory, beetle carapaces and tortoise shell. The visual experimentation and high level of craftsmanship used to bring the array of materials together is where the intellect is embedded and, where the level of risk and innovation can be measured. The value of this observation of practice was that great care must be taken when evaluating craft in terms of the aesthetic (where aesthetic is the intellect). It also indirectly raised an issue with the use of language when looking at craft as an intellectual inquiry, specifically in the application of familiar terms or categories of form such as ‘traditional’ and ‘non-traditional’. If innovation and radical thinking can be found in traditional forms employing a historical aesthetic, then mindfulness must be adopted when observing craft that employs contemporary materials and new, advanced technologies to achieve unusual forms: one cannot assume innovation exists within craft because it exposes an unusual form or applies new techniques and/or technologies to create an aesthetic.

Figure 3: ‘Heigh Ho’ is an example of the intellectual and visual voice of Trinidadian jeweller Barbara Jardine.

‘Future Voices: Celebrating Diversity’ evidenced (amongst other issues) differentiation of craft aesthetic specifically in terms of technological, material and cultural-led aesthetics and, the myriad forms of craft that result from the interplay between technology, material and culture. It indicated that craft research is having a positive impact on contemporary developments, influencing thinking and the quality of product in terms of a new aesthetic of ‘captured time’, for example the work of Gillian Bunce, Drummond Masterton and Hazel White. It was observed that technological pathways also act as a progenerator of works, achieving aesthetic qualities previously unattainable through traditional skills, materials and techniques (see for example, the works of J R Campbell and Tara Carrigy in Figures 4 and 5). These works embrace the human body as part of their aesthetic with interaction as the aesthetic, moving the tradition of the automaton[12] further forward. The exhibition raised a number of questions, including: when craft knowledge is used in the production of a visual object, can the object be framed as craft? Are historical frames of reference appropriate when evaluating the aesthetic impact of modern technologies on postmodern craft? Is twenty-first-century craft an ethos embedded in the maker rather than being embodied in an end product of making? How can we evaluate the aesthetic of postmodern craft?

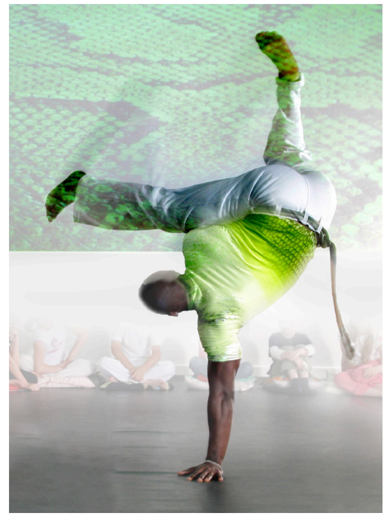
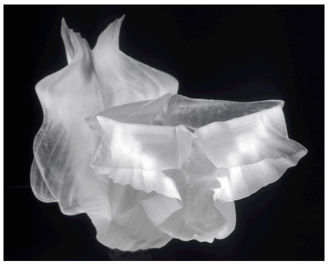


Figure 4 (left): J R Campbell's 'Wearing this Distorted Image' and Figure 5 (right): Tara Carrigy's 'Adaptive Craft'. The aesthetic lies in level, form and sophistication of interactivity between object, viewer and environment, which has been facilitated by advanced technologies and, in the case of Carrigy within an interdisciplinary context involving scientists, musicians, dancers and engineers.

The exhibition and its associated international peer review process of selection provided the platform for identifying and commissioning five practitioners to engage formally with the '*Past, Present and Future Craft Practice*' project and create new works. The following practitioners were selected: Hazel White (Figure 6), interactive jeweller and conceptual thinker; Tim Parry-Williams (Figure 7), a textile designer working from a depth of understanding of the nature of textile material; Geoffrey Mann (Figure 8) whose work is concerned with capturing the transient through the use of new technologies; Sally Moir (Figure 9), curator with the ability to conceptualise space and, Drummond Masterton (Figure 10), silversmith using a reductionist approach to product development. They are all mid-career and have an acknowledged reputation for their work in the UK. Selection was made on the basis that the work demonstrated a strong visual aesthetic or indexical mark, had clarity of purpose and was articulate in discussing and revealing conceptual thinking.





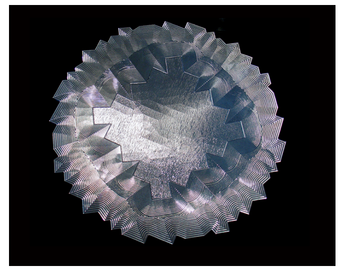


Figure 6 (top left): ‘Charmed’ process image by Hazel White and, Figure 7 (top right): Handwoven textile by Tim Parry-Williams. Figure 8 (bottom left) ‘Flight’ by Geoffrey Mann, Figure 9 (bottom middle): Sally Moir, section of her New Craft Future Voices curatorial strategy. Figure 10 (bottom left): An example of Drummond Masterton’s craft.

Removing the ‘Blinkers’[13]: a phenomenological study of craft practice

> Phenomenology is a school of philosophy that focuses on the description of consciousness and of objects and the world as perceived by consciousness … [It attempts to take seriously the fact] that we know we are conscious beings and that everything we know is something we know only in and through consciousness … A primary focus of phenomenology has been to get ourselves out of everything we take for granted about the world and about ourselves through ‘bracketing’… [a process] that sets aside aspects of a situation in order to focus full attention on other aspects of it (Bentz and Shapiro, 1998, p.40-41).

In terms of this research, the culture of inquiry helped me to look at the phenomenon that is craft practice by ‘bracketing’ the everyday definition of ‘craft practice’. It was the means with which to *reconsider* it as a final product or object, in order to focus fully on the experience, process, product, and service aspects. I looked at craft practice from this collective perspective by creating a ten-year map of an individual’s ‘lifeworld’ (Figure 11), rather than drawing a chronological portfolio of the production of single objects (Figure 12). This perspective is of craft as a lifework, an ethos developed through time where technique, attitude and behaviour evolve through, and emerge within, a mixture of life experiences, for example, behavioural tendencies, educational background and cultural engagement activities. I also created a series of creative, critical writings as a means of familiarising myself with the different modes of craft practice and as a vehicle for evaluating the extended conversations with the practitioners.

This notion of ‘lifeworld’ in the context of craft is referred to as a ‘cultural enrichment cycle’ (by the lead researcher) whereby craft practice is understood to be a constantly moving and continually growing process, with embedded layers of meaning and experience. It is considered in terms of layers of activities, running concurrently through the everyday life of an individual craft maker, rather than a solid ‘block’ of unrelated events or projects. This viewpoint is understood to be one way in which this work contributes to craft knowledge as many existing historical and theoretical contributions favour interpretation of craft practice as a finished object(s) disassociated from the deep personal tendencies and individual values of the maker.

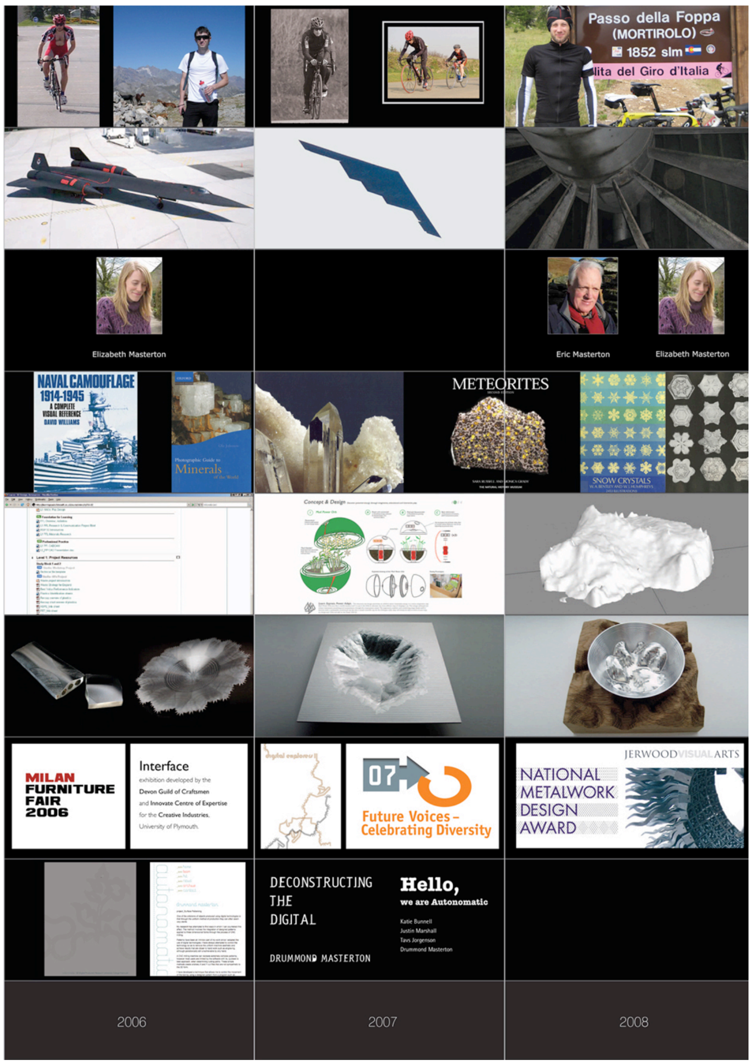


Figure 11: A snapshot of (three years out of the ten year) visualisation map or ‘cultural enrichment cycle’ for Drummond Masterton, created by the lead author, offering an alternative viewpoint from which to understand the term ‘craft practice’. From top to bottom, the concurrent layers of activity that constitute ‘craft practice’ for Drummond are cycle racing, developing knowledge of military modes of transport, (specifically aeroplanes and submarines – their form and nature), people who influence his thinking, reading of books concerned with mathematical structures and visual forms such as crystals and meteorites, teaching 3D design, crafting objects, exhibition participation and academic writing.

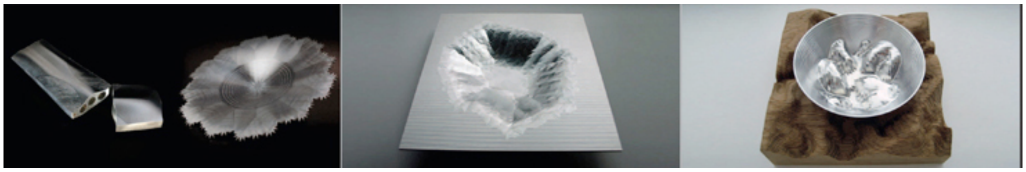


Figure 12: A snapshot of objects from the 'cultural enrichment cycle' for Drummond Masterton, representing three out of ten years of craft practice.

Phenomenology is very useful for noticing what things we take for granted and it encourages us to see things in a new way, to step outside of our culture and question our habitual ways of describing and defining things. In this respect it is part of mindfulness. In a world where the concept of 'change' is a given and technological progress pervades our everyday existence, this viewpoint was deemed appropriate as it supports the need for questioning basic assumptions about the concept of 'making' craft, and a reappraisal of the question, 'What is craft practice?'

The 'cultural enrichment cycle' as craft practice was questioned directly and indirectly via extended conversations with the practitioners. I paid attention to the phenomena being investigated by writing a deep phenomenological description of my own experience of craft practice: my experience of the craft of five practitioners and extended conversation with them about their practice. What was their way of experiencing craft practice? As human phenomena, what does craft practice mean from the perspective of an individual maker?

In this study, I am the instrument of articulation and to become this I developed deep empathy with the concept and practice of craft through observation and extended conversation with contemporary practitioners. As Bentz and Shapiro (1998:97) note, '[t]he primary tool of the phenomenologist is the inquirer's own consciousness'.

I am not the subject. In my preparation for working with the research participants, I immersed myself in experience that matches the participants. I continued nurturing my lifeworld and reflecting on the development of my 'cultural enrichment cycle'. I engaged in the creation of new work (which in my practice is visualisation through interactive media) and I taught design and practice-led research to a range of undergraduate and postgraduate art and design students. I daily discussed the business of design and the practice of creativity with my partner (a design consultant). I wrote and I nurtured my network by engaging in a series of new activities (such as novel research projects) and conversation about craft, design and the future of education for the creative industries. In doing so, I created in-dwelling awareness.

What is important to note about this phenomenological study of craft practice is that the process brought into awareness and made use of my 'Grasshopper' tendencies. What do I mean by 'Grasshopper? I mean my propensity to see opportunities all day, everyday and to pursue the subconscious idea that shines brightest or speaks loudest.

The rhythm of my hopping and jumping does not always make sense, sometimes it can appear that too much is going on at one time and at other times, it can look as if I have gone off at a tangent for no apparent reason! The important aspect *is* the random movement; this movement is a way of evaluating, it provides necessary time and space to test new ideas and talk to different people. It creates an intellectual freedom to look at work from different points of view and, perhaps most importantly, it keeps my mind active. The other thing that my 'grasshopper' strategy helps to manage is a tendency to want everything to be perfect. This characteristic is with me in all that I undertake, but through this study I realise that it is balanced by the inherent *inability* to give full attention to one study or project – a mixture of small and large, complex and complicated. It is also distinctly possible that it is the perfectionist in me that brings out the 'grasshopper' rather than the other way round!

In this research, the implications of 'grasshopper' were that my engagement with the 3D metalworker, curator, jeweller, product artist and woven textile designer were mixed together as one collective process, where conversations, interviews, observations, workshops, writing and visualisation activities flowed in and out of awareness. Attention was given to all of them and none of them and reflection on small pieces of information was made in parallel with reflection on the entire *Mindful Inquiry* framework.

It is important to highlight that while I present this work by writing in first person rather than third person (which is the convention for much scientific research), it does not devalue it, or imply that it is detached from the real world. A critical attribute of phenomenology is the ability to provide rich descriptions of the phenomena and the ability *not* to approach discourse analysis through a mechanistic manner of interview, transcribe and thematic identification. As Bentz and Shapiro (1998:104) note:

> [T]o believe that phenomenology is focused primarily on the personal experience of the researcher and her subjects or on subjective experience cut off from the real world is a mistake. Although phenomenology may focus on personal experience, one of its primary goals is to understand the real world. It simply recognises that the real world is given to us in consciousness.

The Hermeneutic Dimension: interpretation of and for craft practice

The interpretation of texts or the theory of interpretation and understanding is the basic premise of hermeneutics. This view, note Bentz and Shapiro (1998: 40) was extended by Martin Heidegger,

> into a general approach to our understanding of our existence and Being in general….[Indeed, h]ermeneutics emphasises that all our understanding and interpretation are bound to, and shaped by, our existing in a particular historical and cultural context, because we use the concepts, language, symbols and meanings of our time to interpret everything. Therefore hermeneutics involves us in perpetual asking, of anything meaningful that we study as well as ourselves, 'Where are you coming from?'

Interpretation has a divergent nature; it is methodologically open-ended and ambiguous. In this sense, it can be directly linked with theories of design where indeterminacy is a key tenet and the activity of rhetoric (as both a language and a metalanguage) is a core element in a designer's thinking (Buchanan, 1995; Cross, 1999; Valentine, 2001 and 2004). Subsequently, there are two contradictory elements to the hermeneutic analysis for this study which must be acknowledged – one is that a heightened level of ability and understanding of ambiguity has been achieved by the lead author through her 17 years of design studies, yet, this interpretive ability and viewpoint may cloud her judgement when analysing the texts gained through extended conversation and observation with the five contemporary craft practitioners. However, this realisation of a potential prejudice is one of the values of hermeneutic analysis as Bentz and Shapiro (1998: 114) note, 'The hermeneutic encounter is one that, when done mindfully, prompts the interpreter to reflect on her prejudices, understand them, attempt to justify them as rationally as possible, and go beyond them through what is encountered.'

In this study, hermeneutics is blended with phenomenology to provide contextual awareness and perspective, where narrative, specifically the method of storytelling, is used to identify the theoretical underpinning of an individual's craft practice by analysing his/her craft practice through visualisation and extended conversation. It is also used to nurture understanding of the meaning of craft practice in modern society. The stories are the rich descriptive texts created as part of the phenomenological perspective of this *Mindful Inquiry*. The texts are both an outcome of interpretation and a basis for further interpretation. They denote a level of understanding about craft practice when read as individual pieces and as a collective body, and they also form the basis for further interpretation.

The stories exposed craft practice as a meditative act requiring mental and physical distance during the decision-making process, yet a constant, intimate relationship with the idea. They revealed craft practice as a pursuit of personal and professional 'identity': a means of realising and recognising the concept of 'self'. It was unveiled as a social activity, a dynamic network of conversations with people, places, memories, ideas, objects, fact and fiction – both *in* time and *through* time *ie* conversation(s) with people in real time, mixed with conversation(s) with the self about past experiences and knowledge. Craft practice was understood to be a fascination, indeed an obsession with developing their own visual language or indexical mark, where experimentation and risk taking were central tenets and the essence of the term 'making'.

The stories offered insight into the personal need to achieve excellence and seek approval – sometimes from the external world and sometimes from themselves, sometimes only from themselves. There was an intuitive need to clarify the value of their ideas in the context of culture through exhibition(s), awards, lecture(s) and workshop(s). There was also a business need to secure financial investment through these same aforementioned activities.

They provided insight into how individuals create the questions with which to challenge the idea. They revealed that the practitioners all looked for rhythmic activities, and constructed meditative spaces in different ways to suit their lifestyles in order to internally resolve issues within their making practice. The interactive jeweller's rhythm was found in the way she engaged people within her thinking process; her craft is a social product. She carried the most recent prototype with her at all times and used the interstitial moments in her day to unwittingly inform colleagues of her new work and seek their immediate reaction, using this to inform her questioning and decision-making. The silversmith's rhythm was found through the solitary pursuit and physical challenge of cycling/cycle racing which was used as a means of resolving 'tension' in his craft practice, often riding for hours at a time to understand the intellectual conflict hindering progress; his craft is a meditative product. The woven textile designer's intimate relationship with material (fibres, structures and finishes) coupled with his audacious and poetic personality was the home for his rhythm; his craft is also a social product. His affinity with the cultural ethos of Japan significantly influenced his thought process, especially his efforts to achieve a holistic approach and a balance between tradition and modernity. The curator's social relation with object (be it art, craft or design) and the insatiable need to take the object to new audiences is where we found her rhythm; her craft is also a social product. The speed with which she conceives and transposes her visions from two-dimensional abstract forms to three-dimensional tangible environments and, the manner in which she communicates with her team and artists is where we find the intellect and decision-making. In a similar way, the ceramic and glass artist is also audience driven, and the rhythm of his practice was tied to the pursuit of identity through international acknowledgement, which stimulates his new product cycle; his craft is both a social and political product.

The stories revealed physical making *ie* the application of techniques and hand skills, as a small proportion of the craft practice process as they exposed a large repertoire of activities, personal traits and personal histories that impact on their craft. The stories described the rhetorical act of craft practice by exposing the myriad of interrelated activities that exist within the process, irrespective of the material or technology employed to physically expose the idea and transpose it into a tangible object. In doing so, they exposed craft practice as a personal journey conducted through life, where a heightened, proficient and eloquent use of the visual language is developed and used to question and resolve a concept.

It is important to draw attention to the fact that hermeneutic inquiry is not a free-reign approach to analysing text but a mindful quest for objective understanding through interpretation. It is founded in the belief that the researcher cannot escape from being involved in the context of explaining which naturally encroaches on the context of the data. This is the 'nub' or the heart of the challenge for the researcher, in that close proximity,

> is both the problem of validation and the basis for validation. The researcher's job is to bring to bear on the data all he knows about his present context in order to understand the context of the data. For in the long run the validation is the ability to make sense of the relations between the two contexts. (Bentz and Shapiro, 1998:112)

Craft Practice

In this investigation, a dialogue with practice was nurtured. The involvement of craft practitioners was seen as a fundamental tenet of the research project, in that the voice of practice is missing in large part from literature on crafts. The assumption underpinning this was that viewing contemporary craft practice from the practitioner perspective would enable primary knowledge and give clarity to the way in which craft was advancing and evolving within contemporary visual culture.

The research sought to understand the development of a craft practitioner's personal journey, of how they gain inspiration and what drives them to develop their work, whether it is developed on the visual, conceptual, material or technical basis. In order to understand an individual's development the research looked at recent practice to understand whether the journey is linear, moving in a forward direction, laterally or backwards. To facilitate this understanding visual timelines were constructed from final product/objects and personal influences including literature, travel, teaching, sport and related creative practices, such as writing and exhibiting. This visual mapping allowed for an evaluation of patterns of productivity, from which an individual's development can be extrapolated and compared in order to understand whether craft practice operates a universal model, or whether it is idiosyncratic in form and dependent on many variables.

Given the rationale for selection it may be possible to understand that different individual imperatives require specific circumstances for craft to operate within, and to develop an understanding of which particular environments allow for the greatest progress to be made, collectively and individually.

The visual timelines and stories encapsulate the working life and environmental constructs used by the practitioners in the formation of their work. The model has the potential to act as a developmental tool for ongoing use by practitioners to enable them to understand the generative circumstances under which they operate most effectively, and how they operate within certain patterns, and what effect apparent disparate and unconnected elements have on their practice.

Outcomes of 'Mindful Inquiry' were constructed through stories and ten-year visualisation maps of each practitioner's journey of practice. The assumption of craft as a lifetime journey means the ten-year snapshot was the shortest timeframe possible to give coherence to the practice of the practitioner, and allow an understanding of the patterns of an individual's progress and the constituent parts of their practice. Mindful Inquiry of Craft Practice through the work of the four practitioners all showed different patterns and the visualisation maps identified rhythms within practice revealing progress. However, ten years was too short a timeframe to gain a full sense of these; a timeframe of 15 years would allow for verification of the working processes and practices. The maps identified the progress of skill, intellect, content and knowledge; understanding progress within practice, not through singular objects, but as a holistic journey. The maps or pictograms evidenced that intellectual skill developed in the work of all the practitioners, as did knowledge of material and technique, people and culture. And, the ability of the practitioners to develop self-knowledge directly impacted on the levels of innovation within their practice.

Craft research has a value to craft practitioners, demonstrated through taking a research methodology and applying it to support understanding of both practice and research.

On reviewing the research process and outcomes, it is acknowledged that they offer a basis to undertake a SWOT analysis of the individual's practice to understand the different layers of activity that makes up their practice. The visualisation will allow for an individual evaluation of the impact of the different elements of their life journey on their work; providing an insight into different aspects and their direct effects on practice, through research, intensive engagement, volume of work and their management within it. Potentially the practitioner could alter these relationships within their portfolio, rebalancing and influencing potential impact thus perhaps driving innovation at a faster pace than their current practices.

The model offers an understanding of craft practice as layers of a journey of the self, which influence how an individual moves forward; it is the self that requires understanding as a practitioner/researcher with layers of activity rather than through an outcome or output.

The ten-year snapshot is the shortest timeframe possible to give coherence. The authors believe a 15-year timeframe would allow for verification of the progress of skill, intellect, and understanding progress within practice as a journey. This further research will need to be undertaken through revisiting the practitioners within a five-year window.

The 'Mindful Inquiry' model revealed that all the practitioners developed their intellectual skill, knowledge of material and technique, people and culture: they also enhanced their ability to develop their self-knowledge to increase the level of innovation within their practice.

In order to make this model universal Valentine will develop a series of self-reflective questions along with a pro forma for practitioners to place the essential elements that make up their journey, which embodies the elements of practice. This will offer individuals an understanding of craft practice as layers of a self-directed journey.

Endnotes

[1] A 'lifeworld' is essentially 'the world of everyday life'. In this research, the lead author's life is situated within the field of design, having trained as a printed textiles designer and developed her visual thinking through interactive media over the past decade. Richard Buchanan's philosophy of design has shaped her knowledge of design and her understanding of its role within contemporary society and culture. Buchanan's work emphasises the rhetorical dimension of design thinking and is discussed in the context of the liberal arts. He articulates design as both a language and a metalanguage.

[2] The ideas underpinning this study were initially articulated by the authors in the original Arts and Humanities Research Council (UK) grant application proposal, 'Past, Present and Future Craft Practice: an investigation into the relation between skill, intent and culture'. For further information, visit www.futurecraft.dundee.ac.uk. [Accessed May 2010]

[3] Glenn Adamson's *Thinking Through Craft* (published by Berg in 2007) explores historical and contemporary ideas surrounding 'craft'. His examination offers a range of historical, critical and cultural perspectives, giving insight into the instrumental space that craft occupies in contemporary art. In his book Adamson discusses, for example, craft as an altered currency in today's visual lexicon, he examines attitude between art and craft, provides a forum for 'thinking though craft' and what such thinking might entail and he considers the finished work (be it art, craft or design) as supplemental to the underlying concept. He does not seek or provide definitive answers. This in itself is a useful and much needed contribution to the field.

[4] *A Theory of Craft: Function and Aesthetic Expression* (published by The University of North Carolina Press, 2007 and written) by Howard Risatti addresses one of the most persistent issues in craft; that of craft's relationship to fine art. As discussed in the introduction, the process of 'intellectualising' art – from the Renaissance humanists to the present day – has no parallel to date in the craft field. This lack of an equal theoretical framework has cast craft in a negative light and it is this imbalance that Risatti addresses by providing a new formal theory of craft. The abiding theme of the text is the notion of craft and the crafted object: what distinguishes a 'craft' object from a 'fine art' object? Can craft objects be considered 'art' objects at all? What is the difference between functional objects and 'art' objects and does craft's symbiosis with making, use and function preclude the label of 'art' at all? Rather than seeing craft as a traditional practice which is unconcerned with the challenges posed by modern industrial production or an area of practice, which should be allowed to dissipate into 'fine art', Risatti argues for a theory grounded in craft's own distinguishing features; not a theory imported from elsewhere and adapted to fit.

[5] Richard Sennett's *The Craftsman* (published by Allen Lane in 2008) examines the articulation of technique, and is viewed from the social context of material culture rather than a visual arts perspective. In this first volume (of a potential three) the author addresses the theme of craftsmanship and the portfolio of mental and physical skills required to do something well, for its own sake. Sennett draws upon diverse facets of society to illustrate this, citing examples ranging from parenting to computer programming. By using an eclectic range of illustrations, he broadens the parameters of what constitutes craft thus introducing a new concept, which one might describe as 'social craft'. Sennett's earlier career was that of a cellist and his understanding of the sensitivity and craft of music greatly informs his writing. *The Craftsman* is split into three parts (Craftsmen, Craft and Craftsmanship), and each section addresses elements that constitute the mix of skills required for the dialogue that exists between mind, body and materials.

[6] 'I' denotes the lead author

[7] Examples of the trade fair events include 'Collect' (2006 and 2007 at the Victoria and Albert Museum [V&A], London) and 'Showcase' (2006, Crafts Council of Ireland, Dublin). Exhibitions included 'International Arts & Craft' (2005, V&A Museum, London); 'Black Mountain College' (2006, Oxford); 'Beauty & Japan', (2006, British Museum), 'Out of the Ordinary: Spectacular Craft' (2007, V&A Museum, London), 'Cutting Edge Craft' (2007, National Museums Scotland, Edinburgh); 'Memory and Touch' Symposium (2008, Royal Institute of Architects, London).

[8] National agency meetings included one with Dr Helen Bennett, (the then Director of the Crafts Division), the Scottish Arts Council; Professor Stuart MacDonald, (the then Director of) The Lighthouse, Glasgow; Ms Rosy Greenlees, Director of the Crafts Council, London; Mr Leslie Reed, (the then Chief Executive of), Crafts Council of Ireland (1994–2006) and Ms Rose Watban, Senior Curator of Applied Arts Collections, National Museums Scotland, Edinburgh.

[9] The lead author organised a series of talks, inviting craft champions to visit Dundee and discuss their work with the research team and their colleagues. Examples include: the silversmith Michael Lloyd; the Scottish craft historian, Elizabeth Cumming; interactive jeweller Jayne Wallace and curator Amanda Game. For further information, visit www.futurecraft.dundee.ac.uk

[10] Professor Georgina Follett is the Principal Investigator of the '*Past, Present and Future Craft Practice*' research project. She is a craftsperson with over 30 years' experience in the field of 'plique-à-jour' enamelling. Producing pieces of high aesthetic value, Professor Follett's work has been exhibited widely including the jewellery gallery of the Victoria and Albert Museum, where examples of her work are on display in their collection.

[11] '*New Craft: Future Voices*' was a three-day event with 45-refereed papers and five keynote speakers. There were 125 delegates from 14 countries and the 'Future Voices: Celebrating Diversity' exhibition showcased 27 projects and over 250 pieces of work from eleven countries. The rational and content for the international conference '*New Craft Future Voices*' can be viewed at www.newcraftfuturevoices.com. (Accessed 12 January, 2010)

[12] 'Automoton' is a machine with a hidden or clockwork control that makes it move.

[13] 'Blinkers' or 'blinkered' refers to narrow-mindedness and a restricted view. It implies the ability to see only what is directly in front of you when moving forward, closed-off from seeing what is at either side of or behind you when engaged in a journey. It is a term of reference derived from working with horses where 'blinkers' were put on a horse to prevent it from being distracted and proceeding in a straight-forward pathway.

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A Didactical Framework to Experiment the Potential of Visual Languages in Engaging Social Complexity.

1 - Introduction

Development models often apply expert knowledge to social needs using a top-down approach, thus rendering these models insufficient in coping with the issues of a complex world. Effective changes in social systems arise from iterative and dialogic processes in which information and knowledge are exchanged between heterogeneous actors, building a common background that enables a shared hypothesis.

The design approach involves the ability to select results from various disciplinary fields, activating a trans-disciplinary circulation of concepts. Designers should use their skills to facilitate the emergence of a system, rather than concentrating on finding solutions to specific and well-identified problems. The focus should be on developing tools that can be self-adaptive, continuously modifiable and improvable by utilizing the ongoing process of wicked problem transformation. Social complexity requires new processes fundamentally attuned to the social and conversational nature of decision-making and design work; these processes should enable an increasingly valuable interaction level and dialogue among the actors of a social system.
And considering the Design discipline in respect to language, Communication Design could allow for the creation of visual and interactive languages relevant to the representations of Complex systems, thus creating shared visions within multi-actor contexts. In this sense, communication design can facilitate dialogues within participatory actions, and verify the potential of communication artifacts in supporting and externalizing sustainable and self-adaptive learning processes.

Therefore, the possibility of consciously facing social issues and orienting the behavior of complex social systems could benefit from the use of communicative tools and methodologies, thus supporting collective learning processes and building a common vision, shared by various stakeholders. Engaging complexity calls for visual languages.

2 – The role of Communication Design within the Complexity Framework

The centrality of communication and learning processes in dealing with complex systems - especially social ones - has been explored and criticized in several domains in different disciplines: from the theory of social systems (Luhmann 1984) to knowledge management (McElroy 2000). How these processes should be handled and shaped in order to be able, effectively and collectively, to drive and orient the evolution of a complex social system is a subject that is less explored and less clear.

We believe that communication design capabilities go beyond the general approach of taking into account complexity and developing a systemic perspective, and then examining the limits and opportunities of such a system. The type of communication design we are advocating includes the skills to concretely and actively insert, in every kind of process that aims to confront complexity, an intervention that enables a system change. In its evolution, the design field has defined itself as a cross-field discipline with different competences, addressing interdisciplinary issues, and often developing, by the creative recombination of knowledge units, the ability to create connections and new ties, thus giving shape to innovation. The design discipline creates innovation by pursuing relationships and combining the usual elements in a new way. Design has the capability to foresee, represent, and potentially visualize a complex of elements and relationships. Zurlo (2007) summarizes design capabilities as, *see* (understanding the context), *show* (visualizing the information) and *foresee* (making critical predictions), thus communication design is able to make complexity visible, understandable, accessible, and more easily practicable.

The importance of the concept of shape grounds the systemic thought that moves the focus from single parts to the whole, and sustains the need to understand the specific configuration of relationships (*pattern)*[1]. Understanding and intervening in a complex system requires the perception of the system as an integrated structure, and understanding which properties characterize the whole system, rather than belonging to any one specific component…those properties that emerge from the relationships and the interactions between single elements.

In our research, and in students activities, we assume the idea that the distinctive pattern of a complex system belongs to the visual domain of networks: it's the common organizational structure that belongs to all living systems, as Capra (2001) recalls: "Anytime we observe a form of life, we observe a network pattern […] the life pattern, we can say, is a network pattern that is able to self-organize".

To make the complexity of a system visible means to show what is latent; a fundamental step to enable access and intervention to the system itself. Both design disciplines and complexity theories refer to the domain of possibility and the hypothetical, and the specific contribution of design bases on the ability to both make a pattern visible and to assume the point of view of users: a user centered approach that produces prototypes as cognitive tools, for testing activities and reflective learning (Cottam and Leadbeater 2004):

> *Designers make problems and ideas visible, creating frameworks to make visual sense of complex information, and quickly sketching ideas to share work-in-progress with others. Making even intangible concepts visual creates a common platform for discussion, avoids misinterpretation and helps build a shared vision.*

The teaching and research program we propose explores and develops the visualization of networks, their features and dynamics, with the aim of educating designers in the exploitation of visual languages in dealing with social complexity. We intend to amplify the peculiar competences of designers to perceive and make visible those complex structures and concepts.

3 – The DensityDesign Laboratory: complexity, density and communication design

DensityDesign Lab was born in 2004 as a didactic initiative with the aim of developing experimental visual representation languages, to facilitate the sharing and the development of knowledge within groups of heterogeneous actors engaged in a complex system.
Let's imagine a decision-making table around which different stakeholders sit together: students are asked to define the concept and the design of communication artifacts intended to visualize the system as a complex whole, to create a common knowledge base for different actors.

The resulting communication artifacts cannot be considered as the solution to a wicked problem: mostly they are cognitive tools that are supposed to contribute both to better understanding and better acting, taking into account - through the visualization - both uncertainty and unpredictability.

3.1 – Density method: from graphs to diagrams

The communication artifacts designed by students during the laboratory are conceived as negotiation and decision-making tools. Communication design builds, through a visual language, the dialogical tools that allow the depiction of a common and shared understanding, and the emergence of common interests and goals in multi-actor contexts. From the beginning we

1 Capra says: "In the study of structure we misure things. But schema cannot be weighed: they need a visual representation. To understand a schema, we need to draw a configuration of links and relations. In other words, structure entwines quantity, and schema is more related to quality" Capra, 2001.

designated these artifacts with the generic term of *maps*, which evolved through the support of doctoral research[2] into the concept of *diagrams*. The etymology from the Greek διαγραμμα, DIÀ (through) GRÀMMA (sign), is open to the widest visual opportunities, and includes those communication artifacts that have a revealing ability - such as maps, scenarios, schemas, storyboards etc. - and represent the *visions* behind visualizations.

In our meaning, diagrams provide the system with an understandable and sharable shape that can overcome the constraints related to technical and disciplinary languages. Diagrams can visualize not just quantitative data, but also ideas, concepts, point of views and perspectives, as well as qualitative and value assets of complex systems observers. Beginning with a review and interpretation of insight into diagrams emerging from architectural research, we underline four important characteristics of diagrams (Corbellini 2007):

Condensation: diagrams can manage huge amount of data and information, and can demonstrate connections between elements that otherwise would be difficult to understand.

Connection: diagrams are able to express relationships between non-homogeneous data and information, encouraging unexpected interpretations and perspectives.

Proliferation: diagrams enable dialogue and inspire different ways to approach the problem setting and the understanding of systems; they are also fertile narrative devices.

Inexactitude: the construction of diagrams always displays a partial and non-comprehensive description of the system. Acting within complexity requires considering the impossibility of reaching an exhaustive knowledge of the system in which one operates. This difficulty could be overcome by developing strategic stances that allow for the ability to face system changes and their evolution, and are also the opportunity to visualize complex information referring, not solely to the communication of quantitative information, but also to intangible values and qualitative data. In this sense, it's necessary to emphasize that for designers, diagrams always represent a process of choice between the representation of certain things, and the renunciation of others. It's a political action, intentional, and arbitrary, and an aspect that clarifies and pinpoints the designers' responsibility when constructing visual representations.

The diagram takes the Deleuzian meaning of *conceptual device, abstract machine and proliferating machine, enabling method*, and *discursive instrument*. Through diagrams, the visual language demonstrates the shift from product to process, the movement "from the sensible to conceptual, from symbolic to syntactical" (Corbellini 2006), and from visualizations as a result, to visualizations as a process (attitude).

The methodology through which we approach the representations of complex systems is based on the visualization of (a) actors (people and organizations), (b) the relations between those actors and (c) the pattern of flows that involve those actors, defining also information *graining*, the boundaries of the system (*framing*), and the size and perspective of observation (*scaling*) (Scagnetti et al. 2007, Authors et al. 2008).

This is the approach that grounds our practice; the ability to reconstruct the schema, the shape of the system, and the entwining of connections and influences, even if the full potential of diagrams has not yet been fully exploited. Barabasi (2005) states, "networks are just the schema of complexity, the basic mechanisms. In order to describe the society we have to hold the links of the social network with the actual dynamic relations between people".

2 Gaia Scagnetti, 2009, The design practice of complexity. Communication atlas for sustainable social system integration. Author3, 2010 expected, Seeing what they are saying: diagrams for socio-technical controversies

3.2 DensityDesign tools: diagrams as a cooperative visual device

The interest in diagrams is less about the result itself, but rather as a visual/discursive tool and the generator of dialogical actions. Diagrams are not a final solution, but are instruments for better framing an issue. An apparatus in the hands of the visual designer, diagrams enhance not only the designers' own ability to see, but also enhances the vision of others by creating a collective vision of a form that binds the different elements of an issue or complex system; a precious skill when addressing contemporary problems that require a more participative and collaborative approach:

> *To speak of a problem and to engage with solving it is to engage in a conversation among stakeholders (people who care about the outcome). In my thinking about wicked problems, I like to introduce the notion of 'social complexity' as inseparable from problem wickedness. There are no single stakeholder wicked problems. (Conklin, Basadur, VanPatter, 2002)*

To make visible the relational structure of a complex system, and to describe the dynamics that animate this structure, by combining various tools and visual patterns, is what communication design can add in order to facilitate the exchange between stakeholders, enable negotiations and mediations and enlighten common visions and intents. It's a relevant contribution, acknowledged by Burkhard (2004):

> *You don't so much "solve" a wicked problem as you help stakeholders negotiate shared understanding and shared meaning about the problem and its possible solutions. The objective of the work is coherent action, not final solution. Thus, Rittel and Webber's contribution was well ahead of its time, and is now finally helping us understand why communication and collaboration, more even than creativity, keep emerging as critical to success on large projects.*

The design of diagrams, and a diagrammatic approach, are primarily useful for the design process itself, especially when faced with complexity: "The emerging horizon of the designer depends mainly on the capacity of building and improving the perception of the complex reality, even before building and improving the skills to address it" (Pizzocaro 2004). Some of the proposals that drive the continuous redefinition of the design discipline, bestow the field with the duty of diffusing and making more accessible the design method itself: the development of "open" languages enabling the participation of non-expert users in producing diagrammatic visualizations, is tangible evidence of the enlargement of the communication design domain.

4 – The structure of the Density framework

Since 2004, we have defined and improved the processes of building and structuring visual languages. The methods and procedures of visual analysis, and representations of complex systems have undergone continual improvement over the last five years, and with the development of specific conceptual and operative tools, the initiative has recently reached a more ripened stage (2009). The following section briefly describes the process utilized during the laboratory's activities, and includes the presentation of some artifacts along with descriptions of sample results.

4.1 – Visualized data, information and knowledge

The potentialities of visualization are experimented in two complementary domains: 1) the visualization of Data, Information and Knowledge (DIK), 2) the visualization of the structure of complex social phenomenon (structural visualization).

In the first domain, the students work to improve the cognitive processes that transform data into information, and information into knowledge. Within these processes, any visualization acts as a translator: it identifies and visually represents relationships between data and information, in order to communicate it and leverage knowledge. In the second domain, the focus is on the form of social phenomenon, assuming that understanding a system means understanding its form, and understanding form means to see and visualize a pattern. In this domain, visualization aims to amplify the *pattern finding* human capability (Ware, 2004), connecting the actors and/or the forces that drive the complex system or the dynamics of social phenomenon.

In general, the perspective of complex systems is recognized as the best occasion in which *"to observe the social world and its' making of. […] According to this approach, nothing can attain a collective existence without being the result of a collective work and controversies are the settings where this work is more visible"* (Venturini 2009). With this feature, any actor within a complex system is continuously involved in data production, information gathering, and knowledge exploitation, in order to support and nurture his own position and interest within the collective undertaking. Data, information and knowledge are the structural and basic elements of representation theories, and in a general way, of the communication and cognitive disciplines. The connection among these elements and visualizations is a key issue in the communication design field.

Any kind of discussion and research that tries to better redefine the role of visualization within the evolution of complexity cannot avoid a clear reflection about the role of design in the process of transformation from, and to, data, information and knowledge. The distinction between these three elements still remains commonly confused. Data and information are sometimes intended as synonymous, and information generally converges with the concept of knowledge. Timetables, for example, are basically lists of data. These raw — and thus disordered — data about train numbers, departure times, arrival times, and routes, etc., become information when they are structured, passing from a state of high entropy to a state of low entropy.

The timetable example illustrates the role of communication design as a tool for sensing, retrieving and using data. In fact, once data has been organized the second step is represented by the user's assimilation and interpretation. Thus, it emerges that information and knowledge do not represent the same notion. Only thanks to previous knowledge, an internalization or interpretation process, are we able to contextually comprehend a message by transforming the information into further knowledge, thus allowing for action. In this way we can define the second difference between information and knowledge (i.e. knowledge as action).

A Pyramidal hierarchy is often used to represent the relationship between data, information and knowledge (Awad and Ghaziri 2004; Bellinger, Castro, and Mills 2004; Chaffey 2005), yet a flow representation better depicts the relationship between these elements (Cooley 1987; Choo 1996; Jacobson 2000; Bellinger, Castro, and Mills 2004). For this reason, understanding the transformation from data to information is a fundamental matter: the way data and information are presented is of crucial importance in enhancing, understanding and facilitating effective action. Knowledge can be externalized in books or documents (thus turning into information) but can be represented only by experience: *"knowledge is a fluid mix of framed experiences, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers"* (Davenport and Prusak 2000).

Knowledge can be seen as an interpreter in the transformation of data to information; information can be extracted from data only through knowledge. Even though it's not hard to imagine a designer visually representing data and information about controversies, the problem arises when trying to visualize the knowledge produced by the actors of a complex social system.

We have to come to terms with the impossibility of visualizing knowledge, per se, or of considering it an instrumental, operative and reproducible object as it is defined by some knowledge management research lines. Still, we can represent it. However, visualization can only be given by representing knowledge in action, tracking back to the last step of the flow, the one that leads from information to knowledge (i.e. from knowledge to information).

Visualizing, communicating and sharing knowledge means to engage in a process opposite to that of natural acquisition, taking in a contrary direction the data, information, and knowledge continuum. Knowledge has to be converted into information so that it can be transferred and transformed into a physical and visual artifact. Thus signifying that every graphical representation is a visualization of information.

4.2 – DensityDesign experiments and outcomes

Over the years, the number and typology of the didactical modules have been refined, along with the range of disciplines that have been involved and integrated. The choices have been made primarily according to the results of two activities: a) internal discussions with professors of other disciplines (i.e. Statistics and Semiotics) about the outcomes produced by students and, b) the collective discussion sessions organized at ENEA (the National Agency for Energy and Sustainable Development) during the development of Alessio Romeo's Master thesis, "Sistema Energia Italia: Progettazione di un dispositivo comunicativo per i processi decisionali inclusivi" *(Italian Energy System: Designing a communicative system to support inclusive decision-making processes)*. During these sessions, stakeholders from the Italian energy system were asked to depict possible scenarios through the collective discussion of the system maps produced within the thesis work (see fig. 5a, b, c).

In the first stage of the Density Design didactical framework, students were asked to identify a social system, about which they were passionate, and to then gather data and draw a description of that system. The students designed the diagrams, providing a visual representation intended to provide a comprehensive description of the system, in order to better depict its current configuration and dynamics. These kind of maps supported the next design action: using their maps the students would articulate a communication design strategy relevant and useful to the system dynamics, and then return to the diagrams to depict the impact and the new configuration of the system after the interventions. At that stage, the basic intention was to reflect on the selective processes that give shape to a map, and to refine the visual language and empower the ability of representing these different views by the exploitation of details.

A more reflective capability has been explored over the years, and the framework evolved towards a more articulated definition of the visualization modules, according to the communication goals. The current structure of the framework is composed by four modules that drive students from the use of the standard techniques in information visualization, to the development of motion graphics artifacts, depending on the communicative goals. Two modules – *information visualization* and *motion graphics* - belong to the first visualization domain previously mentioned (DIK visualization); the others - *causal diagrams* and *system maps* - are expressions of the structural visualization domain, based on the need to understand the social system/phenomenon as a whole. Similarly, the impact of visual rhetoric has been introduced, in order to evaluate the potential role of visual metaphors and analogies. This distinction between the diagrammatic modules and the Infovis modules refers to the different intentions of the visualization process: diagrams exploit the system's analysis and display, while Infovis explores the narrative techniques, and the conversation between form and meaning.

Information visualization

The challenge of the information visualization module is to nurture and clarify the process of translation from data to information to knowledge. In this module, complex data sets are explored and transformed in visual representations that aim to clarify the meaning of data and make them useful to knowledge enhancement.

Our recent experiments have explored the socio-economic phenomena that present both representational and visual problems. Economic statistics involve understanding complex, multidimensional, ambiguous and dynamic phenomena, and building formal representations (models) based on statistical data. Communication Design addresses complex phenomena in order to interact with them, building multi-dimensional visual representations based (in some cases) on statistical data. The goal is to contribute to the construction of representation and visualization models, while respecting and preserving the inner structure of the analyzed phenomena, allowing users to know (or see) them as a whole.

We used official data (provided by the ISTAT) about poverty and social exclusion conditions in Italy (2007), with each of the students asked to provide a visualization about poverty in Italy, using the data as their primary, though not exclusive, source.

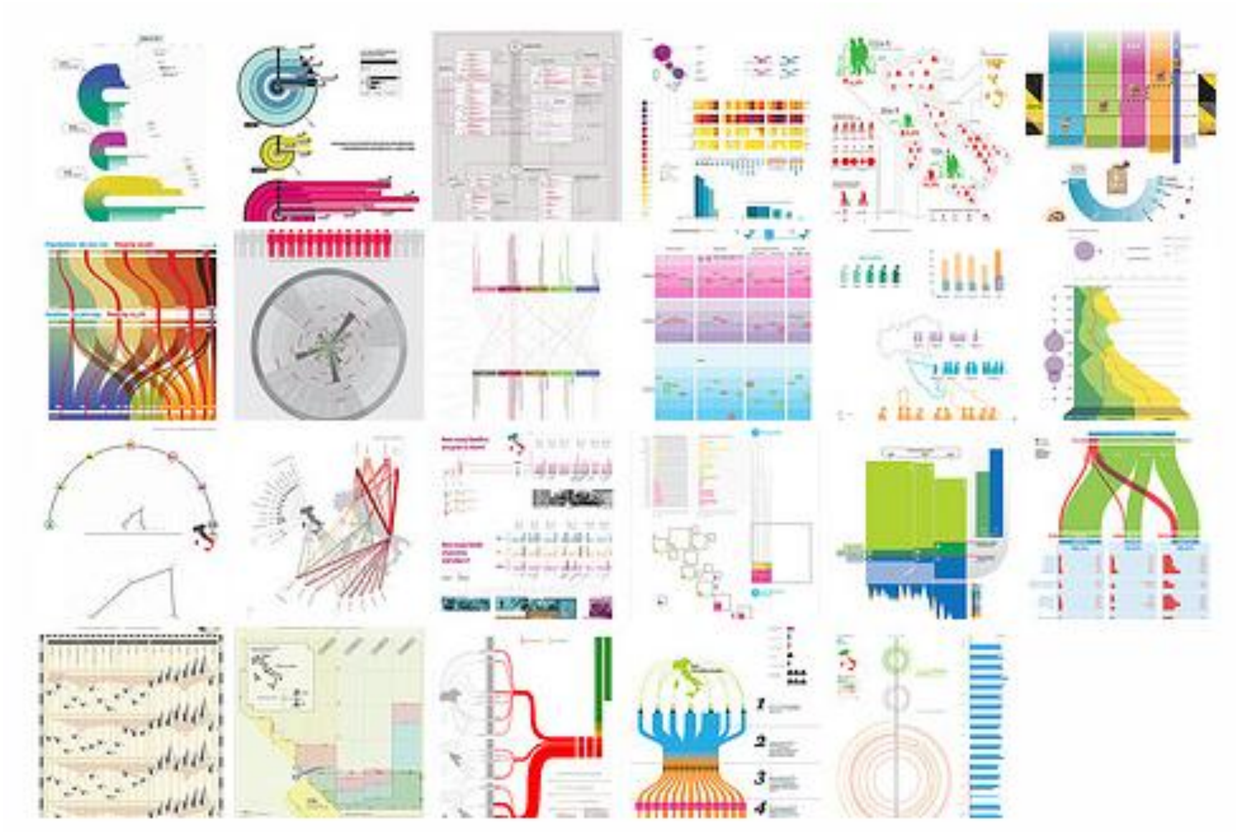

Figure 1 –from data to information: an overview of the different maps designed with the ISTAT italian national report about poverty

Exclusion is a socio-economic status that refers to people located at the margins of society, because of their economic, psychological, physical, and/or cultural conditions. To evaluate the forms and intensity of exclusion requires models that consider a multitude of dimensions, for the determination of poverty status cannot be reduced to a simple and single indicator. The representation of socio-economic problems is not reducible to a single problem or purely algorithmic technology, not because of lack of quantity of data, but rather because complexity, multi-dimensionality and ambiguity are difficult to reduce into algorithmic computations.

This module requires the development of new visual grammars and communication tools that do not superimpose artistic elements, over the representation of the phenomena, but rather build narratives deeply consistent with its inner structure. Visualization artifacts, diagram and maps, have to *respect* the robustness of the scientific approach to phenomena, while remaining *consistent* with the structure of the cognitive and logic capabilities of the observer.

Causal diagrams

The module of casual diagrams is a structural visualization tool that aims to fully describe the actors and variables of a system, and to exploit their influence and directions. It is a kind of representation that better describes the structural part of the system, pointing out the elements as single and detailed, as well as the main structure and influences. At this stage, students were required to split into groups, and select one specific topic from within the wider poverty framework, and to further develop their visualization. Casual maps are necessary to fix the mechanism of the system, and they are the primary schemas in the understanding of system behavior.

A causal loop model has been developed in order to help understand the complex systemic structure of poverty in all of its dimensions. System diagramming is here a loose term used to describe the activity of conceptually representing and visualizing a system in its constitutive elements: the elements, the relationships and the system boundaries distinguishing what does, and does not, belong to the set. The system has been visualized in a particular format: a causal loop model (or diagram). In a causal loop model, boxes represent the system's elements (factors, variables), while arrows represent the causal relationships between the two variables. The variable at the tail of the arrow has a causal effect on the variable at the point. In addition, a distinction can be made between positive and negative causal relationships. A positive causal relationship implies that both variables will change in the same direction: if variable *a* (at the tail) increases, then variable *b* (at the point) will also increase (and if *a* decreases, then *b* decreases). A negative relationship, on the other hand, implies that variables change in opposite directions. The causalities discussed so far are linear causalities (from *a* to *b*). Circular causalities (e.g. from *a* to *b* and from *b* to *a*) in systems maps are called feedback loops. They are an important feature of causal loop models because they help to explain the dynamic behavior of the system.

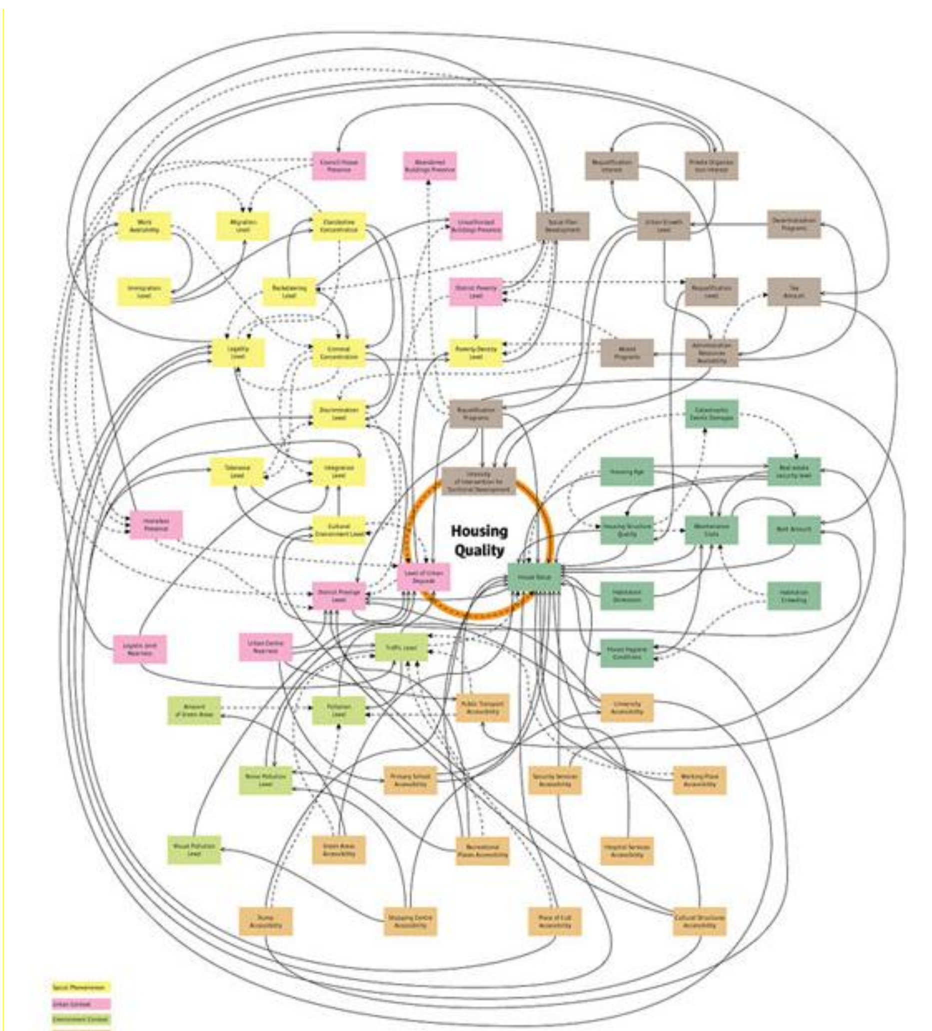

Fig. 3 –a casual diagram about the poverty system

Motion graphics

The motion graphics module mostly explores the narrative power of information visualization. In this case data become information, and then knowledge, and the visual languages are devoted to defining a relevant narrative. Motion graphic techniques are used not for the systemic representations of complexity, but rather serve as thick descriptive tools, able to reduce the distance between data, patterns and meanings within a narrow perspective of the system. Information visualization, in this case, provides a thick description of a single perspective, and visually clarifies the way in which the specific point of view is related and interconnected with the wider configuration.

Fig 2 – from information to knowledge: screenshot from the video Choice, motion graphics about the Poverty System and Food, http://www.vimeo.com/4002528

System maps

The final artifact discussed is the system map, which can be considered as an overall perspective of the system, a sort of bigger picture that describes the components, dynamics and contextual characteristics of a system. System maps emerge from a hybridization of the previous diagrammatic artifacts and a deep visual description of all the content; they aim to suggest the form of the system by the visualization of the found pattern. System maps don't emerge just from data analysis, but are connected to some previous knowledge that is itself depicted within the maps. They are composed of raw data and structured information and are able to finally provide a wide scale representation.

Maps are intended for an audience that is within, or related to, the system, and for those actors who operate from within the system. The maps exploit the knowledge layer related to experience, and should be able to activate dialogues and discourses about the system itself. Maps represent the final step in the cycle between data and knowledge, and transform and elaborate the previous contents in order to enrich a collaborative and shared knowledge.

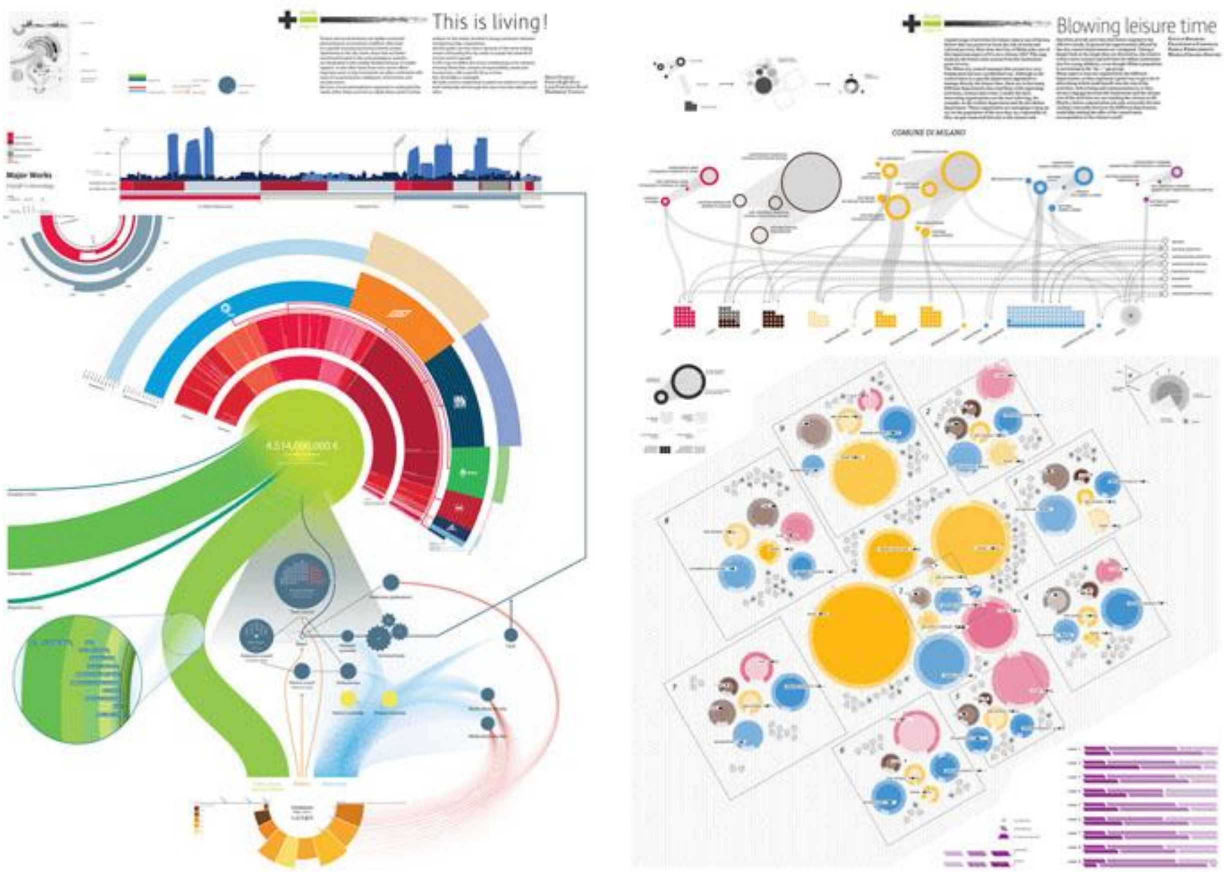

Fig. 4a,b –the system map, Poverty&Housing, Poverty&Leisure

In this module the possibility of evaluating the projects in real contexts is more relevant; finding an evaluation context for projects always means interfacing with institutions, organizations, and identitary structures, and represents a concrete example of negotiating and decision-making that is supported by visual languages. In many cases the process has been successful, and the students were able to verify the effectiveness of their own design, thereby making improvements.

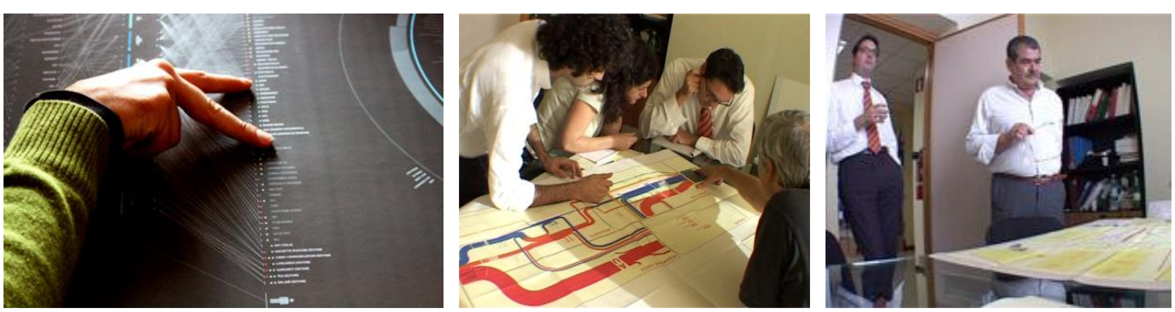

Fig. 5a, b, c: Stakeholders discussing possible scenarios based on the Energy system map at ENEA (the National Agency for Energy and Sustainable Development). Alessio Romeo, MA thesis “Sistema Energia Italia. Progettazione di un dispositivo comunicativo per i processi decisionali inclusivi” (Italian Energy System. Designing a communicative system to support inclusive decision-making processes).

Conclusions

In these pages we have tried to systematize both the theoretical and the artifact outcomes that we have experienced in the development of the DensityDesign Lab. The theory and the results are ongoing tensions that we continuously consider in our research and teaching practices, and that we mainly try to get across at concrete evaluation stages by prototyping (in case of interactive

artifacts), as well as in the participation of decision-making tables. In fact, an extension of the practice of evaluation in real contexts is needed, and the trend also in publications and conferences indicates a fertile horizon in this direction. The challenges shaped by global change require a collective disciplinary engagement, and design is called, and strongly aspires, to participate in finding the solutions to these challenges.
Through the DensityDesign approach, we hope to provide those facing global challenges with a cognitive and practical set of visual tools, a generative machine that allows for a discourse about a changing system, and that facilitates a more conscious approach to complexity. These visual tools aim to originate from common objectives, and consequently develop shared perspectives.

The approach requires a continuous refinement of the nature of the team, and an open and interested attitude toward future projects. The didactical framework proposed here is intended as a multidisciplinary platform, where visual design is the core and leading discipline, complemented with the integration of semiotics, statistics and network science. In order to nurture an intersection between the disciplines, the development of the framework will follow two main directions. First, more research is needed into understanding the cognitive issues of information visualization, and the language of visual narratives. This will involve the efforts of communication design using both representation skills, and interaction and cooperative capabilities. A more unexplored, second direction, introduced through a real data set, is more technical, and involves the power of computational and semantical processing of data. A structural robustness in the framework can be achieved by consolidating the approach to quantitative data, along with the effectiveness and variety of the transformation process into visual information. This step represents a marked evolution, for the integration of other disciplines will certainly lead to experimentation with the field of computer science, to theories of network semantics, as well as social system theory, and will challenge communication design skills to constantly cross languages, from bi-dimensional illustration to interactive processing.

The more refined the process of visualization becomes; the more articulate becomes the strategy of data gathering. These are the basic tensions that we tie to the concept of visual languages as a multidisciplinary cognitive device.

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Is systemic design the next big thing for the design profession?

Design is increasingly used for tackling large and complex problems and this new systemic design thinking is often interlinked with large societal issues. This paper will give the historic background and context to this development; it will show how the overall economic situation affects the design profession as well as exemplify recent development of the design practice. In order to do this it will describe three case examples of recent design usage in large societal issues: the birth of a new university, the municipal commitment of using design to improve society and the national approach of Finland in pushing systemic changes through design.

Keywords: Design and society, Design Practice, Systemic design

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Economic downturn has tended to bring forth the moral aspects of the design profession in Europe (Author, 2006, article). In a shattered post-war Europe, belief in a new world and modern liberal democracy was largely expressed through consumerism and not many moral considerations of what was designed were raised. During the late 60s and the oil crisis of the 70s, designers sought for moral and ethical stances, and the ethical justification of capitalism was frequently questioned. Victor Papanek turned the ethical blowtorch on the industrial design profession (Papanek 1972, Lewis & Gertsakis 2001,19; Whiteley 1993, vii; Heislinger & Marcus 1993, 249) and many others followed. With the economical upswing in the 1980s, ethics were suddenly again of lesser interest for the designers. Designers no longer aimed to find one ideal product solution or to defend those with disabilities, but to do good business. The postmodernist ideals of the 80s saw the meaning of a product to be the primary criterion in its conception and use, rather than the uses to which it was to be put (Heskett, 2002, 57; Julier 2000, 31). The arrival of the 90s saw an economic downturn in many European countries, and the importance of brands grew for companies. The main focus was no longer purely on the product portfolio, but also on the end-user experience of the corporate and its brand (see Press 2003; Mitchell 1993; Kuniavsky 2003; Shedroff 2001; McDonagh 2004). There was a paradigm shift from the utilitarian, rationalistic-individualistic, neoclassical paradigm, to a new paradigm where people were considered to be able to act individually and rationally but with a very strong moral and emotional underpinning.

In Finland crisis has always been a good cause of change for the design profession. The industrial design profession was born in the aftermath of the Second World War, where the national reconstruction also included rebuilding much of the national identity through design. Many Finnish designers gained great international fame during this era and a vivid discussion on design education with an industry approach flourished. This debate resulted in founding the industrial design education and the first educated industrial designers graduated in 1965. (Korvenmaa 2009; Sotamaa (ed.) 1999)

During the late sixties, seventies and eighties the professional practice of design developed steadily but slowly, becoming a formalized but still very small practice used by pioneering and broad-minded companies throughout the country.

The next major crisis for Finland came fifty years after the war. In the early nineties, Finland experienced an unexpected and exceptionally deep recession (Kiander 2004). The recession, together with the fall of the bilateral trade to the Soviet Union and the opening markets of the EU, which Finland joined in 1995, positioned the Finnish industry in a totally new and more competitive environment. (Kalela 2001) Design was seen as a great way to compete in the tougher markets, and the usage of design grew rapidly (Author 2007, book). The education of industrial designers grew exponentially and companies increasingly founded in-house design departments. This coincided with brand building, strategy and then in the 2000s with building the national innovation agenda.

Economic and social crises have thus been fruitful opportunities for the design profession to change. What has been common for these changes is that it has largely been the designers who have strived to develop their own professional practice forward and to ameliorate their professional standing (see Larson 1977, Abbott 1988). It is most likely that the economic crisis we are currently in will affect the design practice, but it remains to be seen exactly how. To get a proper historic view of the development we will need to wait at least another ten years, but we can already see starting phenomena and start formulating a hypothesis of how the design practice might be developing. In order to do so, this paper will first describe current developments in design and then review and analyse three recent cases in design.

RESEARCH APPROACH

This paper aims at showing recent developments within the design profession and at giving them a historical framework. The topic is reviewed from a profession studies perspective. Among the success factors of the design profession have been aligning the professional practice with the dominant ideological structures, such as the national system of innovation, as well as sharing new knowledge through research (Larson 1977, Abbott 1988, Author 2007, book).

This paper will first show the history of how an economic downturn has tended to shift the approach of the design profession and how the practice is currently changing. To review the very recent changes, three sites of development and some of their projects are reviewed as a basis of illustrating and further understanding the current developments within the design practice. All of the three cases are from Finland: the city of Helsinki and its project for becoming World Design Capital 2012, the Aalto University and the role of design in it, and the Finnish Innovation Fund Sitra and its two projects, the Helsinki Design Lab and the Low2No project. The purpose of presenting these cases is partly descriptive – to illustrate recent phenomena in the professional development – and partially analytic. The case descriptions include objectives of why designers are pursuing current directions, as well as key players and steps in initiating the projects.

In addition to the printed material about the three cases, specialists involved in the development projects have been interviewed or their public presentations have been used. These are Pekka Timonen, Cultural Director and Jussi Pajunen, Mayor, City of Helsinki, Mikko Kosonen, President, and Marco Steinberg, Director of Strategic Design, of the Finnish Innovation Fund Sitra, and Tuula Teeri, President of the new Aalto University.

Similar developments within design are now happening around the world in different scales, and the aim of this paper is also partly to give a Finnish perspective to the recent developments in the design field. Many scholars are currently involved in defining what this change is about, and hence the practical examples from one country can serve as an interesting point of comparison internationally.

APPROACHING COMPLEX PROBLEMS THROUGH DESIGN

Currently we are again facing a new kind of marketplace and a recession. This time, however, the starting point for design in Finland is very different than in the early 1990s. The professional practice of design is now fairly well established, and the usage of design as part of product development has become commonplace in most companies. There are now substantially more designers educated than before the 1990s, and their skills in areas such as marketing and strategic thinking are remarkably better.

Since the 1990s there have been many areas of development within industrial design. More and more focus has been moved from product design to the development of services (for Finnish examples, see Järvinen&Koskinen 2001, Miettinen 2007, 2009), to a user-centric focus (Keinonen 2000, Lindholm et. al 2003, Battarbee 2004, Mattelmäki 2006, Hyysalo 2009) to design discourse and to a more research based approach (Karjalainen 2004, Ryynänen 2009).

In general, there appears to be a shared quest for finding more meaning in design. Some, like Klaus Kippendorf, point on the deeper cultural meaning of the products themselves. Others (such as Jordan 2000, Press&Cooper 2003) focus on the more meaningful experiences that can be created through design. Many others, like Walker (2007) and Fry (2009), look at finding meaningful answers to global issues of sustainability. Increasingly the approach tends to be towards finding solutions to large and complex issues and understanding the relevancy of design to the larger whole.

Designers are not aiming for a more systematic view for the first time in history. Even the first wave design theoretics talked about the rationalist and logical designer (Bousbaci 2008,38). The second and third generation models brought the concept of the designer with a bounded rationality and many of the current theoretics, with the starting point of Donald Schöns *The Reflective Practitioner* (1983) talk about designers as reflective practitioners. Bruce Archer wrote *Systematic Method for Designers* as early as in 1981. He saw design research as a systematic search for and acquisition of knowledge related to design and design activity.

Currently the ability to reflect over practice and to approach large systemic issues is frequently viewed through the concept of wicked problems, originally put forward by Rittel and Webber in the 1960s (Rittel & Webber 1973; 1984,136). The notion is that there is an entire class of social system problems, which are ill-formulated, where the information is confusing, where there are many clients and decision makers with conflicting values and where the ramifications in the whole systm are thoroughly confusing. The relationship between these issues and design thinking has been taken forward by Buchannan (see for example Buchannan 1995) and partly also by Nelson & Stolterman (2003).

Many researchers have focused on the creative abilities of designers to view things differently and to make the unforeseen future more tangible. Kippendorf (Mitchel 1993,71) talks about the designers' ability to invent or conceive possible futures and their ability to work with how desirable these futures are. Laurel (2003,17) notes that there is an emerging paradigm where the old working processes are being inverted, where design is seen as a front-end method, aiming at a set of methods and practices for getting insight into what would serve and delight people.

Some push this ability to affect the future even further. Fry (2009, viii-3) wants design to make a standpoint in the field of political action. He claims that the design community should forget design as a territory and practice that can be laid claim of (the drive of professionalization), stop talking to one selves (the internal dialogue of design events), give up repackaging design with design (codesign) and start talking to other people, other disciplines; broaden ones gaze (beyond the design process, design objects and design's current economic positioning), and engage the complexity of design as a world-shaping force and help explaining it as such. He sees the modelling of design problems, design solutions, design experience and creativity all becoming applications of "intelligent systems" for creating and delivering "design tools". (2009,14)

The role of design, and the definition of what design is, is again changing. Design is now seen as a potential contributor to improving our relationships with each other, our communities, our cultures and our democracies. Design is seen as not only serving the needs of our businesses, but also determining and working towards the greater good for society and government, education and the environment. (Lunenfeld 2003,14) Design is no longer considered to be an isolated activity within one profession, but its contribution to the society and larger collaboration is vividly discussed. Focus has moved from design and design activity to the whole world and larger social issues, as Nicola Morelli is asking if designers can "Industrialize" Socially responsible Solutions and is proposing a shift of designers' activities from products to systemic solutions. (Morelli 2007,6)

FINLAND AS A HOTSPOT

In Finland, the rapidly changing environment is once again forcing the society to look for new innovation. The previous recession meant a major competitive shift in the Finnish industry and design was seen as one of the solutions. The usage of design grew rapidly, partly because of the shift in industry, partly because the designers promoted themselves and what they could do and aligned their work with the dominant ideology in order to ameliorate their own situation.

Now we are in the middle of a recession again, but in addition to this we also need to tackle problems like global warming, aging population and failing healthcare systems. This time it is not designers aiming to ameliorate their own situation but the entire society, the government, city and academia, believing that design, or design thinking, might be part of the solution for its complex problems.

The approach to societal development has also changed through time. According to John Kao (2009) several countries now have end-to-end innovation eco-systems and innovation is increasingly becoming the new wealth – and typically comes from blending disciplines. As part of this new approach to innovation, design is increasingly seen as a thinking tool for solving large, indefinable challenges. Kao defines Finland as one of the new hotspots of the world, where a small country with a strong innovation ecosystem and many informal connections among the different players can pioneer large-scale, holistic solution finding.

In Finland, there are currently many activities embracing this new way of design thinking. In this paper, I will cover three initiatives: the inclusion of design in municipal systemic thinking through Helsinki and its Design Capital 2012 approach, the formation of a new university and the relevance of design in a broader cross-disciplinary curriculum at Aalto University, and design as systemic approach to global issues through the activities of the Finnish Innovation Fund Sitra. What is common to all of these is that it is no longer the professional practice of design alone that is promoting new usage of design, but large, social institutions being formed on the principle.

CASE 1: EMBEDDING DESIGN IN SOCIETAL DEVELOPMENT

Design as a new way to think about complex issues has been embraced on municipal level and integrated into the development of society. The Finnish capital Helsinki was recently chosen to become the Design Capital of 2012. Altogether 46 cities from 27 countries applied for the designation. An international jury first shortlisted Helsinki and Eindhoven of the Netherlands and then awarded the designation to Helsinki. Helsinki's theme in its World Design Capital year 2012 is Open Helsinki – Embedded Design. Embedded design is seen as an enabler of an open city that boosts social, economic and cultural development and as a connector between different disciplines aiming to meet the inhabitants' needs with desirable solutions. The influence of design is also described in the city's strategy.

The process of applying for the Design Capital has largely been on the shoulders of the people working in the municipality, most remarkably on its Cultural Director Pekka Timonen. However, the entire design community has participated actively. The original idea for applying came from the Designers association of Ornamo, and individual designers also did some background work before the application process started. Once the city decided to apply, all the work of driving the process further has been done by the city, albeit through the participation of many designers. This may be part of the secret of why this process has been so successful: all players in the design fields have felt that the theme of embedded design is inviting to them and participated eagerly in the development process, but a player outside the field itself has been the one to hold all threads together.

Mayor Pajunen points out that design should be seen from a broad perspective. “Our goal is to build a better city and to improve our quality of life. Among other things, design-oriented thinking can be used to reform public services. The basic values of good design include user-friendliness, sustainable development and enjoyment.”

This approach to design, called embedded design, ties design to innovation from the very beginning whenever solutions to citizens’ needs are sought. Thus embedded design helps to render new innovations, technologies and systems sustainable and brings together human needs, aesthetic qualities and functionality. Helsinki approaches design from a broad perspective, and design underlies all processes that bring about social, economic and cultural improvement. This municipal approach is part of the larger national scheme of Finland’s National Innovation Strategy. The strategy expands innovation policy from traditional innovations to new areas and makes user- and demand-driven needs the cornerstones of the policy.

CASE 2: APPROACHING NEW KNOWLEDGE

Another area where many changes have happened is within the Universities. The whole university system is undergoing a major reform in Finland. According to a Government Programme, the financial and administrative autonomy of universities will be increased. In this connection, university governance and decision-making is reformed. From August 2009, all Finnish universities will be either institutions under public law or foundations under private law and all universities will cease to operate as part of the state budgetary system. Part of this process has been the foundation of the new Aalto University, consisting of the previous Helsinki University of Technology, Helsinki School of Economics and the University of Art and Design Helsinki (TaiK). It started in January 2010 and comprises a total of around 17000 students and 4000 staff. The Government has made a commitment to finance this foundation- based university with an extra 500M€.

The whole concept of combining the three universities was first put forward by the then Rector of University of Art and Design Yrjö Sotamaa, in his speech for opening of the school year in September 2005 (5.9.2005). Since then, a lot of work within different bodies has been done. Within the universities eight transformation groups with various focus, supported by the three existing rectors and the Aalto University Foundation Board, were actively trying to define what the new university should be about. In each of the transformation groups there has been people with a design background, but also specialists from other fields. In total, 400 of staff and students were represented in the working groups. In spring 2009 the university got its first President, Tuula Teeri, who has since then been heading this development process.

Aalto University has a unique combination of knowledge and the university approaches many of its initiatives through design thinking. The mission of Aalto University is to strive to change the world through top-quality interdisciplinary research, pioneering education, surpassing traditional boundaries, and renewal. Aalto University is to educate responsible, broad-minded experts with a comprehensive understanding of complex subjects to act as society’s visionaries.

In order to do so the Aalto University develops strong teaching and basic research in each of its three disciplines, creating professional researchers, designers, artists, engineers and economists. In addition to creating strong professionals the university actively develops new platforms, where different professional competences work collaboratively. One of the most prominent is the concept of Aalto Factories.

The three Aalto Factories, in the area of Design, Media and Services, all use design in grasping complex problems, providing learning, teaching, research, and co-operation environments in which the academic teams, companies and communities work together. The workshops are based on open innovation, an interdisciplinary attitude and new ways of learning and teaching.

Design and design thinking has also been defined as part of the universities focus areas. In order to define and evaluate the different research specialities, a large Aalto University Research Assessment Exercise (RAE) was conducted in 2009. The Research Assessment Exercise was conducted as a peer-review assessment by nine international panels with 62 highly esteemed experts. Altogether the research of 46 units (departments, institutes or equivalent entities) was assessed and the results were published in September 2009. The RAE was complemented by a separate report by the Academy of Finland called Research in Art and Design in Finnish Universities, also published in 2009.

The findings of the Aalto RAE suggest that the most distinctive strength of research at Aalto University is the level of its societal impact in general, and its interaction and cooperation with industry in particular.

The Academy of Finland report sees artistic activities as naturally integrating in nature. They claim that in solving complex problems we need, in addition to analytical research, the holistic way of working and thinking which is typical in artistic activities and design. Art has also a communication dimension, as visualization is needed in understanding many problems. They continue that the artistic activities at Aalto University include the study of societal and cultural heritage as well as formulating a worldview through creating and experiencing art. Art is thinking and its criterion is the skill that is based on the individual's experience and the connection to other people that it makes possible. What is central is the experience that is created through a meeting of the worlds of art and of those who experience it, where new meanings, new adaptations, creativity and innovations are born.

In the Aalto RAE the research on usability, user-centred design, user experience design and domestication of design carried out at the School of Design at TaiK was assessed as being of outstanding international level and comparable to the best international groups in the same field. Integrating this research with a high-quality artistic practice based approach was considered to provide a great opportunity for further development. Moreover, Aalto University was seen as creating brand new possibilities for this area of research to interact with various disciplines. In particular, user-centred design combined with sustainability and technology was seen as forming a starting point for a multidisciplinary engineering design approach, including media technology, within Aalto University and to contribute to economy and society in a new and innovative way.

CASE 3: PUSHING FOR SYSTEMIC CHANGE

A third player to push new thinking in design has been Sitra, the Finnish Innovation Fund. Sitra is an independent public foundation with a mission to build a successful Finland for tomorrow. In Sitra, the aim is to help Finland prosper as a global pioneer in systemic changes that generate well-being. Sitra defines systemic change as broad, far-reaching change that simultaneously affects the structure of the society and the everyday life of its citizens. Sitra engages in foresight activities and advances these changes in cooperation with other actors.

Lately, many of the Sitra programmes and strategic processes have included or consisted of design activities. Two of them will be presented here. The Helsinki Design Lab (HDL) gathered a global community of designers and decision makers interested in using design as a strategic tool to resolve complex challenges facing contemporary society. Their idea is that Finland as a small, well integrated, forward-looking society is an ideal place to prototype systemic change that may be too difficult to initiate elsewhere.

For three days in June of 2008, a group of 108 people from around the world, each a leader in their respective field, converged in Helsinki to discuss the potential of design. HDL2008 sought to develop a manifesto for design that produces 21st century solutions to 21st century challenges. This manifesto saw design as synthesis; visualization; holistic; human centric; and integrated to provide more effective solutions to "big picture" problems afflicting today's societies. It continued with twenty points of what design should be, including design tackling real problems, real stakeholders, real collaboration, and real resources, design being socially relevant and design as a political tool.

This dialogue is continued at the Helsinki Design Lab 2010 that will in September 2010 convene a global community of designers and decision makers interested in using design as a strategic tool to more effectively resolve the complex and systemic challenges facing the contemporary society. This time the HDL will focus on bridging the gap between thinking and doing, building a more effective link between design and government.

As HDL is moving towards execution, Sitra is also pushing for systemic change in a project called Low2No. The aim of the *Low2No Jätkäsaari City Block for Sustainable Construction* project is to develop and demonstrate energy efficient and innovative solutions in urban design and construction. The solutions developed in the project will serve as examples in Finland and internationally.

With the completion of Vuosaari Harbour in 2008, the urban structure of Helsinki is undergoing its most radical transformation since the industrial era. The city's cargo terminals and heavy road and rail traffic are now consolidated to the eastern edge of Helsinki in this new harbour facility. As a result, as many as six large logistical spaces (including Jätkäsaari) are being redeveloped to meet the needs of Finland's modern information economy with office and commercial space, residences and infrastructure. Moving the ports out of the city centre provides the rare opportunity to reconsider the city's urban structure and systems. The master plan for the Jätkäsaari area covers 100 hectares of mixed-use development and infrastructure. It is expected that by the completion of all phases of the master plan in 2025, Jätkäsaari will house 16.000 inhabitants and 6.000 new jobs.

As part of this development, Sitra is moving its own headquarters to the area and using the building block and its environment as an opportunity to improve sustainable building practices, creating an example of the construction of passive and plus energy buildings. In order to do so Sitra together with the City of Helsinki launched a sustainable development design competition.

More than merely a single design, Sitra has been asking the competitors for a credible strategic framework for change, and the principals upon which the framework was built. With the selection of a team comprised of Arup, Sauerbruch Hutton, Experientia and Galley Eco Capital, the competition is moving from ideas to implementation. This next phase includes not only design development of the architectural and strategic solution, but also many activities targeted at raising the level of awareness and sophistication of Finland's national sustainability discussion.

SO IS DESIGN USED IN SOLVING SYSTEMIC ISSUES?

Economic downturn has made the design profession change and redirect its activities many times, and typically an economic downturn has also made designers more aware of the moral aspects of their work and more concerned about global issues. Now we are in this situation again, as the economy is taking a major turn. Although we cannot yet give the exact results of the current development it is quite obvious that new design thinking is forming. Internationally, a large body of litterature on what this new design thinking is about is appearing, and the current debate and development in rhetoric suggests this type of movement. Design has moved from the designing of individual products and services to a more holistic approach, and this systemic thinking is generally applied in solving larger issues within the society.

This paper has shown three case examples where large social structures are being established, which clearly support this new approach of design. They show design as a means to solve larger problems, to attack social issues that wouldn't be easy to tackle using more traditional means of science as well as a structural player in thinking about large issues in a more creative way.

The Finnish case examples clearly show that broader societal issues are approached through design. It is also obvious that this time it is not only designers developing their own profession, but a larger societal movement including others than designers. The fact that the development is not in designers' hands alone also makes the potential outcome of this development more difficult to predict, and it might mean that something we cannot predict at all will come out of it. It will change the way we see what a designer is, and challenge how we educate them.

Time will show if the new systemic approach will change the professional practice as strongly as the change caused by the previous economic shift did, but it looks quite likely. The challenge is whether designers really have the competences needed for the work that is now expected from the profession. This time the change is not quantities, about how many designers are educated or how many companies use design, but it is about the whole view of design quality, why the profession is to be exercised and what constructs good design. Or in the words of Mayor Pajunen in the Open Helsinki application: "Design is everywhere, everything is design and design is for all. In the end, everything is just a question of good or bad design - a question of quality".

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Explaining and Relating Different Engineering Models of Functional Decomposition

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Abstract

In this paper I analyze the use of different models of functional decomposition in engineering design. I consider models that refer to sets of desired behavior-functions, to sets of desired effect-functions, and ones that refer to sets of purpose-functions. It is argued that the choice for a particular model is affected by whether or not its construction will be based on known function-structure connections for the functions in the model or on known behavior-structure relations that implement the functions in the model. It is then argued that whether or not such knowledge is taken into account is affected by specific design objectives. Finally, I thus argue that the choice for and suitability of particular models of functional decomposition depends on the design objectives for which these models are employed. Based on this result, it is concluded that the co-existence of different functional decomposition-models has engineering value, defining the remaining task to relate them. To this end, a strategy is proposed for relating different models. The above analysis is focused on three approaches that advance particular models of functional decomposition: the Functional Basis approach in which models refer to sets of desired behavior-functions, the Functional Interpretation Language approach in which models refer to sets of desired effect-functions, and the Dual Stage approach in which models refer to sets of purpose-functions.

Keywords

functional decomposition-model; design objective; design knowledge.

As evidenced by a recent review of Erden et al. (2008), engineering design research has produced an impressive number of functional modeling approaches. In these approaches a variety of definitions of functions, representation schemes for functions, and strategies and representation schemes for the decomposition of functions into sub functions are formulated. It is however acknowledged in the literature that this richness of different conceptualizations has its price: it can lead to cross-communication problems between engineers working with different functional frameworks (e.g. Rosenman & Gero, 1999; Deng, 2002). In the review given by Erden et al. (2008) the authors state, for instance, that not all reviewed approaches are compatible with one another. This sets a research challenge for establishing human and automated communication across functional frameworks. Different responses are given in the engineering literature to the diversity of functional frameworks. Erden et al. (2008) suggest that incompatibilities between approaches are due to different educational backgrounds and different application domains they are aimed at. Yet, at the same time, these authors aim with their review to develop a common framework for functional modeling that rises above the domains. Achieving this aim however suggests the discarding of a number of approaches for, otherwise, it seems that due to these incompatibilities the envisioned framework cannot provide the desired common frame that transcends particular application domains, and functional modeling thus will remain domain-specific (cf. Vermaas, 2009). Other authors seem to acknowledge the worth of keeping different functional frameworks side-by-side, considering them useful for different applications, yet at the same time they voice preferences for particular ones (cf. Umeda et al., 1996; Deng, 2002).

In this paper I evaluate the merits of adopting a single and common framework for functional modeling. The benefits of adopting such a common framework are immediately obvious: cross-communication problems will presumably be solved. However, adopting a common framework may at the same time narrow down the application scope of functional modeling. I will assess by means of a case study how a single and common modeling framework fares when employed in different application domains. Focusing this analysis on models of functional decomposition, graphical representations of organized sets of functions, I identify three particular notions of functional decomposition-model and three specific engineering objectives that are advanced in the functional modeling literature. These models and objectives are derived from: the Functional Basis (FB) approach (Stone & Wood, 2000), the Functional Interpretation Language (FIL) approach (Price, 1998; Bell, Snooke, & Price, 2007), and the Dual Stage (DS) approach (Deng, Tor, & Britton, 2000a; Deng, Tor, & Britton, 2000b; Deng, 2002). Framed in the context of this case, this paper addresses the research question whether the use of one of these three models of functional decomposition is suited for achieving each of the three objectives. This case study shows that, rather than favoring a single framework-proposal (and displacing a number of models), particular models are suited for specific objectives, implying the engineering value of keeping different models of functional decomposition side-by-side. Given this result, the challenge then becomes — with an eye to the cross-communication context mentioned earlier — to relate different models of functional decomposition. This paper also briefly outlines a strategy to meet this challenge.

I start my investigation of the different notions of functional decomposition-model in terms of an analysis advanced by Vermaas (2009). His analysis shows that specific meanings of the concept of technical function are used in engineering to advance specific descriptions of technical devices. Since these descriptions are all useful to engineering, he thus explains why the concept of function is used with more than one meaning in the field. He identifies three archetypical meanings of the concept of technical function: desired behavior, desired effect of behavior, and purpose. Using this analysis, I argue that FB models refer to sets of behavior-functions, FIL models refer to sets of effect-functions, and that DS models refer to sets of purpose-functions. In the research of Vermaas (2009), the choice for advancing a specific meaning of the concept of function, apart from the connection between a specific function meaning and a specific description of a technical device, is a question left implicit. In the case of functional decomposition, it is argued here that (i) the choice for a particular model is affected by whether or not its construction will be based on known function-structure connections, as laid down in engineering knowledge bases, for the functions in the model, and that (ii) whether or not such knowledge is considered is affected by specific design objectives that engineers aim to achieve with their models of functional decomposition.

This research is conceptual and example-based. It focuses on the internal structure of the FB, FIL, and DS approaches, in particular the use of knowledge bases. Empirical examples of functional decomposition-models as specified in these approaches are analyzed, compared, and used as demonstration. This paper is organized as follows. The account of Vermaas (2009) is introduced in section 1. Different models of functional decomposition are discussed in section 2. Design objectives and the use of design knowledge bases are analyzed in section 3. Conclusions are given in Section 4.

1. Simplifying full descriptions of technical devices: relating goal to behavior and/or structure in different ways

Vermaas (2009) has presented an analysis of the flexible meaning of the concept of function as it is used in engineering. This analysis is developed in terms of the notions of a full and a simplified description of a technical device. Vermaas identifies five key concepts in full descriptions of technical devices (see Figure 1): *goals* of agents that refer to states in the world that agents desire to realize by using devices; *actions* that refer to intentional behaviors that agents carry out when using devices; *functions* that refer to desired roles played by devices; *behaviors* that refer to physicochemical state changes of devices; and *structures* that refer to the physicochemical materials and fields of devices, their configurations, and their interactions.

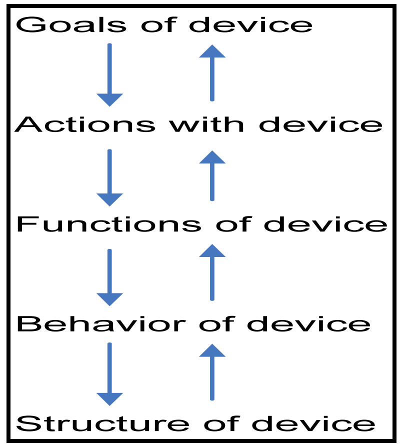

Figure 1 Full description of a technical device in terms of five key concepts (adopted from Vermaas, 2009)

Vermaas asserts that the concept of function is used with different meanings and that this flexibility affords different ways in which such full descriptions of technical devices can be simplified. Full descriptions in terms of the five key concepts are elaborate, and in particular engineering settings it makes sense to simplify them by "by-passing" one or more of the key concepts. Vermaas (2009) demonstrates this by-passing of certain key-concepts in terms of three approaches toward the modeling of or reasoning with functions, each advancing a different meaning of the concept of function: the FB-approach of Stone and Wood (2000), the Multilevel Flow (MFM) approach of Lind (1994), and the Function-Behavior-Structure (FBS) approach of Gero (1990).

Vermaas (2009) argues that in the FB approach, the concepts of action and behavior are "by-passed" and that the concept of function is used in its meaning of *desired behavior* (by specifying the role a device should play in terms of its behavior) to relate goals to structure (see Figure 2). FB-functions are modeled as operations-on-material, energy, or signal flows. Vermaas argues that these descriptions refer to physical behaviors since they represent conversions of matter and/or energy in which the input quantity matches the output quantity, meeting physical conservation laws. A function of an electric screwdriver, for instance, that is described as 'converting electricity into torque and heat' (Stone & Wood, 2000) in which the energy of the electricity equals the sum of the energies of heat and torque. In the FB approach, the concept of behavior is thus bypassed and the concept of function is instead used to refer to behavior(s). Vermaas asserts that in the MFM approach the key concept of action is by-passed but not the concept of behavior (see Figure 2). And he argues that in this approach the concept of function is used in its meaning of *desired effect of behavior* (by specifying the role of the device in terms of the effects of the device's behavior) to relate goals to behavior. Functions in MFM are represented in terms of operations and flows, and may be represented in terms of only input or output flows. A function example may be, say, 'producing torque'. This description also refers to (features of) behavior but does not meet conservation laws, referring only to the desired effects of behavior (which makes good sense, since the concept of behavior is used to account for the conservation of matter and energy). His analysis of Gero's FBS approach further broadens the spectrum of engineering meanings of the concept of function. His analysis of the simplified descriptions advanced in this FBS framework shows that the concept of function may also be used to refer to a *goal* desired by an agent. A function example may be, say, 'having a rotational force down a shaft'. This description refers to a state of affairs in the world, intended by an agent. Vermaas (2009) considers two ways in which simplified descriptions in this FBS framework may be interpreted, due to the shifting position of Gero on the meaning he ascribes to the concept of function: either as functions as goals to behavior, and then structure, by-passing the concept of action (see Figure 2), or, alternatively, as side-stepping both the concepts of goal and action, and reasoning from functions as desired effects to behavior, and then to structure.

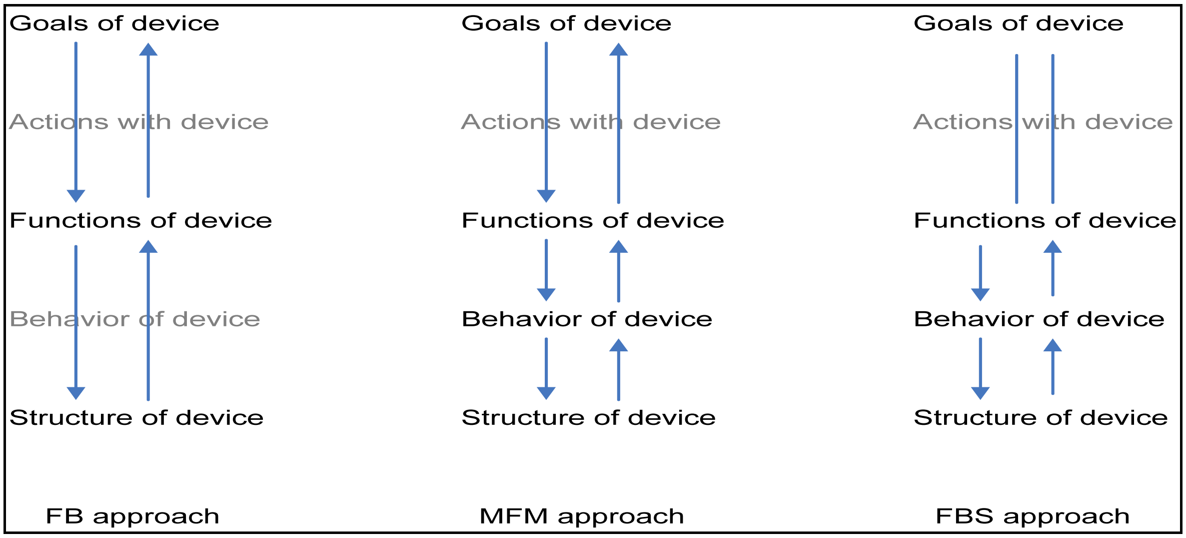

Figure 2 Simplified descriptions advanced in the FB, MFM, and FBS approaches (adopted from Vermaas, 2009)

2. Engineering models of functional decomposition

The foregoing analysis shows that different meanings of the concept of function are employed in relating goals to structure and/or behavior: desired behavior, desired effect, and goal. To distinguish goals of users from goals of designers, I coin the latter purposes. Purpose-function descriptions hence refer to states of affairs in the world, intended by designers. These different meanings of function are given in Table 2.

Behavior-function: desired behavior of a device
Effect-function: desired effect of behavior of a device
Purpose-function: purpose for which a device is designed

Table 1 Three meanings of the concept of function

These three types of functions are also described in models of functional decomposition, graphical representations of organized sets of functions, and the flexibility in the way goals (or designer purposes) are related to structure and/or behavior is also in play in the functional decomposition case. Often, in engineering design, models of functional decomposition (that make up an overall function) are advanced to relate goal (or purpose) to structure (cf. Stone & Wood; Deng et al., 2000a, b; Chakrabarti & Bligh, 2001). In this section I give an analysis of 3 approaches toward functional modeling, each advancing a different model of functional decomposition (*fm_D*) by which goals (or purposes) are related to structure and/or behavior. These three models are depicted (and abbreviated) in Table 2. Behavior function-*fm_D* 's are advanced in, for instance, the FB approach, the Systematic approach (Pahl & Beitz, 1988), and the Functional Reasoning approach (Chakrabarti & Bligh, 2001). Effect function- *fm_D* 's are advanced in, for instance, the FIL approach and the MFM approach. The third notion of purpose function-*fm_D* is advanced in the DS approach. (I do not consider here the use of the concept of function to refer to a user action, nor the description of such functions in models of functional decomposition. See Van Eck (2010a) for these details).

Functional decomposition model of organized set of behavior-functions (behavior function-fm_D)
Functional decomposition model of organized set of effect-functions (effect function-fm_D)
Functional decomposition model of organized set of purpose-functions (purpose function-fm_D)

Table 2 Three models of functional decomposition

Based on this analysis, I then develop the position in section three that the choice for particular models of functional decomposition is affected by particular design objectives that engineers aim to achieve with them.

2.1. Functional Basis approach

The Functional Basis (FB) approach, developed by Stone and Wood (2000), is an approach to functional modeling that is aimed at supporting the engineering designing of new products in the electro-mechanical domain, as well as the archiving, and communication of functional descriptions of existing products. In the FB approach, an overall product is described in a verb-object form and represented by a black-boxed operation on flows of materials, energies, and signals. A sub function, describing a part of the product's overall task, is also described in a verb-object form but represented by a well-defined basic operation on a well-defined basic flow of materials, energies, or signals. The black-boxed operations on general flows representing product functions are derived from customer needs, and the basic operations and basic flows representing sub functions are laid down in libraries of operations and libraries of flows, together called a *functional basis*.

To support engineering designing, Stone and Wood (2000) present a three-step methodology to develop functional decomposition-models. The method starts with describing a product function in a verb-object form, derived from customer needs and represented by a black-boxed operation on flows of materials, energies, and signals. A chain of operations-on-flows is then specified for each black box input flow, transforming that flow step-by-step into an output flow. These operations-on-flows are to be selected from the FB libraries. Finally, these chains of operations-on-flows are aggregated, completing the model of functional decomposition. Such models are intended to provide a "form-independent blueprint" of the functions of a product-to-be-designed, meaning that no known technical solutions for sub functions – structures – are taken into account during its specification. Not taking such existing function-structure connections into account during specification of a model is intended to support creative, and innovative designs (Stone & Wood, 2000). And in order to support such mappings after completion of a model, the sub functions in it should be small and easily solvable ones. The FB approach currently includes a web-based repository in which functional decompositions of existing products are archived, as well as components counting as design solutions for the sub functions that are part of these decompositions, supporting such mappings systematically.

Functional decomposition-model

Relative to the behavior, effect, and purpose meaning of technical functions, FB-product functions and sub functions can be taken to refer to desired behaviors (which may include their effects) since they represent conversions of matter and/or energy in which the input quantity matches the output quantity, meeting physical conservation laws (cf. Vermaas, 2009; Van Eck, 2009). For instance, the sub function 'converting electricity into torque and heat' (see section 1 and Figure 3). FB-models thus are behavior function-fm_D 's, organized such that the output flows of preceding behavior-functions constitute the input flows of succeeding behavior-functions (Figure 3).

Relative to the five key concepts, the concepts of action and behavior are bypassed and sub functions in FB-fm_D 's relate a goal – customer need – to structures (components as archived in the FB repository).

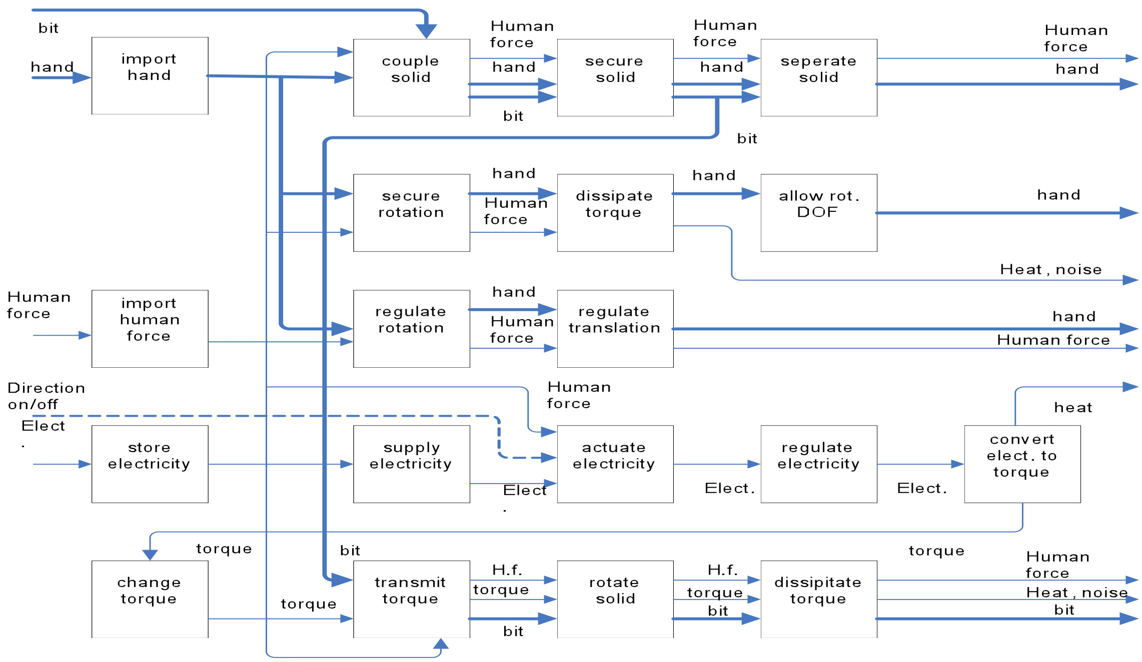

Figure 3 FB behavior function-fm_D of a power screwdriver (Stone & Wood, 2000)

2.2. Functional Interpretation Language approach

The Functional Interpretation Language (FIL) approach (Price, 1998; Bell et al., 2007) is an approach to functional modeling that is aimed at supporting design analysis tasks, such as failure analysis and design verification, mainly in the electro-mechanical domain. In this approach functions of technical devices are taken as and represented by trigger-effect pairs. An overall function is represented in terms of three elements: the "purpose" achieved by the function, the "trigger" of the function, and the "effect" of the function. Purposes in FIL refer to goals that agents aim to achieve when using devices. Triggers and effects in FIL describe the boundaries of a technical device, and are intended as labels that allow linking to relevant properties of its behaviors (in a design analysis context). Sub functions are either represented in terms of these three elements or as combinations of two out of these three elements, depending on the type of device analyzed.

In a design analysis setting, an overall function is decomposed into sub functions when its achievement depends on more than one trigger and effect, or when different trigger-effect pairs can achieve the overall function. In a model of functional decomposition that results, the triggers and effects of the sub functions then replace the trigger and effect (originally) associated with the overall function. Such models allow linking (in a design analysis context) to relevant properties of the behaviors of a technical device, both for tracing the cause of failures and for verifying whether a device's behavior implements the effects that are desired. This is done by checking the "on/off" states of triggers and effects. For instance, in a functional decomposition-model of a room light-function a sub function is represented by the trigger-effect pair "switch on-light on". Now, say, if the lamp switch position is "on" (trigger) and the effect "light on" is absent, this sub function has failed (Bell et al., 2007). This trigger-effect relation allows tracing those behavioral properties that cause this failure, say, an electrical short circuit. Such functional decomposition-models describe the (sub) functions of devices of which its required behaviors and structures are known.

Functional decomposition-model
Relative to the behavior, effect, and purpose meaning of technical functions, FIL overall functions and sub functions can be taken to refer to desired effects of behaviors. For instance, the sub function of the room light-function above only refers to the desired effect of the light being on, and not to the behavior due to which this effect is displayed, say, the conversion of electrical energy into light and heat. FIL-models thus are effect function-fm_D ‘s. (Figure 4)

Relative to the five key concepts, the concept of action is bypassed and sub functions in FIL-fm_D ‘s relate a goal – FIL-purpose – to behaviors.

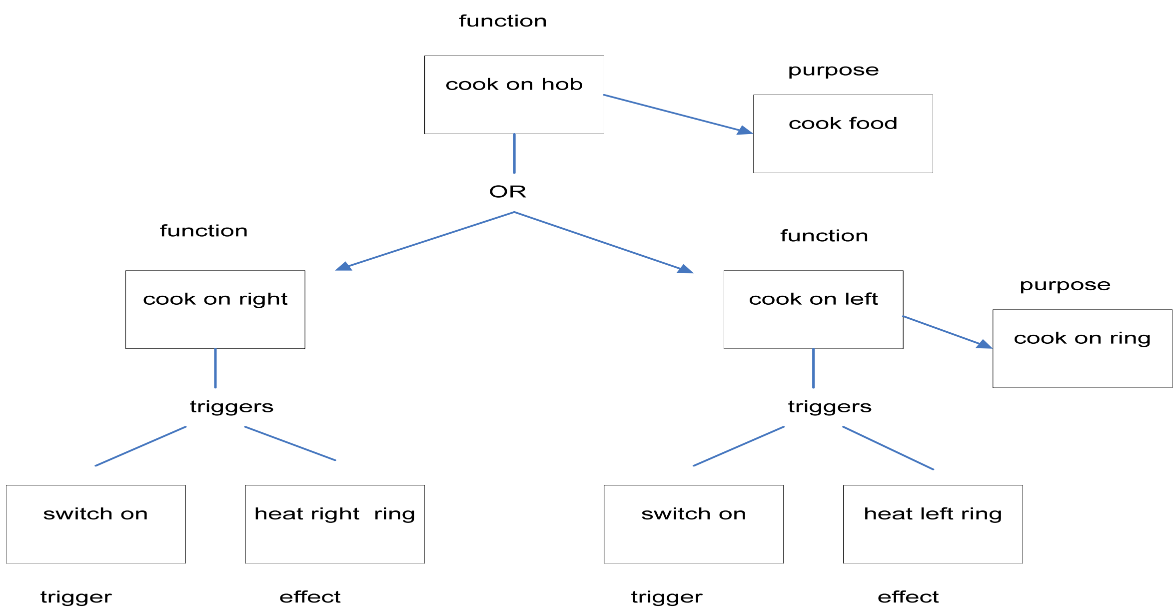

Figure 4 FIL effect function-fm_D of a two ring-cooking hob (Bell et al., 2007)

2.3. Dual Stage approach

The Dual Stage (DS) approach, developed by Deng, Tor, and Britton (2000a, 2000b, 2002), is an approach to functional modeling that is aimed at supporting the engineering designing of products in the mechanical domain. In this approach two types of functions are defined: purpose functions and action functions (Deng, 2002). A purpose function refers to a designer’s intention or purpose of a design. An action function is defined as an abstraction of intended behavior. Both types of function are represented by verb-noun descriptions.

To support engineering designing, Deng, Tor, and Britton (2000a, 2000b, 2002) present a knowledge base-assisted method to develop functional decomposition-models of an overall purpose function. First, an overall purpose function is decomposed into purpose sub functions, using a function-library in which existing functional decomposition design-knowledge is stored. This library archives descriptions of purpose functions that have “pointers” added to them, linking them to sub functions and to functions of which they are a functional element. An overall purpose function is decomposed into those sub functions to which it is linked in the library. Then, these purpose sub functions are mapped onto structures using a physical structure-library, in which descriptions of commonly used structures are archived. The purpose sub functions stored in the function-library also have pointers to the structures housed in the physical structure-library that are suitable to implement them, thus supporting function-structure mapping. These steps constitute the first stage of the DS-modeling framework. When functions from the function-library do not have pointers to physical structures as housed in the physical structure-library, hence cannot be mapped onto structures, a physical phenomena-library is then employed to carry out function-structure mapping. This library stores descriptions of commonly used physical behaviors and their effects, which have pointers added to them, linking them to structures in the physical structure-library. Action functions refer to behavioral effects (Deng, 2002). This physical phenomena-library is searched to retrieve those behavioral effects – action functions –- that are deemed suitable to achieve an unmapped purpose sub function. By linking a purpose sub function to a behavioral effect, which has a pointer added to a physical structure, purpose function-structure mapping is supported. These steps constitute the second stage.

The usage of these libraries in specifying models of functional decomposition (and supporting function-structure mapping) is aimed at employing past design knowledge in a systematic way to assist engineering designing (Deng, 2002). Models of functional decomposition are constructed that consist of sub functions for which structures are known. For instance, Deng et al. (2000a) specify a purpose sub function of the overall purpose function of a rivet setting device as "to exert certain force on the rivet by a working head, during the process the working head moves down a specified distance" (p. 43), which contains a pointer to the structures of "working head" and "rod". This type of designing in which known function-structure relations (and function-behavior-structure relations) are employed in constructing functional decomposition-models is also referred to as design-by-analogy or analogy-based-design (Goel & Bhatta, 2004).

Functional decomposition-model

Relative to the behavior, effect, and purpose meaning of technical functions, DS-purpose functions and sub functions can be taken to refer to states in the world desired by an agent-as-designer. For instance, the sub function above refers to the desired state that a rivet has force applied to it, come about by a sequence of states pertaining to the position of the working head. DS-models thus are purpose function-*fm*$_D$'s (Figure 5).

Relative to the five key concepts, the concepts of action and behavior are bypassed in the first stage and sub functions in DS-*fm*$_D$'s directly relate designer purposes to structures. (In the second stage, the concept of behavior is not bypassed and effect-functions are used to relate designer purposes to behavior. In this stage the step from goal to behavior is taken via a single function, not via a model of functional decomposition).

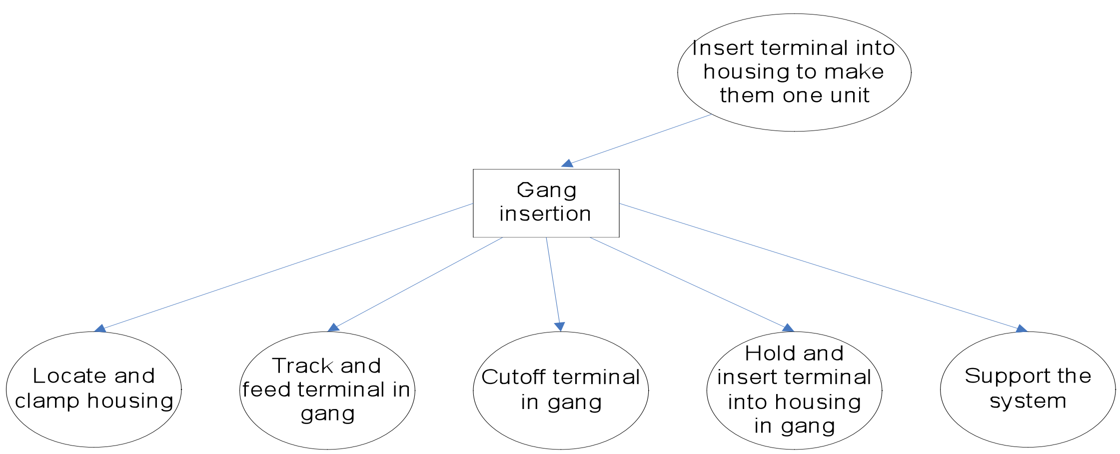

Figure 5 DS purpose function-*fm*$_D$ of a terminal insertion device (part of an automatic assembly system for manufacturing electronic connectors, the block "gang insertion" refers to knowledge about physical structures that implement the functions, depicted in the oval nodes) (Deng, 2002)

3. Choosing functional decomposition-models: design knowledge employment and design objectives

Returning to the notion to discard a number of functional modeling approaches and settle for a single and common framework for functional modeling, here an alternative position is developed. I will argue that the choice for constructing particular models of functional decomposition (behavior function-fm_D 's, effect function-fm_D 's, or purpose function-fm_D 's) is based on their suitability for achieving particular design objectives. And that none of these three models alone is (best) suited for achieving the three considered objectives of innovative design, design analysis, and design-by-analogy. Given the suitability of particular models for particular objectives, one can both explain and defend the keeping of different models of functional decomposition side-by-side (and the approaches in which they are advanced) in engineering design.

Consider that, due to particular design objectives, particular design knowledge is or is not used in the construction of models of functional decomposition: construction of a model can be based on known function-structure connections for the functions in the model (DS), known behavior-structure relations that implement the functions in the model (FIL), or, instead, not based on such (types of) knowledge (FB). Precisely the type of design knowledge that is or is not employed, as due to design objectives, makes the models suitable for achieving the objectives for which they are advanced.

Consider FB-models that are used to support the objective of innovative design: relating goals to structures by fm_D 's without employing known function-structure connections or behavior-structure relations during construction of these fm_D 's. Since behavior and structure are not taken into account in the construction phase, behavior function-fm_D 's are suited for relating goals to structures since behavioral descriptions (which may include effects) are detailed enough to support the selection of structures after the model is constructed. Purpose function-fm_D 's and effect function-fm_D 's, instead, are too coarse-grained to allow the selection of structures in any precise way, when existing knowledge on behaviors and structures is not considered in the construction phase of such models. The use of such models, skipping reference to behaviors and effects in purpose function-fm_D 's and to behaviors in effect function-fm_D 's, does not give (in a precise manner) those structures that exercise certain behaviors, resulting in certain effects that are suitable to achieve the goals one wants realized. In the case of purpose function-fm_D 's, the designer may choose to select structures already known to him/her to achieve the purpose-functions in the model, but this changes the objective of innovative design into design-by-analogy (precisely the objective for which models of functional decomposition are employed in the DS approach). The use of effect function-fm_D 's to relate goals to structures, skipping reference to behaviors, also seem to provide insufficient precision for selecting (potentially innovative) structures that exercise behaviors which result in the effects desired (although more precision is gained than using purpose function-fm_D 's). For instance, a car's headlight effect-function "light on" may be sufficient to select well-known structures of an incandescent lamp or halogen one, but without a desired behavioral specification, the choice for, say, a more recent LED lamp (which differs in its behaviors by which the effect "light on" results) is not obvious (again the design objective would shift from innovation to analogy).

Now consider FIL-models that are used to support the objective of design analysis: relating goals (FIL-purposes) to behaviors (of structures) by fm_D 's that are constructed based on known (and required) behavior-structure relations of an existing design. Since behavior and structure are known, effect function-fm_D 's are suited for relating goals to behavior, since they allow verifying whether the behaviors exercised by structures display (in the intended fashion) the effects that are desired for contributing to the goals of the device. Using a purpose function-fm_D, instead, skipping reference to effects, does not give the precision to ascertain whether or not the desired effects are indeed manifested *in the intended way* by the behaviors of the device. For instance, the purpose function "illumination in a room" seems sufficient for determining whether the behavior of the device implements the effect-function “light on”. Yet, only an effect function-description, say “switch on-light on”, is suited for verifying whether the behavior of the device implements this effect in the intended way: say, the switch might be “off” while the light is still on. The device’s behavior, in this case, implements a desired effect but not in the intended fashion. This goes undetected with the purpose function-description “illumination in a room” (More elaborate behavior function-fm_D ‘s may also do the trick, but are unnecessarily complex in this setting).

Consider, finally, DS models that are used to support the objective of design-by-analogy: relating purposes to structures by fm_D ‘s that are constructed based on known (purpose) function-structure connections for the functions in the model. Since these connections are known, purpose function-fm_D ‘s are suited for directly relating purposes to structures. Constructing more elaborate behavior function-fm_D ‘s or effect function-fm_D ‘s is unnecessary for this objective, only adding additional complexity to the design task and decreasing efficiency (if, however, there are no structures available for the purpose functions, behavior function-fm_D ‘s or effect function-fm_D ‘s do become suited for relating purposes to structures. See, for instance, the use of effect-functions in the DS approach for relating purpose to behavior and then structure).

In sum, different models of functional decomposition are suited for different objectives (and as the “switch on-light on” example above shows, particular representational frameworks are suitable for particular objectives as well). Therefore, I submit that the co-existence of different approaches, advancing specific fm_D ‘s, has engineering value and is to be preferred above a single and common framework for functional modeling. A task remaining is then to relate different fm_D ‘s.

This step of relating different fm_D ‘s is developed in more detail in (Van Eck, 2010a,b). The idea behind it is that in order to relate behavior function-fm_D ‘s to effect function-fm_D ‘s or to purpose function-fm_D ‘s, the information expressed in the effect function-fm_D ‘s or purpose function-fm_D ‘s must be expanded in order to relate them to behavior function-fm_D ‘s. For instance, whereas an effect function-fm_D only represents desired outputs such as ‘producing torque’, a behavior function-fm_D contains more elaborate descriptions such as ‘conversions of electricity (input) into torque and heat (output)’. By expanding the desired effect (or purpose) descriptions with input and (other) effect descriptions (such as ‘electricity’ and ‘heat’), the descriptions become behavior-function descriptions that meet physical laws. Such descriptions are the ones advanced in behavior function-fm_D ‘s. By rephrasing effect-function (or purpose-function) descriptions as behavior-function descriptions by expanding them one can thus relate different fm_D ‘s. Vice versa, one can move from behavior function-fm_D ‘s to effect function-fm_D ‘s or purpose function-fm_D ‘s by selecting and describing only specific elements of behavior function-descriptions, namely their desired effects.

4. Concluding remarks

In this paper I have analyzed the use of different models of functional decomposition in engineering design. I considered models that refer to sets of desired behavior-functions, to sets of desired effect-functions, and ones that refer to sets of purpose-functions. It is shown that the choice for and suitability of particular models of functional decomposition depends on the design objectives for which these models are employed. Based on this result, it is concluded that the co-existence of different models has engineering value and is to be preferred above a single and common framework for functional modeling.

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Approach for Designing Elderly Care Homes

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Abstract

Most research has been unable to combine organisation, management and design studies. This seems a major shortcoming when looking at elderly care homes, because well-being in these institutions depends on all three approaches. Hence the aim of our research is to produce new knowledge on the interdependence of the three aspects. Special emphasis is put on planning processes. Numerous new buildings for the elderly will be planned in coming years and, at the same time, renovations of old buildings will be carried out. We will especially look at the design objectives for these undertakings.

This paper is about a work in progress by a team consisting of researchers and doctoral students in organisational and management studies at the University of Eastern Finland and design research at the Aalto University School of Art and Design. The four-year project started in 2009 and is funded by the Academy of Finland. Already in the early phase, the multidisciplinary team has produced inspiring new ideas.

One of the research methods has been to use photographic documentation of municipal and private elderly care homes. During visits to cares homes in North Karelia, systematic documentation was created. Selected photographs were, then, discussed by six focus groups representing various stakeholders. This research material, experiences and documentation of visits and sessions, was used to describe and analyse conditions and concrete product environments, in order to lead to better understanding, planning and organisation in the future. In this paper, the concept of homeliness is examined from a design point of view and as a part of well-being, based on empirical data and literature.

Keywords

Elderly care home, design, organization, homeliness, well-being

Our study conceives well-being as a process that starts from early conceptions of care in a design context and continues to evolve in the activities of care organisations in actual centres. Consequently, the embodiment of goals and values in design, organisation, and the actual environment is conceived as a process. A specific feature of our research is looking into the actual functions in care centres and collecting empirical data from various existing institutions. One of the case studies concerns small care homes, both private and municipal, in North Karelia; another case is situated in the Helsinki area. Interviews have been and will be carried out with elderly people, personnel, managers, designers, entrepreneurs, financial planning personnel, owners, municipal officials, the construction industry and other stakeholders. Data gathering methods include visits, documentation, focus group sessions and interviews. Environmental conditions, power structures, schedules and conflicting viewpoints in the care home practice will be brought to light in order to enable stakeholders to understand the processes and discuss their outcome.

The central concepts of the study are *well-being* and *homeliness*, which frequently appear in literature and various discourses (e.g. Cold; Lundgren; Wahl). These concepts have been and are still used as basic goals for organisation, leadership and design; in many countries, guidelines have been made for achieving these broad aims.[1] When looking more closely at the written research literature, documents, and the actual centres, it appears that these concepts are always used in some way. New technological applications may reduce homeliness while curtains may increase it. However, they seem too vague, unspecified or narrow for design purposes. According to the early results of our study, the actual care centres look very different even if research based recommendations and guidelines have been applied.

Photographic analyses

Our research has set out to look for all kinds of favourable qualities in existing care homes, as well as to identify and observe negative features by using various methods. One method is to analyse photographs. To do so, we set out to meet and converse with people who had different backgrounds and viewpoints in relation to care homes. To analyse and find out how the different stakeholders conceive of care homes, six focus groups were formed. In the summer of 2009, all in all 30 persons discussed photographs in groups of five: two groups of elderly persons inhabiting care homes, one group of personnel and entrepreneurs, and one group with experts in design. Design researchers, some of whom had experience of design research related to elderly care, formed a fifth focus group, and the sixth group comprised interior design students who were familiar with the design of care homes for the elderly.

The groups discussed photographs of four different private and municipal sites. The pictorial material for the sessions was selected from a vast amount of photographs taken systematically during 2008-2009 in North Karelia for the most part by two interior design students, led by Hannele Komu and Mirja Kälviäinen.[2] The same four spaces were chosen from each home: living room, dining room, toilet/bathroom and corridor. All spaces were semi-public. These were depicted in a total of 16 photos for the focus groups, each of which was led by one of the researchers in our group.[3]

[1] See Kälviäinen and Miller.
[2] They visited 17 care homes in 2008 and early 2009. Then, two researchers, Hannele Komu doctoral student who is well familiarized with the problematic of elderly care homes and Dr. Mirja Kälviäinen Senior Design Researcher from our research group visited the four selected care homes before the focus group sessions. The photographic material is supplemented during the whole research process.
[3] Before carrying out the group discussions, our group Rissanen et al. had planned the sessions and how to handle their outcomes.

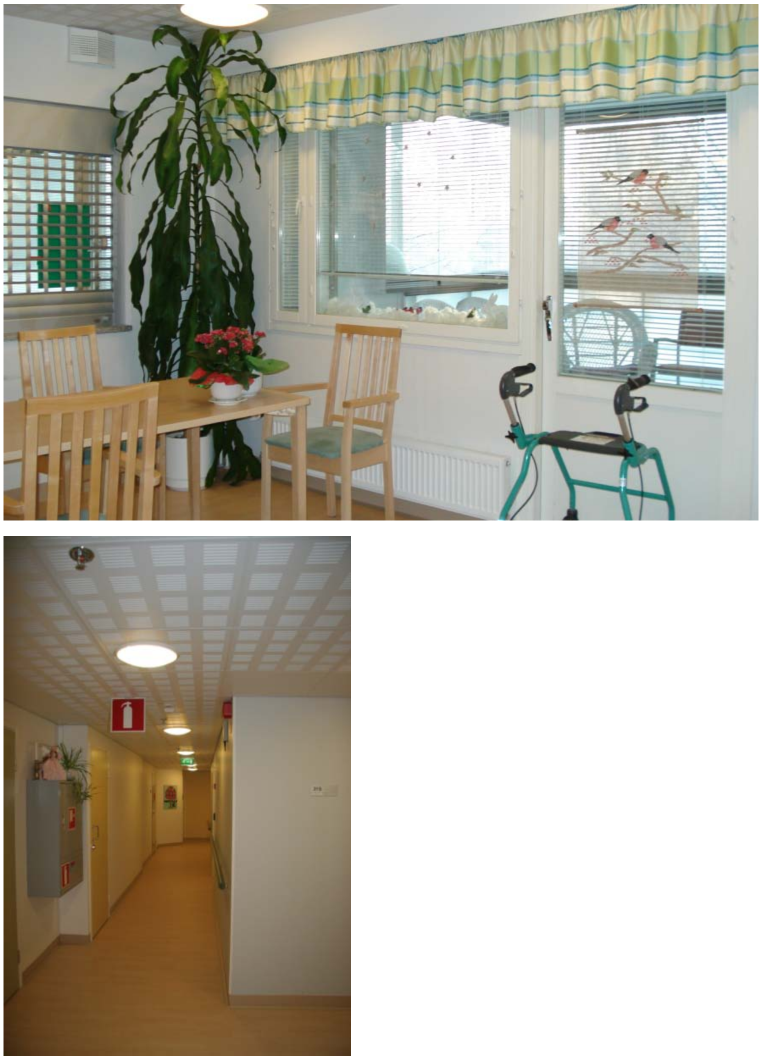

Figure 1. Three examples of photographic documentation of the care homes: a living room, a dining room, and a corridor.

Before the actual focus group sessions, the researchers discussed the difference between looking at pictures of spaces and actual visits. Clearly, a lot is left out of pictures, remaining outside of the frame, and the experiences differ in many important respects.[4] Yet many conclusions can be drawn on the basis of carefully taken and well-grounded photographs while being aware of the difference in experience and of the fact that a photograph is always an individual's personal view seen through a lens. The focus group sessions consisting of designers and personnel were well aware of this discrepancy.

For the group discussions, five introductory questions were formulated and agreed upon to help focus the topic of conversation and, for later research purposes, to help compare the different group sessions. The groups were asked to verbalise their impressions and thoughts of the

[4] Some of the features of experiencing real places, such as sound, smell, changing atmosphere, people's activities, etc., were documented during the many visits to the same centres. These aspects can be combined with the pictorial material thanks to the notes and dates, to provide a more comprehensive view.

spaces pictured in the photographs, and to indicate what they liked. They were also asked to think of what they would want to change. Lastly they were asked if they would like to live in the places pictured. The sessions ended with discussions on views and ideas about the topic and about elderly care homes in general. The discussions were recorded and transcribed. The material is being processed according to different points of view during the research.

Content analyses and design semiotics

To begin with, for the purpose of design research, I collected all the adjectives from the recordings of the group discussions. I also listed all the interior details mentioned and all descriptive nouns referring to spaces. All these words can signify positive or negative aspects in the discussions and can be checked later when necessary from the recording, where they are uttered in context. At this stage of my study the point was firstly to acquire an overview of all the possible aspects expressed with the adjectives mentioned (and later also to see what was left out). Secondly, the aim was to look closer at some of the salient qualities revealed by the material and then to compare the findings with results given in research literature, with our experiences of visits, with photographs of other care centres, etc. By clarifying the actual discourse in this way research results can support the design of the milieus.

Adjectives

The most frequently used adjectives (n=101) were without doubt *homelike* or *homely* (referring to *homeliness*), *messy*, *well-lit* and *institutional*. At this phase of the study it is not important to concern ourselves with the specific users of the words, because the aim is only to show the full variety of the adjectives and, then, to analyse why some of them appear more frequently than others.

The first one, homely, was probably popular because it relates to the public discourse of several recent years in Finland about institutional living in general. In actual fact, homeliness has been the prevalent goal lately. This goal has most likely spread to people's everyday discourses through its use in political discourse and the mass media – notably also to people other than the elderly. The aim highlighted by the national discourse has been to organise living and accommodation that is less institutional or clinical. But, without detailed or critical descriptions of this desired quality, the aim may fail. Naturally the concept also refers to the place where the elderly come from, their previous homes. These homes are places they have lost or gave up when they moved to the care centre. Their homes were created by them to a greater or lesser degree, and the elderly (perhaps also many other stakeholders) may have a tendency to compare the care centres with them. This is why it may be worthwhile to look into the respondents' personal histories and residences.

Despite the ensuing loss of concreteness, it seems important to focus on the central concept of homeliness and to analyse its potential meanings, even if they are often not well articulated in our verbalized data. With the help of content analysis (e.g. analyses of words in our data) and relate it to the photographs and research literature, we can specify and exemplify homeliness; we may concretize its meaning, and visualize and demonstrate it; we may compare different conceptions of it. In this way we can approach homeliness and achieve something that also concretely contributes to it, if it is the aim of the design and organization.

Possible references of the concept of homeliness (the many words and descriptions used to describe it) and its concrete embodiments (in the care centre setting) will be interpreted. Care home milieus will be conceived as semiotic signs (cf. Peirce) as referring to qualities and things.

Some of the frequently mentioned adjectives that can be construed to relate to homeliness and its positive connotations were *uncluttered* (as opposed to messy), *soft*, *cosy*, *spacious* and *colourful*.[5] These connections and relations will be further scrutinised, thematized and exemplified by design options.

However, at this stage of our research, the big underlying question remains: should homeliness be the general aim of design and organization? Or should the goal be formulated in another way by using more specified concepts or descriptive examples? If the actual references to homeliness seem too far-fetched, then heavy arguments can be made against using the concept at all. The concept often seems an empty slogan or too large an entity, which is tough to deal with. We can see this manifested in the actual institutions. Due to the vagueness of the concept, it may be that designers, entrepreneurs, personnel, etc. understand the term in their own ways and are not in fact discussing the same thing. They may also be unable to articulate it and identify its full potential.

Moreover, it may be useful to look at the most negative adjectives, which were often direct opposites of the positive ones. *Dark*, *colourless*, *narrow* and *cold* were among these. *Long* most often referred to a corridor and was given as a negative attribute. Long corridors (which actually are not very long at all) seem to emphasise uncertainty, anguish and impersonal features.

The range of adjectives was surprisingly large, at 101 words used during the sessions. It repeatedly included different shades of the same quality, e.g. dark, blackish, gloomy, murky, shady and sombre, or calm and restful.

Other descriptive wordings

All in all, 38 items from the interior spaces were mentioned in the six focus group discussions. The groups were not asked to list the depicted items in the rooms, but discussed characteristics by pointing out specific items as examples of what they meant. The items (words denoting objects depicted in the photographs) were therefore a part of either positive or negative comments and belonged to the more general discourse. Among the items were pieces of furniture, fixed interior details, vases and curtains, as well as collections of items. Our research will look into the policies of choosing and arranging these items. Who bought them and when, and who decorated each room?

In addition to the adjectives and list of items occurring in the discussions, I found 30 descriptive nouns that were used to illustrate the character of a space. Among these were common nouns related to the function of the room, such as *kitchen*, *corridor*, *hallway* or *toilet*. There were also many descriptive formulations such as *contemplation room, class room, cafeteria, flea market, nest*, *hotel*, etc. This approach to the data exemplifies people's awareness of the items and the overall quality of the product environments, as depicted in the photographs or as remembered. The photographs presented to the viewers visible existent items and their conditions, interior design, colours, materials, etc. At the same time the items and their placements connoted attitudes, habits and possibilities for various activities. We can clearly identify what is impossible or not allowed, and argue about the justifications and reasons of this. These aspects will be included in the next step, the semiotic analysis, where the reference relations of items will be interpreted in use in actual care homes, supported by photographic and other documentation.

A design semiotic analysis will demonstrate *how* various meanings are embodied in care home environments, especially in the semi-public areas. Items in a room embody specific styles; they

[5] With the help of the transcripts we can check the context or topic in which each adjective is used, and also link them to the photographs, and to the actual centres.

refer to similar forms in other contexts; they point at production methods and their origins. They function as metaphors that may also unconsciously connote emotions and moods, traditions and habits, ideologies and beliefs. Items function as symbols whose content should be carefully interpreted by all parties. These connotations are crucial in a multicultural setting.

For the designer, metonymic relations are also important. This means that items affect our interpretations based on their proximity in the space. Qualities can be transferred from one item to another nearby one. The metonymic aspect is not often made explicit in the planning process or in actual design solutions. Metonymic relations analysis is one way of demonstrating how concrete manifestations of the organisation and management function. By studying items' relations in office spaces, entrances, corridors, layouts, information systems, schedules, meetings, etc. the character of the arrangements can be illustrated. Our research will point out metonymies, which can or should be changed to better serve the aims of the care home.

A new home or something else?

Moving into a care centre signifies a change into another form of living: from a private home to a collective dwelling. The move includes crucial changes in the lives of the elderly, to fixed schedules, unfamiliar faces and contacts, unexpected meetings with strangers, smaller private areas, limited age variation in human contacts, diminished areas for own activities and initiatives, etc. Such major changes can easily also narrow the conception of the *homely*. Should, then, the institutions be called homes or something else? We have not yet answered this question. In any case, the goals for this new form of living should be formulated in a motivating and supportive manner for the benefit of the elderly, the personnel (including managers), friends and relatives. *Homeliness* may include many of the necessary qualities. But, what are they? For an answer, the concept must first be analysed together with the other important requirements. A hierarchy of the necessary qualities can perhaps be construed to permit the use of the concept homeliness.

Our research will produce new information with regard to the organisation and design of care homes based on empirical data and on literature. The content and formulations of guidelines and recommendations produced in Denmark, Norway, Sweden, the UK, and the US will also be analysed. This is a work in progress, and it is still too early to present well-reasoned findings. However, it seems apparent to me that care homes share the typical characteristics of all kinds of institutional living and accommodation. Standards and recommendations are important to follow, but what matters are their formulation, style and signification to the stakeholders. Do they inspire designers to develop new forms and create novel solutions to some of the routines that again and again seem to bother the stakeholders and, in fact, reinforce the negative aspects of these institutions?

The results of our study may be helpful for other institutional accommodation programmes and renovations, too. Moreover, in our prior studies we have found similar features and difficulties outside of Finland, in other European countries.

Furthermore, new kinds of communication tools are needed for designers, staff, relatives, visitors, the elderly and other to continuously follow the processes in practice and to understand the point of view of the different stakeholders. The care centres are living areas, social semi-public spaces, workplaces, communal institutions and private enterprises. All these aspects reflect the attitudes of people and the society towards the culture of ageing, and are manifested in the concrete care homes and their organisations.

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L'Utilisation du Geste dans des Réunions de Conception Architecturale

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Résumé

L'importance de l'utilisation, dans l'interaction humaine, d'autres modalités d'expression et de représentation que l'audible (le "verbal") a été reconnue largement dans le domaine du *cognitive design research*. A quelques exceptions près, ce n'est toutefois que le graphique qui a fait l'objet d'études en tant que modalité d'expression et de représentation visibles (le "non verbal").

L'objectif à long terme de notre recherche est de déterminer la contribution relative de chacun des différents systèmes sémiotiques (verbal, graphique, gestuel et autres modalités d'expression et de représentation visibles) et leur articulation dans l'interaction entre des personnes dans des situations de collaboration. Dans ce texte, nous nous focalisons sur l'utilisation du geste dans la conception collaborative. Pour analyser celui-ci, nous avons conduit deux études empiriques basées sur des enregistrements vidéo de réunions de conception architecturale.

C'était sur la base de données verbales et, dans une moindre mesure, graphiques, que nous avions élaboré notre approche de la conception (Visser, 2006). Nos analyses antérieures de la conception collaborative avaient conduit à y distinguer deux grandes familles d'activités, représentationnelles et organisationnelles.

Dans nos travaux sur l'utilisation de gestes dans des réunions de conception architecturale, nous avons retrouvé ces deux types de fonctions. En effet, les gestes y contribuent également à la construction de la représentation de l'artefact et à l'organisation des activités de conception et de l'interaction. L'analyse présentée ici montre en plus qu'ils le font d'au moins deux manières: dans une combinaison intégrée avec la parole ou de façon autonome, c'est-à-dire sans coexpression verbale.

Mots-clés

gestes; interaction multimodale; conception collaborative; représentation; cognitive design research; architecture

Abstract

The importance of the use, in human interaction, of other modes of expression and representation than the audible (the "verbal") has been widely recognised in the field of cognitive design research. With few exceptions, however, the graphic mode has been studied as *the* expression and representation modality of the visible (the "nonverbal").

The long-term goal of our research is to determine the relative contribution of each of the different semiotic systems (verbal, graphic, gestural and other modes of visible expression and representation) and their articulation in the interaction between people collaborating on a task. In this text, we focus on the use of gesture in collaborative design. Therefore, we conducted two empirical studies based on video data collected in architectural design meetings.

It was based on verbal, and to a lesser extent graphic data that we developed our vision of design as the construction of representations (Visser, 2006). Our previous analyses of collaborative design led to distinguish two main families of activities, representational and organisational.

In our work on the use of gestures in architectural design meetings, we found again these two types of functions. Indeed, gestures contribute both to the construction of the representation of the artefact and to the organisation of the design activities and of the interaction. The analysis presented here shows in addition that gesture does so in at least two ways: in an integrated combination with speech or independently, that is, without verbal coexpression.

Keywords

gesture; multimodal interaction; collaborative design; representation; cognitive design research; architecture

L'importance de l'utilisation d'autres modalités d'expression et de représentation que l'audible (le "verbal") a été reconnue largement dans des études sur la conception dans le domaine du cognitive design research (domaine qui englobe, mais dépasse celui de l'ergonomie cognitive de la conception). A quelques exceptions près, ce n'est toutefois que le graphique qui a fait l'objet d'études en tant que modalité d'expression et de représentation visibles (le "non verbal"). L'utilisation du geste a été peu examinée dans ce contexte (encore moins l'ont été des modalités comme le paraverbal, le regard, la posture ou les mimiques; dans Visser, 2010a, nous avons commencé l'analyse du regard et de la posture dans une réunion de conception de logiciel). Il est pourtant connu aujourd'hui dans le domaine de la pragmatique interactionnelle que les gestes jouent un rôle essentiel dans la communication, l'interaction et la collaboration.

L'objectif à long terme de nos recherches est de déterminer la contribution relative de chacun des différents systèmes sémiotiques (verbal, graphique, gestuel et autres modalités d'expression et de représentation visibles) et leur articulation dans l'interaction entre des personnes dans des situations de collaboration. Dans ce texte, nous nous focalisons sur les gestes dans la conception collaborative. Pour l'analyse, nous utilisons des données vidéo recueillies dans des réunions de travail entre architectes, travaillant en face à face et colocalisés (réunions en présence ou "en présentiel"). A partir d'exemples tirés de ces réunions, nous illustrons les fonctions et types de gestes, les différentes formes qu'ils peuvent prendre et les différentes manières dont ils s'articulent avec le verbal.

"Gestes". Les gestes que nous analysons sont des "gestes" dans un sens restreint: il s'agit de mouvements des mains et des bras qui sont accompagnés de parole—même si ce n'est pas toujours au moment même— et qui sont coexpressifs avec celle-ci (notez que, plutôt qu'une simple description, ceci est une position théorique, formulée et défendue par McNeill, 2005).

Organisation du texte. Après une section présentant des analyses du geste dans la conception collaborative effectuées dans des études antérieures, nous présentons les différents types de gestes que nous avons identifiés, prolongeant nos analyses effectuées précédemment sur la fonction des gestes dans la conception collaborative. Dans la troisième section, nous présentons les différentes formes d'articulation de gestes et verbal, aspect que nous abordons ici pour la première fois. Dans la Conclusion, nous formulerons surtout des questions évoquées par notre étude.

L'utilisation du geste dans la conception collaborative: études antérieures

Des études sur la communication et l'expression humaines ont montré que l'on n'utilise pas seulement des gestes dans des situations où l'on est face à face avec d'autres personnes ou visible par elles. On en utilise, par exemple, également au téléphone (Bavelas, Gerwing, Sutton, & Prevost, 2008); des personnes malvoyants font aussi des gestes (Iverson & Goldin-Meadow, 1997). Ici nous ne nous intéressons toutefois qu'aux gestes utilisés dans l'interaction avec d'autres, dans des réunions de travail en conception.

En comparaison avec l'interaction verbale ou graphique, l'utilisation de gestes dans la conception collaborative a été peu examinée. Dans l'une des premières études sur la conception collaborative (conception d'un combiné de commande à distance), Tang (1991) note que l'expression de nouvelles idées se fait autant de façon gestuelle que graphique ou écrite. Cependant, les gestes jouent un rôle particulièrement important dans la gestion de l'interaction: plus de la moitié des gestes ont cette fonction.

Bekker, Olson et Olson (1995) (conception d'un bureau de poste automatisé) observent des gestes de caractère spatial (pour indiquer la taille, l'emplacement ou la distance). Ils remarquent, par ailleurs, que l'utilisation de gestes peut servir, à côté de la conception proprement dite, la gestion et la régulation de la conversation en général.

Dans son étude portant sur une équipe d'architectes, Murphy (2005) analyse l'activité de ces concepteurs en termes d'"imagination collaborative". Les architectes observés utilisent des gestes pour imaginer des caractéristiques des entités de conception (leurs mouvement, structure et fonctionnement) et des expériences d'utilisateurs (actions que ces derniers produisent sur les entités de conception).

Parmi les fonctions des gestes identifiées par ces auteurs, nous voulons souligner les deux que nous avons également identifiées comme importantes dans nos analyses. (1) Le geste offre des possibilités spécifiques pour, d'une part, exprimer des qualités spatiales et des qualités ayant un rapport avec le mouvement de l'artefact et, d'autre part, représenter des séquences d'action à travers la simulation mimée de celles-ci. (2) Le geste a un rôle organisationnel important dans l'interaction.

C'est dans deux études empiriques sur des projets architecturaux que nous avons commencé l'analyse du geste. Il s'est agi de deux réunions dans des étapes amont des projets en question.

Dans une première étude, nous nous sommes restreintes, quant au geste, au dessin virtuel que les concepteurs peuvent effectuer en gesticulant avec une main ou un stylo sur des représentations externes, notamment des plans et des calques (Détienne & Visser, 2006; Détienne, Visser, & Tabary, 2006; Traverso & Visser, 2009; Visser & Détienne, 2005).

Sur le deuxième corpus (données DTRS7[1]), nous avons analysé les gestes en cherchant d'abord à identifier leur fonction dans le processus de conception collaborative. En accord avec nos travaux antérieurs, nous avons pu diviser les gestes en deux grandes familles, gestes représentationnels et gestes organisationnels (Visser, 2009). Dans un second temps, nous avons analysé la relation entre la fonction et la forme physique des gestes. Nous avons conclu que cette relation n'est pas systématique: des gestes ayant une fonction identique n'ont pas toujours la même forme, et des gestes ayant la même forme n'ont pas invariablement la même fonction (Visser, 2010b). Dans ce texte, nous ne reviendrons pas sur les liens entre la fonction et la forme physique des gestes.

Pour les analyses présentées dans ce texte, nous avons repris le deuxième corpus, qui concerne un projet de conception d'un crématorium. Par rapport aux analyses effectuées précédemment sur ce corpus (Visser, 2009, 2010b), nous avons effectué, d'une part, une analyse fonctionnelle plus poussée des gestes représentationnels et organisationnels identifiés jusqu'ici. D'autre part, nous avons procédé à une analyse des gestes sur une nouvelle dimension, à savoir, leur articulation avec le verbal (analyse structurelle).

Deux types de gestes: représentationnels et organisationnels (analyse fonctionnelle)

D'un point de vue théorique, nous analysons la conception en termes de construction de représentations (Visser, 2006). Le modèle classique en *cognitive design research*, hérité de Simon (1969/1996), analyse la conception comme une activité de résolution de problèmes—ce que la conception est en effet, d'un point de vue formel. Toutefois, une vision et analyse de la conception en termes de construction de représentations permettent, à notre avis, de mieux rendre compte de la richesse des activités et structures mises en œuvre dans la conception.

[1] Ces données proviennent du "*DTRS7 dataset*" (P. Lloyd, J. McDonnell, F. Reid and R. Luck, 2007), un ensemble de données mises à la disposition des participants au 7[ième] Design Thinking Research Symposium (McDonnell, Lloyd, Luck, & Reid, 2009). Ces données ne sont pas publiquement disponibles. Nous remercions les participants à la réunion de nous avoir permis de les filmer et d'analyser leur activité.

C'est sur la base de données verbales et, dans une moindre mesure, graphiques, que nous avions élaboré notre approche de la conception. Nos analyses de la conception collaborative avaient conduit à y distinguer deux grandes familles d'activités, représentationnelles et organisationnelles. Comme noté ci-dessus, nous avons retrouvé ces deux types de fonctions dans nos travaux sur l'utilisation des gestes dans des réunions de conception architecturale. En effet, nous avons observé que les gestes peuvent, d'une part, contribuer à la construction de la représentation de l'artefact (désignation et spécification d'entités de conception) et, d'autre part, avoir une fonction organisationnelle (organisation des activités de conception et organisation de l'interaction).

Dans ce qui suit, nous détaillons ces différentes fonctions des gestes.

Construire une représentation de l'artefact à travers des gestes

L'utilisation de gestes pour la construction d'une représentation de l'artefact peut prendre des formes diverses, en ce qui concerne leurs fonction, forme physique et mode de production et les types d'attributs de l'artefact exprimés gestuellement.

Représentation d'attributs spatiaux de l'artefact. Comme nous avons souligné dans la présentation des études antérieures, les gestes se prêtent particulièrement bien à l'expression d'attributs spatiaux de l'artefact, liés à des caractéristiques spatiales (notamment 3D), au mouvement de l'artefact ou à son utilisation dans l'espace. Ainsi, les dimensions de l'artefact ou de parties de celui-ci sont spécifiées souvent de façon gestuelle. Tant qu'il s'agit de dimensions précises, ce type d'attributs se laisse bien indiquer de façon verbale ("… 57,8 cm.…") ou graphique. Dès qu'il s'agit, cependant, d'approximations ou d'éléments flous, le geste permet plus facilement de "donner une idée" qu'une expression verbale (cf. aussi toute la littérature sur les difficultés de l'utilisation des systèmes de CAD ou autres qui demandent une expression précise de l'élément spécifié; cf., par ailleurs, l'ambiguïté possible de gestes, v., par exemple, Streeck, 2009, p. 2, Note 1).

Représentation de la référence du discours. Le caractère spatial est aussi particulièrement présent dans de nombreux gestes qui permettent d'indiquer la référence du discours, le "ce dont on 'parle'". Cette référence est, en effet, souvent de nature spatiale, un objet sur le plan ou un objet dans le bâtiment. Par exemple, Adam, le concepteur principal dans la réunion analysée, disant "you've still got another toilet there" ("vous avez là encore une autre toilette"; AM1, 699, Ad[2]), indique, en pointant d'un doigt, un espace sur l'un des plans qu'il a faits et apportés à la réunion avec ses deux clients (un geste "déictique").

Caractère plus ou moins circonscrit de l'entité représentée. La référence du discours peut être assez bien circonscrite (comme dans l'exemple donné ci-dessus), comme elle peut être plutôt globale. En tant que cliente dans la réunion analysée, Anna dit qu'elle aimerait consulter des utilisateurs (des entrepreneurs de pompes funèbres et, surtout, des personnes qui portent le cercueil). Adam demande "can we do that soon because the idea of this meeting is for me to go away with what I can knowing how to rev up the design to get it into planning?" ("est-ce que nous pouvons faire ça rapidement car pour moi l'idée de cette réunion est d'en partir avec tout ce qui est possible en sachant comment je peux monter en régime le projet pour passer à la planification?"; AM1, 1204-1206, Ad). En disant cela, il passe avec sa main droite ouverte, doigts étendus, au-dessus du plan, qui représente, dans ce cas, le projet global (v. Figure 1, page suivante).

Caractère plus ou moins concret de l'entité représentée. L'entité représentée peut être plus ou moins concrète. Dans l'exemple que nous venons de donner, elle était quelque peu abstraite: "le projet". Un autre exemple de référence abstraite, de nature bien différente est un simple "ceci" renvoyant à une partie du discours énoncée préalablement dans laquelle une entité complexe a été élaborée à l'aide d'un geste. Ce "ceci" est accompagné maintenant du même geste, de sorte que

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[2] Les extraits du corpus sont pourvus du code de la réunion ("AM1" correspondant à la première réunion de conception architecturale), la ligne dans la transcription et le code du concepteur ("Ad" = Adam; "An" = Anna; "Ch" = Charles).

seuls les participants ayant été présents à la création du geste peuvent le comprendre (v. Becvar, Hollan, & Hutchins, 2008).

Figure 1 "Couverture" du projet global

Caractère plus ou moins statique de l'entité représentée. A côté de telles entités "statiques", il y a des entités "mobiles". Ainsi, des mouvements, des déplacements, des itinéraires et des indications de direction sont souvent spécifiés gestuellement. Ce type d'attributs de l'artefact est d'ailleurs difficile à signifier sans faire appel à des gestes. Par exemple, décrivant les trois parcours différents qu'il envisage pour pouvoir entrer dans le bâtiment, Adam les trace d'un doigt (geste "déictique" ET "iconique"). Figure 2 montre quatre moments dans la description du deuxième parcours: "the second route is round the end of the pond" ("le deuxième parcours contourne l'étang à son extrémité"; AM1, 1134-1136, Ad).

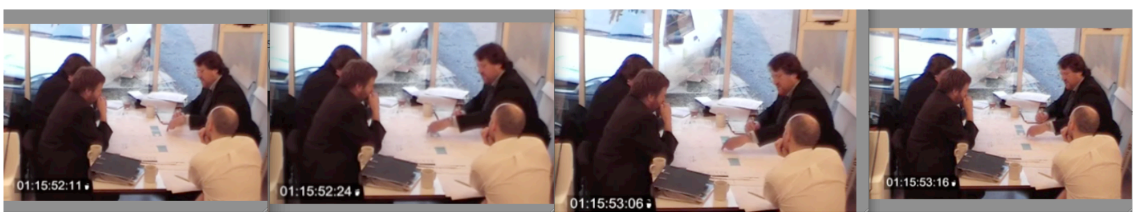

Figure 2 Traçage d'un parcours

Caractère métaphorique de la représentation. D'autres exemples d'attributs abstraits que ceux présentés plus haut sont des qualités de l'artefact liées à l'atmosphère que celui-ci dégage. Ainsi, Adam utilise des gestes pour traduire des qualités du bâtiment comme, par exemple, "intime", "audacieux", "privé" ou "calme". Il s'agit de gestes dont l'expression a un caractère métaphorique. Ainsi, afin de qualifier un espace comme "intime", le concepteur enclot avec ses deux mains un espace, comme un adulte qui entoure de ses bras un enfant. La métaphore conceptuelle que le concepteur semble adopter est celle de "l'intimité est un espace clos, protecteur".

Charles, l'autre client dans la réunion, affirme que, pour passer l'étang, il faudrait "something that’s solid" ("quelque chose de résistant"; AM1, 1178-1179, Ch). Il indique cette "quelque chose" en traçant avec sa main droite une surface qui peut supporter des poids, en faisant la traversée de l'eau au-dessus de la représentation de celle-ci sur le plan (v. Figure 3, page suivante). Ce geste combine des caractéristiques iconiques (un objet qui traverse l'eau) et métaphoriques ("quelque chose de résistant").

Différentes techniques de représentation. Les concepteurs utilisent différentes techniques de représentation dans l'expression par geste. Pour exprimer, par exemple, la forme de l'artefact, un concepteur peut dépeindre celui-ci en deux dimensions (en le dessinant avec un doigt et/ou en en traçant les contours), le modeler (en en faisant un modèle en 3D en le "sculptant" avec une partie de son corps—doigts, main, bras) ou encore en jouer l'utilisation (comme dans une pantomime) (Kendon, 2004).

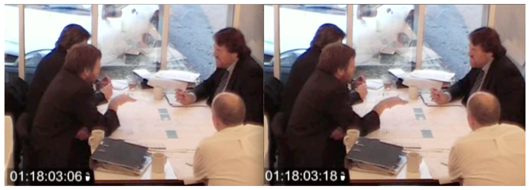

Figure 3 Expression iconique-métaphorique de "quelque chose de résistant" pour passer l'eau

Typologies classiques de gestes. Dans la littérature sur les gestes, de nombreux auteurs ont proposé des typologies et classifications. Un schéma de classification, proposé par McNeill (1992) et repris souvent par la suite distingue "déictiques", "iconiques", "métaphoriques" et "bâtons" (v. ci-dessous, pour un exemple de ces derniers). En dehors de son schéma, McNeill (1992) cite aussi les "emblèmes" (v., ci-dessous, l'exemple de "Stop!"). La classification de McNeill (1992) est utilisée beaucoup dans des études IHM, mais est souvent abandonnée par des chercheurs analysant la richesse des gestes que les personnes font dans des situations de la vie courante, car ces distinctions absolues sont souvent inappropriées. On a vu déjà qu'un geste représentationnel peut être "déictique" ET "iconique". Par ailleurs—comme on l'a montré également—de nombreux gestes représentationnels ne sont pas clairement "iconiques" OU "métaphoriques". Un autre exemple en est donné par Adam quand il dit, d'un espace où les voitures avec les cercueils arrivent, "this is all again under a roof" ("tout ceci est de nouveau sous un toit"; AM1, 1211-1212, Ad) et fait, avec sa main gauche, un geste qui couvre l'espace en question. Il ne représente pas de façon "fidèle" un toit: son geste exprime qu'il y a "quelque chose" qui est "au-dessus" d'un espace et qui "couvre" celui-ci (v. Figure 4).

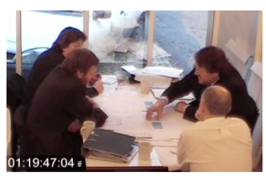

Figure 4 "Couverture" d'un espace par un toit

Organiser la réunion à travers des gestes

L'utilisation de gestes organisationnels peut également prendre de nombreuses formes. Il s'agit de gestes qui contribuent à la gestion de l'interaction (les gestes "interactifs," v. Bavelas, Chovil, Lawrie, & Wade, 1992) et à l'organisation des actions de conception fonctionnelles (la "conception" à proprement parler). Les trois participants font usage de gestes organisationnels (mais v. ci-dessous, notre observation au sujet du caractère idiosyncrasique de l'utilisation de gestes). Pour interrompre les autres et/ou attirer leur attention, ils font, par exemple, le geste "Stop!" ("emblème") en ouvrant la main avec sa palme parallèle au corps, l'ouverture vers le(s) interlocuteur(s).

Un autre exemple sont des gestes qui modulent le discours. Concernant ces gestes en particulier, le corpus de la réunion montre dans quelle mesure l'utilisation de gestes a des caractéristiques idiosyncrasiques[3]. Anna est bien plus expressive que les deux autres participants à la réunion. Souvent elle module son discours de manière particulièrement forte en soulignant ses mots de nombreux gestes bien appuyés. Par exemple, elle ouvre ses deux mains et les étale en face d'elle,

[3] Un autre exemple du caractère idiosyncrasique de l'expression gestuelle se trouve dans la réunion analysée dans la première étude, où l'un des trois concepteurs ne "dessine" que gestuellement: l'architecte en question fait seulement du "dessin virtuel".

disant "so I’ve sent off for [that book] but you try and get them to raise a SAP order for it and you get how often will we need the Spire books company" ("j'ai donc fait chercher [ce bouquin] mais tu as beau essayer de les faire passer une commande SAP[4], tu reçois en réponse avec quelle fréquence on aura besoin de la maison d'édition Spire"; AM1, 39-41, An) (v. Figure 5).

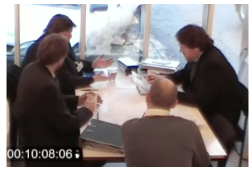

Figure 5 Modulation gestuelle du discours

Bavelas et al. (1992) qualifient ce type de geste interactif de "geste de partage d'information" (dans la classification de McNeill, 1992, ce type de geste est qualifié de "bâton"). Ici, Anna ne partage pas tant une information factuelle que son émotion (irritation) au sujet de celle-ci. Bavelas paraphrase ce geste de "comme vous savez!"—mais les deux autres participants à la réunion ne savent probablement pas autant qu'Anna combien "l'administration" peut vous freiner dans de "simples" commandes.

Deux formes d'articulation de gestes et verbal: intégration ou autonomie (analyse structurelle)

Les gestes peuvent donc contribuer à la construction de la représentation de l'artefact et à l'organisation de la réunion. Par rapport au verbal, ils font cela de plusieurs manières: dans une combinaison intégrée avec la parole ou de façon autonome, c'est-à-dire sans qu'il y ait une contribution verbale.

Les gestes présentés ci-dessus étaient presque tous intégrés avec la parole. Nous avons identifié peu de véritables gestes "autonomes". Un geste interactif comme "Stop!" décrit ci-dessus en est toutefois un exemple.

Caractère plus ou moins concomitant de gestes et parole intégrés. Même si gestes et parole sont intégrés, les deux ne sont pas systématiquement réalisés en même temps. Les gestes sont, en général, suivis, et ceci dans un délai plus ou moins bref, par leur coexpression verbale. Un exemple d'un geste qui précède nettement sa coexpression verbale est le suivant. A un certain moment, Adam tente de qualifier le sanctuaire et n'y arrive pas immédiatement. On voit qu'il cherche (décrire comment on voit cela reste à faire). Ne disant que "it just" ("ça a juste"; AM1, 337, Ad), il ouvre ses deux mains, quelque peu en ovales, paumes l'un orienté vers l'autre, bougeant un peu ces mains de haut en bas, comme tenant—ou formant—dans ses mains un ballon de football americain et le remuant; il reste silencieux quelques secondes et dit ensuite "yeah I felt that architecturally it needed to be a great deal more bold to make a statement about it being a very important" ("ouais je sentais que d'un point de vue architectural ça devait être bien plus audacieux pour faire une affirmation concernant le fait qu'il soit très important"; AM1, 337-338, Ad) (v. Figure 6, page suivante). Déjà auparavant, Adam avait utilisé le geste en question pour exprimer le caractère audacieux du sanctuaire.

La représentation de ce type d'attribut abstrait semble difficile à effectuer verbalement. On a présenté ci-dessus déjà l'utilisation d'une métaphore pour son expression. La difficulté de celle-ci permet d'expliquer que le concepteur y a recours en premier et/ou plus aisément par rapport au verbal. Anna, de son côté, ne sait dire, en réaction à Adam, que "yeah wasn’t enough" ("ouais [ce] n'était pas

[4] Une commande SAP est basée sur une certaine méthode de gestion d'entreprise.

suffisant"; AM1, 334, An)—et elle, bien que particulièrement expressive en général, ne fait ici aucun geste.

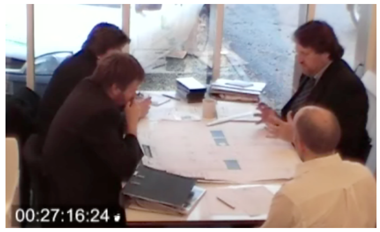

Figure 6 Geste précédant l'expression verbale.
Expression métaphorique du caractère "audacieux" du sanctuaire

Différents types de relations entre gestes et parole intégrés. Même si un geste est fait de façon intégrée avec la parole, son apport peut avoir différents types de liens avec le verbal. Parfois, le geste semble fournir une expression parallèle à ce qui est exprimé en mots. D'autres fois, le gestuel raffine, nuance, précise ou restreint ce qui est exprimé verbalement. D'autres fois encore, il fait le contraire: il est global tandis que la parole circonscrit la chose. Il peut aussi présenter des aspects qui ne sont pas présents dans l'énoncé verbal (Kendon, 2004, p. 161).

Conclusion

Le Tableau 1 présente un résumé de nos résultats.

<table>
<tr><td colspan="5">caractéristiques des gestes au plan fonctionnel</td><td rowspan="3">caractéristiques des gestes au plan structurel:

articulation entre gestes et verbal</td></tr>
<tr><td colspan="4">fonction</td><td rowspan="2">réalisation</td></tr>
<tr><td colspan="2">représentationnelle</td><td colspan="2">organisationnelle</td></tr>
<tr><td>désigner (des parties de) l'artefact</td><td>spécifier des attributs de (parties de) l'artefact associés à

- des qualités spatiales
- l'utilisation
- l'atmosphère
- d'autres caractéristiques

de l'artefact</td><td rowspan="2">organiser les activités de conception</td><td rowspan="2">organiser l'interaction</td><td rowspan="2">techniques de représentation

- représentation en deux dimensions
- représentation en trois dimensions
- représentation à travers l'utilisation de l'artefact
- représentation métaphorique</td><td rowspan="2">- intégration des deux
- autonomie
-- geste sans accompagnement verbal
-- parole sans accompagnement gestuel</td></tr>
<tr><td colspan="2">conduisant à des entités plus ou moins
- circonscrites
- concrètes
- statiques</td></tr>
</table>

Tableau 1 Résultats de l'étude

Notre étude, exploratoire et descriptive, apporte donc de nombreuses données. Elle évoque aussi de nombreuses questions. C'est sur ces questions que nous centrons cette conclusion.

On aimerait savoir comment l'utilisation de gestes influence le processus de collaboration. Cette question nécessiterait des études dans lesquelles on aurait, au moins, deux conditions: collaboration avec et collaboration sans accès au geste—et éventuellement au regard et à d'autres modalités d'expression (cf. les différentes études effectuées par Perron et par Lefebvre, présentées dans Lefebvre, Perron, & Pauchet, 2007; Perron, 2005).

Nos données proviennent de réunions professionnelles entre architectes, travaillant en face à face et colocalisés. Pendant ces réunions, les concepteurs utilisent des plans en papier qu'ils modifient et ils font des croquis sur du papier-calque (les plans "définitifs" sont faits avec des systèmes de DAO, hors réunion). De telles données peuvent inspirer des idées quant à l'utilisation du geste dans des situations de travail collectif à distance où la communication est médiée par l'intermédiaire de systèmes informatiques. Elles montrent, par exemple, que les gestes sont fréquents et ont de nombreuses fonctions différentes. Elles montrent aussi que les gestes ne constituent pas simplement des "illustrations" de ce qui est dit et "dont on pourrait se passer". Il est possible de formuler des hypothèses prédisant des gestes particulièrement utiles (ou fréquemment utilisés), ou même indispensables. Toutefois, la spécification de systèmes informatiques pouvant "médier" dans des situations de collaboration à distance (des systèmes de Travail Coopératif Assisté par Ordinateur, ou, plus généralement, des systèmes de Communication Médiée par Ordinateur) demande, à notre avis, des études spécifiquement dédiées à cette question.

Notre étude ne permet pas d'affirmer que certains types d'attributs s'expriment mieux ou de façon privilégiée de façon gestuelle plutôt qu'en utilisant un autre système sémiotique (verbal, graphique). Nous faisons toutefois l'hypothèse que l'expression de tout ce qui est dynamique, mobile (par exemple, des itinéraires, ou plus généralement, l'utilisation de l'artefact) se fait de façon plus aisée par des gestes que verbalement—et que cet "avantage" vaut aussi bien pour l'expression que pour la compréhension. Nous conjecturons aussi que les gestes constituent un système privilégié pour l'expression de certains attributs abstraits—tels que l'atmosphère que l'artefact dégage.

Une autre question concerne l'influence de la langue, et plus largement de la culture des concepteurs. De plus en plus d'entreprises sont le résultat d'une collaboration internationale et leurs projets de conception font appel à des équipes interculturelles (dans l'automobile, par exemple, France et Japon; dans l'industrie aéronautique et spatiale, par exemple, France, Allemagne et Espagne). Dans la réunion analysée, les trois participants sont anglais, mais, "naïvement", on peut noter des différences importantes dans la gestualité entre les trois qui ne semblent pas uniquement idiosyncrasiques (cf. la Note 3). On peut faire des hypothèses "préscientifiques" sur l'origine de ces différences; les conceptualiser et opérationnaliser pour pouvoir les examiner reste toutefois une autre affaire!

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Biographie de l'Auteure

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Chercheuse en psychologie cognitive à l'INRIA (Institut National de Recherche en Informatique et Automatique), Willemien Visser travaille au CNRS (LTCI, Laboratoire commun en Traitement et Communication de l'Information, Télécom ParisTech). Spécialiste reconnue dans le domaine du *cognitive design research*, elle présente, dans son livre *The Cognitive Artifacts of Designing*, d'une part, une revue critique de la recherche effectuée depuis les quelque 25 ans qu'elle travaille dans ce domaine et, d'autre part, sa propre vision de la conception comme une activité de construction de représentations. Ses recherches actuelles portent sur l'interaction multimodale entre personnes ayant des activités collaboratives, notamment sur l'articulation entre les différents systèmes sémiotiques auxquels ils font appel, en ce qui concerne leur rôle et contribution respectifs.

Designing a design competition: the client perspective

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Abstract

Design competitions are part of the design tradition since ages. Still structured empirical research about this topic is lacking. This paper describes the results of six months participatory observation as a member of a project team responsible for the organization of an international ideas competition. The data include observations, interviews and document analysis. The results for this paper focus on the design of the competition and stakeholder participation from a client perspective. The findings show four combinations of aspects that underlie several problems of design competitions as currently perceived by architectural practice: the dynamics of the brief, the balance between professionalism and ambition, the link between participation and competition aims, and the influence of expertise at client obligations. It is this constant search for a balance between ambitions, aims, opportunities and needs that make clients experience numerous difficulties during the design of a competition. It is however the same search that makes every competition unique and a wealth of information about clients and architectural design.

Keywords

architecture; case study; client; design competition; management; participation

Starting at the latest with the Greeks, competitions have traditionally been a vehicle for the creation of major civic buildings and public spaces, such as government buildings, performing art centres, educational facilities, public libraries, museums and housing (Strong, 1976). The purposes of design competitions are several fold (de Haan & Haagsma, 1988; Larson, 1994; Spreiregen, 1979): disclose new talent, challenge 'convential wisdom', create a dialogue on design, enlarge support, increase competition, select an architect, educate students, gain insight in competences, contribute to the cultural dimension of the built environment and expand the boundaries of design. Svensson (2008) adds the aims of marketing a project, assuring quality through jury assessment, running architecture politics and coordinating different fields of interests. Information on both past and recent design competitions is fragmented, inadequate and frequently unrecorded (Lipstadt, 2005). Still design competitions are considered as a treasury of the profession (de Haan & Haagsma, 1988). The relevance of design competitions is acknowledged worldwide in the world of architecture. Historically competitions have proven to be a breakthrough for several architects. They have produced high profile projects but also a lot of debate, dispute and affairs (Strong, 1996). "Competitions clearly represent for the hopeful contestants the possibility that the best person may win at least for this once, what happens next after that is another story" (Larson, 1994, p. 475).

Spreiregen (1979) talks about three myths in case of design competitions that remain to be persistent: competitions cost money, competitions take more time and competition designs never get built. In the long history of design competitions hardly any attempt has been made to observe, analyze or evaluate the selection process of architects (Strong, 1996). Most publications on design competitions show the diversity of the competition and a statement by the jury on the relevance and quality of the entries for the architectural profession (e.g. de Haan & Haagsma, 1988; Glusberg, 1992). Others describe the aims, procedures, potentials and pitfalls in a historical perspective (Lipstadt, 2005; Spreiregen, 1979; Stichting Bouwresearch, 1980; Sudjic, 2005). Recently a few scholars studied the judgement process of jury panels in the current context of design competitions (Kazemian & Rönn, 2009; Kreiner, 2006, 2008; Spreiregen, 2008; Svensson, 2008) and the strategies of architectural teams that join competitions (Kreiner, 2007a, 2007b; Manzoni, Morris, & Smyth, 2009). These publications indicate that problems in competition mainly concern the honesty of (criteria for) selection of the participants, the requirements of the client, the composition of the jury panel, the objectivity of the jury's judgement, and the financial compensation compared to the amount of work. All these issues are based on decisions that clients make during the organisation of a competition. Yet research from the client perspective is lacking. The main research question is therefore: which difficulties do clients experience in designing a design competition in architecture? This paper addresses four main difficulties that I distinguished from empirical research about clients organizing a design competition.

Background of the study

Competition design

An increase of the amount of invited competition makes competitions more of a public negotiation (Rönn, 2008). In an attempt to address issues of fair competition, the EU has imposed strict rules for the tendering of public contracts. The selection of an architect is considered as the allocation of a contract for architectural design services (European Parliament & Council of the European Union, 2004). Even though the design contest is offered in the EU Directives, most Dutch public commissioning bodies choose to use the restricted tender procedure to select their architects (Geertse, Talman, & Jansen, 2009). In a way Dutch public clients break with the tradition of design competitions by using other EU procedures than the design competition. At the same time they include elements of the traditional design competition in their tender procedure, such as the submission of a design proposal and an open debate about design quality. The accustomed anonymous assessment of the proposals and the expert jury panel is often replaced by other procedures, while it is these elements that secured fairness of design competitions.

In general the amount of design competitions is limited compared to other ways of commissioning jobs, such as tenders. The competition principles are usually incorporated in national regulations, standardized formats and model competition conditions. There are two main competition structures (open and invited); two main competition populations (national and international), and two main competition objectives (ideas or designs) (Lipstadt, 2005). Not every procedure is suitable for every aim. Table 1 provides an overview of the options of general and tender competitions in relation to the specific ambitions of the project. Recent numbers show that in the Nordic European countries (Sweden, Norway, Denmark and Finland) about 100 architectural competitions yearly take place about equally spread over several areas in architecture (Kazemian & Rönn, 2009; Rönn, 2008). About 60 to 75% of these competitions are completed within four (!) years and 15 to 30% is cancelled. The fact that in the Netherlands about 140 restricted tenders and 20 competitions take place per year to select an architect shows the current significance of studying design competitions (Geertse, et al., 2009).

Table 1 Overview of project ambitions and characteristics in relation to possible tender procedures for general projects (based on Heynen, 2001)

Project ambitions / Possible competition and tender procedures * assumes anonymous examination of the plans; # assumes autonomy of the jury panel	Open tender procedure	Restricted tender procedure with presentation of vision	Restricted tender procedure with design proposal	Open design competition #	Restricted design competition #	Ideas competition *#
Exemplary function with stakeholder interaction			+	+	+	+
Stimulation young talent	+			+		+
Complex and/or important location			+		+	
Exploration of concepts and possibilities				+	+	+
Specific project requirements needed		+	+		+	
Specified project definition available			+		+	
Interaction with participants desired		+	+		+	
Limited time and money available	+	+				

Competitions need to be well prepared and realized with great care. Design competitions always involve the development of a design to the point where it realistically prefigures a realizable building. In every architectural competition there are several entrants with an identical problem they try to solve by prescribed rules and procedures (Strong, 1996). A systematic and independent assessment by a panel of assessors is used to select a winner. Spreiregen (2008) describes a competition process in seven components of planning, competition announcement, design, receiving and processing, jury, design announcement, and post-competition phase. The competition programme include three basic sections of general conditions, instructions and a brief (Strong, 1976). According to Kreiner (2006) the competition brief reads as half instruction, half inspiration and should be both unambiguous and non-constraining. He shows the inherent tensions and ambiguities of 'from versus function', 'tradition versus change' and 'requirement versus suggestion' in a brief. A jury report serves the purpose building of trust between the clients and participants, just as it serves "to inform the sponsor of the reasons for the selection of the winner, to clarify the general objectives being sought in the particular design experience at had and as a record and reference of a particular moment of design thought and awareness" (Spreiregen, 1979, p. 234).

Participation

The character of a design competition has a lot to offer in sense of participation options with stakeholders of the future building. Preferences of a jury do not always correspond with those of users and visitors (Nasar & Kang, 1989) because they tend to focus on the meaning of designs instead of convenience and durability (Nasar, 1999). Nasar therefore pleads for systematic visual quality programming as pre-jury evaluation among all groups of people that might experience the building as, especially users. This should be followed by an unbiased evaluation process that is based on insights from environmental psychology about preferences and meaning of design and completed by a post occupancy evaluation to see how the building actually performs (Nasar, 1999). According to Collins (1971, p. 194) "the problem of establishing architectural ideals today is not so much due to the difficulty of weighing the relative importance of 'firmitas, utilitas and venustas' as to the difficulty of creating a realistic understanding in the lay mind of the difference between price and value." This implies that average citizens can do an effective job of decision making if they are provided with accurate and relevant and organized and presented in a way which is meaningful without being patronizing (Crosby, Kelley, & Schaefer, 1986; Robinson, 1972). Crosby et al. (1986) introduce the American concept of the 'citizens panel' which include four days of regional and state wise staff presentations on the topic, witness testimonies of several stakeholder groups and making up a report of the panel members about the recommendations. Evaluation shows the concept as flexible, effective, fair but relatively expensive with a limited power to convince the people in charge. In design and urban planning co-design provides an interesting option because designers and planners work with instead of against community groups (King, 1983). After all, "experiences in the participation process have shown that the main source of user satisfaction is not the degree to which a person's needs have been met, but the feeling of having influenced the decisions" (Sanoff, 2006, p. 140).

Research approach and methods

A client fulfils a very important role in the design of a design competition. The choices made during the preparation phase determine to a considerable extent the results and appropriateness of the competition, as well as the style of the architectural design. Considering the current problems in the field of design competitions, I identified a gap between the structures that are provided and the actual behaviour of clients. Existing knowledge about competitions remains scattered and is not used adequately by the client organizations. Therefore this research focused on exposure of underlying structures and behavioural phenomena of project team during the organization of a design competition.

This paper describes the results of a single case study. The method of studying cases makes it possible to study decision making in a real life context on different levels of individual, group and organizational decision making (Yin, 2009). In this case the representative of the commissioning body, the Dean of a Dutch Faculty of Architecture invited the author to take an active role in organizing the competition. This created a revelatory case, "a situation in which an investigator has the opportunity to observe and analyze a phenomenon previously inaccessible to social science inquiry" (Yin, 2009, p. 48). Since I was already a staff member of the Faculty the entry-exit problem that is common for participation studies was therefore relatively easy to overcome (Bechtel & Zeisel, 1987).

A large set of data was collected by using different methodologies. I was involved as a full member of the project team for 32 weeks in order to organize an international ideas competition. During this period I kept a research log. At least once a week I recorded the activities of that week, the considerations and arguments that led to a certain decision, and I filed all documents including press releases and news paper articles. Personal reflections were noted in a special section of the log. After the project had ended, I conducted semi-structured interviews with the jury members and the project leader. The analysis was conducted a few months after the project was finished and data collection had ended, to create a certain distance to the data. All data were first analysed in Atlas.ti, a software package to support the categorizing of the data. The analysis resulted in a distinction between the actors, the competition characteristics and the competition design, which comprehends the brief, the procedure, stakeholders involvement and the jury process. For the purpose of this paper I take the categories of the brief and the stakeholder involvement central.

Case description

The impetus of this international open ideas competition was a fire that destroyed the old faculty building in May 2008. It can therefore be characterized as a rare event of with important learning effects for the organization (Christianson, Farkas, Sutcliffe, & Weick, 2009). The official objectives of this competition were to collect inspiration for a new building brief, to encourage creativity among the younger generation and to stimulate research and debate. In total 471 international participants joined to win €60.000 of prize money. Preparations for the competition started in July 2008; the winners were announced in March 2009. The evaluation procedure consisted of an assessment phase and an evaluation phase. During the assessment phase the entries were analysed by two internal analysis teams on the content of the proposals and checked against the rules and assignment of the competition by the project team. The results of the assessment, a typology and a quantitative analysis of the entries, were made available to the jury for an anonymous two-day evaluation process. The jury selected six prize winning entries and two honourable mentions in two rounds based on an integral judgement. During the first day 50 submissions were selected, on the second day these 50 were reduced to 8 nominees and finally six winners; three first prizes of €15.000 (see Figure 1) and three second prizes of €5.000. The winners and their ideas were announced during an award ceremony during which a jury report was presented.

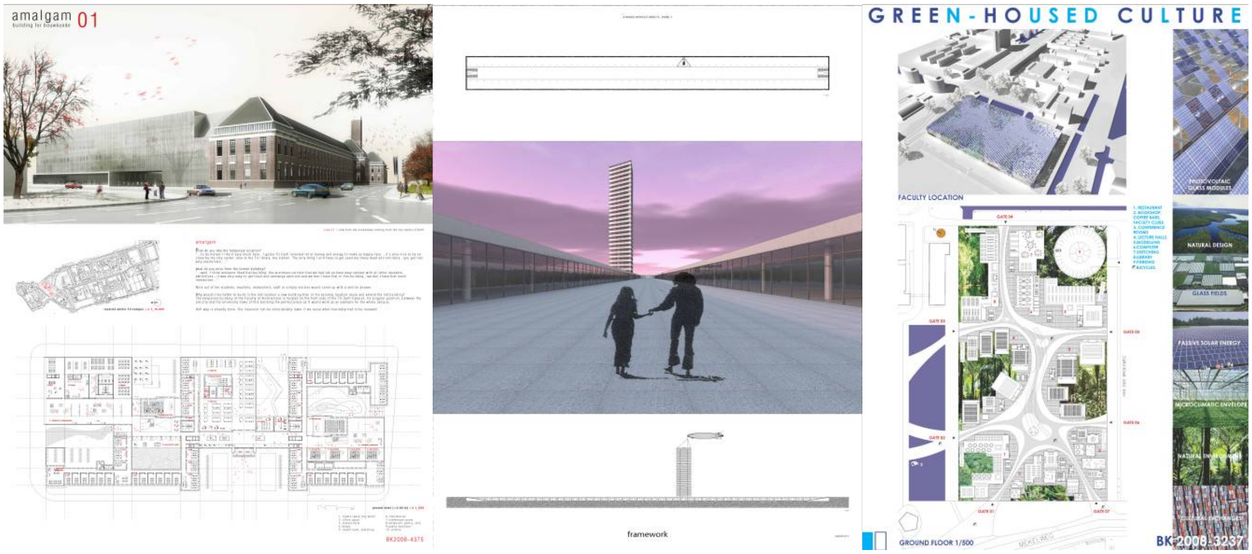

Figure 1 First price winners of the competition: amalgam from Laura Alvarez (the Netherlands), A world without objects from Gijs Raggers (the Netherlands), and Green-housed culture from Marc Bringer & Ilham Laraqui (France)

In the competition the main actors were the steering committee, the project team and the jury panel. The project team consisted of a project leader (externally hired), the Dean of the Faculty (chair), an additional project coordinator (the researcher) and the head of marketing and communication. The website and submission system of the competition was made by a consultancy firm, and the project team was supported by a secretary of the Dean's office and several student assistants. The steering committee consisted of the President of the Executive board of the University, the Head of the Real Estate department of the University, a professor in Real Estate Management and the Dean of the Faculty. Main task of the project team was to write the competition programme, provide the information for the website, prepare the jury meeting and coordinate the whole competition. On several occasions the steering committee provided input for the competition programme and some of the managerial aspects (e.g. finances). In line with tradition in architecture, an international jury was assigned to assess all submissions and decide about the winner. Because the Dean was a member of all actor groups, he acted as the connecting link. Right after the opening of the competition in September 2008 the Dean fell seriously ill, and remained absent during the rest of the competition period. He was not replaced in the jury committee. His responsibilities were assigned to another member of the steering committee.

Findings

Analysis of the complete data set of this case showed a distinction between the actors, the project characteristics and four elements of competition design: the competition brief, the competition rules, stakeholder involvement and the evaluation process of the proposals. This paper focuses on the issues of competition design and the involvement of stakeholders and addresses four combinations of aspects that cover the main difficulties as experienced by the client in organizing the competition: 1) the dynamics of the brief, 2) the balance between professionalism and ambition, 3) the balance between participatory means and competition aims, and 4) the influence of expertise at client obligations. These aspects are mostly based on insights from observations and interviews.

Dynamics of the brief

The dynamics of the brief were mainly caused by the changes in time and context of client organization. The launch of the competition at the opening of the Biennale in Venice (Italy) in September 2008 provided as strict deadline and meant that the competition needed to be set up in two months. There was no clear deadline for the end of the competition, apart from the dates that were announced in the competition programme. The planning was based on the intention to start with the new building project within two years after the fire because of the conditions of the insurance policy. As the competition progressed, the time frame for assessment was extended and the context had changed: the temporary accommodation for the Faculty performed above expectations, the resources of the university were cut down, negotiations with the insurance company were running, the jury date was difficult to set and the initial planning for follow up activities did not seem realistic anymore. This did not lead to an extension of the submission deadline, but did change the date that the nominees and winners were announced. The Dean provided the project team with most of the input for the vision and ambition of the project assignment and criteria in three sessions. His input appeared to be a combination of the needs of a faculty as a client, the expectations of the professional community about the role of the faculty as a client, and his own experience and expectations as an architect about a faculty building. Reflecting on the process of ambition formulation, it seemed fragile that only the Dean, probably influenced by some of his close contacts and network, provided input for the ambition and brief.

The awareness of the importance of the brief increased during the course of the competition. In order to reach the objectives of the competition regarding to stimulation of creativity and debate, the assignment for the competition brief was kept relatively open to any direction possible. During the development of the competition programme the project team was constantly faced with conflicting issues on client and building related issues (see also Kreiner, 2006; Rönn, 2008). Most important in defining this competition brief was the balance between familiarity and innovation. During this process the project team experienced a need for innovation as well as a need to maintain the positive qualities of the old situation. For example, the old building structure provided a 'street' on the ground floor for meeting and group gatherings. At the same time this structure created vertical traffic in the building which did not encourage interaction between the departments and lacked flexibility on the floors. In the assignment social interaction became a central theme, just as flexibility. Another example of the balance between familiarity and change was the location of the faculty building. The old faculty building was situated at the middle of the campus. On the campus map this location seemed relatively central, but in practice most activities and facilities are situated in the northern part of the campus. The project team did not know at the time of publication which location would be best and therefore this issue was left open. The brief created the possibility to choose ‘a well-argued, alternative site’, but only 13% of the submissions proposed another location. These findings suggest that the competition brief should indeed be read as half instructive and half inspiration as stated by Kreiner (2006).

The results show a difference in the availability of information between local and international participants. Because locals were aware of the positive experiences with the temporarily accommodation the dynamics of time, the equality of information among the participants diverged. Participants have to rely on the fact that all information in the brief is valid and reliable because theoretically it should provide the basis for their ideas. Especially for foreign participants the information on the competition website is the primary source of information. Further analysis of the traits of the winning participants showed that five out of six (had) studied or worked at the Faculty as an (exchange) student or employee. These findings show in line with Kreiner (2006) that specific information and a feeling for the relevance of information would improve the chances of winning because the ideas provide a better match with the assignment.

Professionalism and ambition level

The competition rules determined the kind of entrants, format of the submissions, the process of assessment, the communication of the justification of the decisions and the use of the entries after the closure of the competition. The format of the submissions was to be a very important topic of the rules because it influenced the amount of submissions, the amount of information and therefore the process of assessment and evaluation greatly. Among the members of the project team enthusiasm about the submissions grew with the realization of the potential of a competition. This enthusiasm could, however, easily have turned into a situation in which too much was asked of the participants. The project team aimed for a professional jury to assess the submissions because they would be able to judge large amounts of information in a relatively short period of time. Still the project team realized that as a professional client they should be realistic and modest in setting up the requirements for the submissions. The following examples show that a professional client needs to balance between pragmatism and ambitions in designing the submission and assessment format for the design competition. The results indicate that existing competition models do not stress the required balance in the design of the format enough to make clients realize its importance.

A first example of a well considered decision about the competition rules is the balance between the detail of a design proposal and the conceptual power of an ideas competition. The decisions about the format of the submissions have a clear impact on the potential of the ideas. A tradition exists in architecture to present designs on boards, sometimes supported by a scale model. The Dean explicitly wanted the ideas to have at least the level of sketch design because he wanted it to create a characteristic architectural design competition. Based on previous experiences the Dean was convinced of the additional value of a scale model during a competition. However, at the start of the project it was decided among the project team members that the whole competition would be done digitally through a website. A scale model would not fit a digital format. Next to that it would require the entrants to mail the scale model which would results in additional costs for participation. After consulting other organizations who organize design contests more regularly and further discussion within the project team it was decided that a scale model would not be asked. All submissions therefore consisted of A1 posters with a short explanation in A4. Further analysis of the submissions showed that 90% of the entrants decided to submit two posters, while the format provided freedom to submit one poster only. Although all nominees submitted two posters, the number of posters did not seem to increase the chances of winning: the amount of submissions using two posters remains equal in the final 50 (92%). These findings could indicate that one poster might be enough for to assess the quality of the proposal. This could decrease the workload of participants as well as client organizations.

A second example about the decision about the display of the posters showed that not every decision needs to be innovative. The digital poster format offered some additional innovative options for the jury members to assess the submissions with, for example, online assessments, individual voting and teleconferences. This proved to be a bridge too far for some jury and project team members. Therefore the project team decided to select a secured location near the university to meet with the jury. First intention was to lay all posters on the floor. The idea behind this was the flexibility of rearrangement, the informal atmosphere, and the lower costs in preparation. According to the chair an expert needed only a glance at the posters, which could easily be done from above. Finally displays were chosen to hang the submissions on because this would look more professional and did not lead to possible back problems of the jury members (See figure 2). Still jury members could walk along the posters and personal contact among the jury members was ensured. The displays made it possible to present all submissions in one room which benefitted the atmosphere during the jury meeting greatly. This showed the great value of the social element of a jury meeting in the competition design.

Figure 2 Overview of all submissions as presented on the displays and example of personal contact among the jury members

Participation and competition aims

Because of the tremendous effect of the fire within the architectural community, the competition was also organised to support employees, (former) students and the professionals in the field of architecture in the process of coping with the loss of the old building. Ideas about the involvement of the press were strategically formulated from the beginning of the project. The project team did not consciously design a participation strategy for the stakeholders of the case, but developed several participation options with different levels of influence on the final decision of the competition. Further analysis of the different options showed distinctions between the means of consultation, group decision making and delegation, which is in line with the participation model of Vroom and Yetton (1988) or Arnstein (1969). In this perspective assessment by staff as part of the project and analysis team can be considered as part of the consultation, jury processes can be considered as group decision making processes and a steering committee appointing a jury panel to select the winners is a good example of delegation.

The actual influence on decision making was limited. For most stakeholders decisive or advisory options, such as being part of the jury or joining an assessment team, were only available by personal invitation of the Dean. Other professionals, student and employees could participate by joining the competition. For the competition jury decisions were binding. Therefore jury members could influence the outcome of the competition the most. The steering committee did not have a say in the outcome of the competition but did have to consider the results of the competition to advise the board of the University. The members of the steering committee (apart from the Dean) nor the board of the university were, apparently for strategic reasons, part of the jury panel. The data do suggest that if the competition would have been an official tender, the composition of the jury panel would probably have also caused more discussion between the project team and the steering committee because of the larger impact of the decisions. Table 2 provides an overview of the stakeholders that were involved in this case, the participation options, and the actual potential influence in the development of the future faculty building.

Table 2 Overview of participation options and influence on the future building

Stakeholders and options for participation 1 = decisive rights 2 = advisory rights 3 = being informed and provide support CR = Competition rules CO = Competition outcome F = Future direction of Faculty accommodation	Steering committee (by invitation)	Project team (by invitation)	Jury panel (by invitation)	Competition participant	Analysis teams (by invitation and voluntarily)	Invited open activities (e.g. final symposium)	Open activities (award ceremony, publication, exhibition)
Commissioning body (Executive Board)	2-F						
Representatives of client (e.g. Faculty staff)		1-CR	1-CO; 2-F				
Shareholders and supervisors (e.g. Ministry, municipalities)							3
Daily users (e.g. employees, students)		1-CR	1-CO; 2-F	2-F	3	3	3
Non-daily users (e.g. alumni, exchange students & professionals)			1-CO; 2-F	2-F			3
Representative groups (e.g. BNA, student board)						3	3

Based on the results of this case a competition can be seen as a participatory event in itself in which stakeholders from outside and inside the client organisation act as consultants for a jury panel that also consists of stakeholders. In this case, the primary competition aims of stimulation of debate, young talent and creativity, and the hidden organizational project aims to provide a podium for stakeholders and become internationally famous seemed to have strengthened each other. This resulted in an overwhelming amount of high quality ideas for the future faculty as well as a tremendous international exposure of the faculty. Yet despite the amount of participation options, critical comments were heard from the employees because they never had the chance to give recommendations for the jury.

In the retrospective interviews with the jury members they stated that they were satisfied with the level of participation by the stakeholder groups. At the same time they did not seem to be very interested this issue, nor in the level of the requirements set for participation in the competition regulations. The jury members actually considered participation to be a given in architectural culture: organizing a competition implies participation in itself. The client sets the rules and the jury members reconcile to these rules, on the condition that they can do their job properly. At the time of writing most resistance among alumni and staff related to the lack of communication from the management board about the accommodation strategy for the faculty and the follow up of the competition. Improvements on the temporary accommodation still take place but no official announcements are made about the decision to build a new faculty building that is based on the outcomes of the competition. These results suggest that without tangible effects or communication about the resulting actions as performed by a client, participation has probably limited impact on the satisfaction of stakeholders.

Expertise and client obligations

This competition was unique because of the direct relation of the competition to the core activities of the client as a Faculty of Architecture themselves. The level of expertise of employees and students of the organization was consequently relatively high. In the preparation of the jury assessment support could easily be found within the organization. A lot of decisions about regulations and participation were based on tradition and culture within the field of architecture, with which the Dean was very well acquainted. As a former Chief Government Architect the Dean was aware of the potential of a competition, and he felt enthusiastic about creating this opportunity for the field of architecture. These results indicate that a positive perception of the opportunities that a competition can offer and the available support within the organization influenced the approach of the project positively. On the other hand, working with highly experienced and deeply involved stakeholders created a high level of expectations about the quality of the competition. The competition therefore also had an exemplary function, which created additional pressure on the work of the project team and the jury panel.

The findings indicate that competitions have to be perceived and set up as true projects. The level of expertise of the client organization could not prevent tensions in the project team. Most tensions were found in common project management issues, like the input of personnel, inter organizational politics and available finances. Most conflicts originated from a difference in the temporary project aims of the competition and the long-term aims of the organization. The rushed character and sudden impetus of the case surely contributed to these tensions. From the beginning on the tasks and responsibilities were not clearly defined among the members of the project team. This could partly be attributed to the leadership style of the Dean. Trust was lacking among some members of the project team who never collaborated before and appeared to have different styles of working. Especially after the Dean had fallen sick, differences of interests appeared between the internal and externally hired members of the team about patterns of spending and authority within the organization. The conflicts were, for example, shown in relation to the accuracy of information and feelings of responsibility in communication to the professional practice. This resulted in a mistake in a press release and an adjustment in the timing of the announcement of the winners. Overall the competition is considered by the client as a successful event, especially if the limited time span is taken into account. Taken from an overall perspective I sincerely doubt if a less professional client could have done the same.

Conclusion

While within the architectural community most interest is shown in the outcome of design competitions and the chances of winning, the results of this case show that a client determines the playing field of the competition by setting the rules. Participation in the project team of the competition proved to be as successful method to gain insight in the client perspective of a design competition. The results demonstrate that the rules and regulations currently available for clients usually do not address the difficulty of the decisions that precede the official opening of the competition. A considerable amount of expertise is needed to make sense of the decisions that are needed for the design of the competition. I found four combinations of aspects that cover the main difficulties as experienced by the client in organizing the competition: the dynamics of the brief, the balance between professionalism and ambition, the balance between participatory means and competition aims, and the influence of expertise at client obligations. It is the constant search for a balance that makes every competition unique providing a wealth of information about clients and architectural design. Since there is no one formula for success, designing a design competition will always be challenging for every client, not matter the amount of experience and level of professionalism. The findings of this case indicate that competitions do have a lot of participation potential, but that the power of a jury panel does not leave a lot of room for other stakeholder to have decisive rights and therefore influence the final outcome. The large amount of submissions from all over the world indicates that in this case the project team did a good job. Most of the aims of the competition were reached, although one could argue if the full potential of the results is already taken advantage of in relation to research-by-design and stimulating architectural debate. For the future I hope that other clients will open up their organizations in order to supplement our interesting database of this competition with new data to enable a structural comparison.

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Findability of Commodities by Consumers: Distinguishing Different Packaging Designs

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Abstract

What package design features can help consumers find commodities faster? This study assumes that the factors in distinguishing different packaging designs of commodities differ due to consumers' different personal experiences. Thus, this paper studies the findability of commodities by consumers through distinct packaging designs. It consists mainly of two stages: (a) the first stage reviews the existing literature to determine the application of different package designs; (b) the second stage is a focus group interview designed to investigate the factors influencing consumers in distinguishing different package designs. In the investigation process, (i) samples of package bottles for testing were collected through natural observation and convenience sampling; (ii) a focus group interview was conduced to determine how a consumer recognizes the differences among packages; (iii) a grounded analysis model was employed to transfer and encode the data collected from the focus group interviews to construct a conceptual frame for trade dress and the classifications of trade dress, which can interpret variations in the recognition of packaging design differences. The results of the focus group interview showed that consumers focused more on three kinds of "trade dress": property of commodity, label design, and bottle shape design when looking for differences in packaging designs. The "bottle shape design" was the most important factor that the focus group used in distinguishing different packaging designs. The distinction in the different package designs by consumers is not limited to design elements (image, language, color, shape, etc.) only; more importantly, the distinction lies in the relationship between "trade dress" and "classifications of trade dress," which can better reflect the differences in packaging designs.

Keywords

commodity packaging; differences in packaging design; findability; trade dress.

The findability of commodities influences consumer decisions (Brown, 2008). Two-thirds of consumers' buying decisions are influenced by the packages on the shelf (Lundberg, 2004; Nilsson & Öström, 2005; Rettie & Brewer, 2000). Hence, the kind of packaging that is easy to find is a thesis worth investigating. Packaging gives appeal and provides distinction from other commodities. Furthermore, it stimulates the buyers' desire for consumption. An effective package design catches consumers' attention and experience, prolongs lingering time before the shelf, and consequently causes sales opportunity to take place directly (Cheverton, 2004; Doyle, 1996; Mikunda, 2002).

Experience in various commodities is connected with brand identity, packaging design on the shelf, and attempt to link with consumers' personal experiences (Schmitt, 1999). Therefore, design elements such as character, figure, color, brand, shape, size, material, and texture employed effectively by the package designer can create a different package and communication experience (Schmitt & Simonson, 1997; Sonsino, 1990). There are different types of cognition towards the communication design of package comprehension between consumers and designers (Author, 2007). Hence, designers have different preferences in their own design communication owing to their different senses and cognitions of the commodity itself (Antioco, Moenaert, Feinberg, & Wetzels, 2008).

This survey investigates the findability of packages. A literature review on packaging design differences is first presented, and the results of the group interview aimed at exploring the factors affecting consumer recognition and distinction of packaging design differences are then discussed.

Findability and Evaluation

Findability is a popular term on today's web (Morville, 2005). The size, shape, color, and location of an object in the physical environment will all affect its findability. The significant role of a package designer is to develop an effective package design so that the product can easily be found when searched visually. Through an effective design, the location of one commodity and its difference from others can be distinguished. Some research shows that package findability is worth exploring, as it can help consumers quickly find a specific commodity on the shelf. In terms of findability, the most decisive factor is the packaging design (Young, 1987).

Package findability tests can generally be divided into three types: (a) visibility test, which is used to evaluate the readability of the logo and font type on the package (functional comparison among different elements or between functions of packages); (b) image test, which is used to evaluate the fundamental attitude of the consumer towards one product; and (c) usage test, which is used to measure the relevant reaction to package function (Schwartz, 1971). The package designer should dedicate himself in integrating the visible and distinguishable elements on the package design to create a package with higher findability that can attract the attention of consumers.

Visual Search and Object Discernment

When searching for and discerning a commodity on the shelf, the object is first located in space. Visual searching has been widely used in visual recognition studies to evaluate various features abstracted from the visual system (Wolfe, 1994). As for the visual communication mechanism, the designer avails himself/herself of the design elements to trigger one's vision and discern the object within his/her line of sight, attract the curiosity of the watcher, and finally achieve visual communication (Chen & Guan, 2007).

Psychologists have put forward various object recognition modes, including Gestalt psychology, template matching, feature analysis, and prototype recognition (Anderson, 2004). The process of discerning is a course in which an image of one object is received and searched visually, or one is attracted by some distinctive features. The individual then matches the features with the image template existing within him/her, produces the identity sign, and then finally understands the connotation behind it (Giles, 2005). Two factors must be set for discerning the packaging design: the stimulus produced by the differences in the outer packaging design and the one's past knowledge and experience in packaging design differences. These two factors interact and lead to the discernment of the packaging design. This thesis is concerned with the kind of information that can be abstracted from consumers' visual system, which can be explored through visual searching.

Package Design Differences, Trade Dress, and Trade Dress Classification

Elements such as shape, brand, logo, color, information appended, auxiliary packaging material, material structure, and volume lead to differences in packaging design (Lan, 2008). Through visual communication, the package design expresses the trait of one commodity to help consumers find it and to realize buying behavior. Thus, in this study, differences in packaging design is defined as the distinct visual differences among packages brought about by the employment of the elements of packaging design (CommCraft, n.d.).

All firms or companies convey their names, brands, containers, packaging, appearance, and other features. Through these elements, the object's trade dress, such as font, language, sound, figure, sign, number, image, color, and shape, which can express or deliver its commercial value or conceptual behavior is presented to the consumers (Garner, 1999). Trade dress can be categorized into two groups: product design and product packaging. Product packaging refers to the combination of all the design elements and their arrangement, including the logo, pattern, color, and color combination, among others. Product design, on the other hand, includes the shape, surface configuration, and other design features (Handelman, 2008). In this thesis, trade dress refers to the design features embodied in the product or in the visual appearance of its package, while classification of trade dress involves the design elements in constructing the trade dress.

The existing package design research is fragmentary and incomplete. There is a need to investigate the differences in design elements and the findability of relevant trade dress designs on the shelf. Through a literature review, this thesis attempts to explore the concepts of package findability, trade dress, and classifications of trade dress. Subsequently, it investigates how consumers sense and recognize the differences among packaging.

Purpose of the Research and Implementation Method

The factors influencing each testee's recognition of design differences were assessed through a focus group interview. Thereafter, the conceptual model for recognizing packaging design differences was constructed. The investigation flow is as follows (Figure 1):

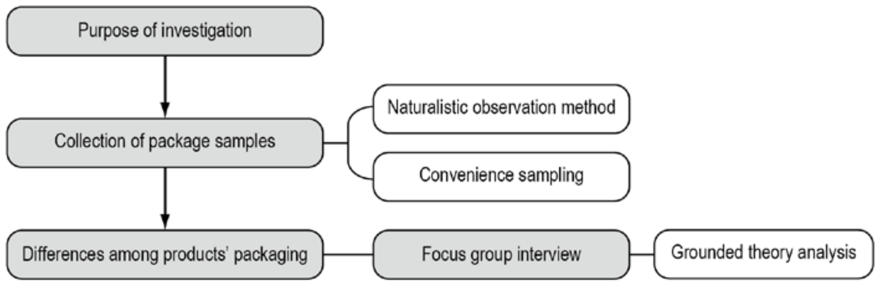

Figure 1 Factor exploration flow chart of packaging design differences recognized by consumers

The stages of the investigation are as follows: (i) samples of package bottles for testing were collected through natural observation and convenience sampling; (ii) a focus group interview was conduced to determine how a consumer recognizes the differences among packages; and (iii) a grounded analysis model was employed to transfer and encode the data collected from the focus group interviews to construct a conceptual frame for trade dress and classifications of trade dress, which can interpret variations in the recognition of packaging design differences.

Collection and Creation of Test Samples

Collection of Test Samples

Samples were taken from the hypermarket. However, not all the articles were included in this thesis because of their diverse package categories. Thus, actual samples were restrictively selected. The following steps were employed:

(i) From naturalistic observation, products with plastic bottles are the most common in the market. Thus, for convenience, samples were chosen from products with plastic bottles.

(ii) Samples with identical shapes and surface designs and packaging designs with similar sizes were excluded from this thesis to diversify the survey samples. When package designs were approximately identical, one article was selected at random. Four hundred twenty-eight actual samples were finally collected.

Design and Creation of Test Samples

Samples were presented in picture cards during the focus group interviews. The sample pictures were made and designed as follows:

(i) Given the cost and interview space, shrunken cards were employed in this study. Four pieces of packaging bottles with the smallest sizes were selected from the samples. Colorful cards were made to represent the real objects visually. The figures were drawn in proportion (10-100%) to the actual sizes of the products. A total of 10 cards were made (see Table 1).

(ii) Subsequently, 16 volunteer testees (aged 20-42) were invited to conduct the visual reading test on the surface information found on the bottle packaging. From the 10 cards, they selected those with unclear proportion thresholds. After self-judgement on the visual threshold value of the product packages, 2 testees were able to read the contents of the 10% card, 7 for the 20% card, and 8 for the 30% card. Sampling cards with a size of 30% of the actual product were made using 10×10 cm cards.

◎Selection of Samples and Testing Procedure

Before testing, the size of the screen was adjusted to the actual proportion of 1:1 after measuring by a ruler. The testees were told to look at the 10 pictures of the product and to choose their threshold values only by subjective judgment. The researchers recorded and indicated the values. Finally, the most reasonable minification of the product card was determined.

Table 1 Size of card, samples, and procedure

Display of Samples

The testing place was set in a quiet and closed assembly room to make the focus group interview run smoothly and to avoid any outside interference. Ordinary lighting was provided (see Figure 2).

Figure 2 Focus group interview and sample display

Selection of Testees

Sixteen volunteer testees, aged 23 on average, were invited to participate in the focus group interview. They were grouped according to gender and frequency of product consumption (buying at least once a week in the hypermarket).

Implementation Procedure of the Focus Group Interview

The researcher induced the group members to express their opinions on the factors that can help them recognize the differences in the given samples. Their responses were timely recorded. To determine the mental working mode of the testees, they were asked to carry out hierarchical grouping tasks on the packaging design differences (Chang, 2007; Chang & Wu, 2009; Peeper, Shrestha & Oliva, 2004; Ramanarayanan, Bala, Ferwerdab & Walter, 2008). A hierarchical grouping task is used to resolve the problem of categorizing heavy and complicated data, while clustering is a way to group apparently similar objects together and to sort data into new types (Chang, 2008; Guo, Peuquet, & Gahegan, 2002; Peeper, Shrestha, & Oliva, 2004; Sherrill, Moy, Reilly, & Bonato, 2005).

Differences among packages were discussed among the focus group members, and proper and rational ways of classifying the packages into two groups were found. The group members continued the sorting until a single sample was identified. To avoid fatigue caused by the long group interview, which might influence the interview quality, a five-minute break was taken every 30 minutes. The entire interview ran for nearly 270 minutes. Its implementation procedure and agenda are shown in Figure 3.

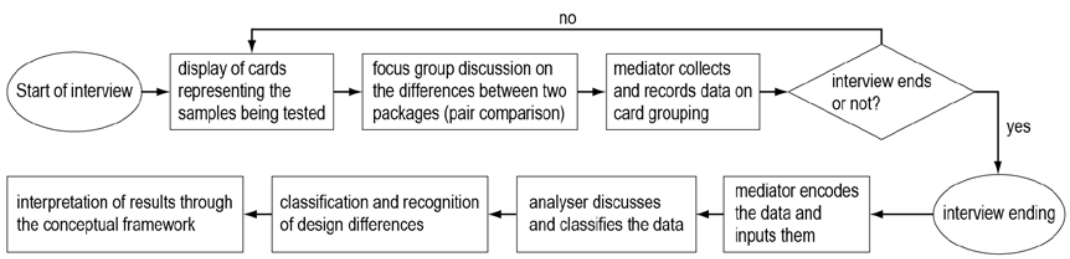

Figure 3 Implementation procedure of the focus group interview

Collection of Interview Data

The focus group interview process and the observations were recorded with a camera. The factors identified by the group members and their judging standards after two group differences were recognized and recorded. Protocol analysis was subsequently carried out. The ATLAS.ti software was used to deal with the content emphasis of the focus group interview on the aspect of data input (Figure 4). A conceptual network chart (see Figure 5) was set to complete the interpretation of the conceptual framework.

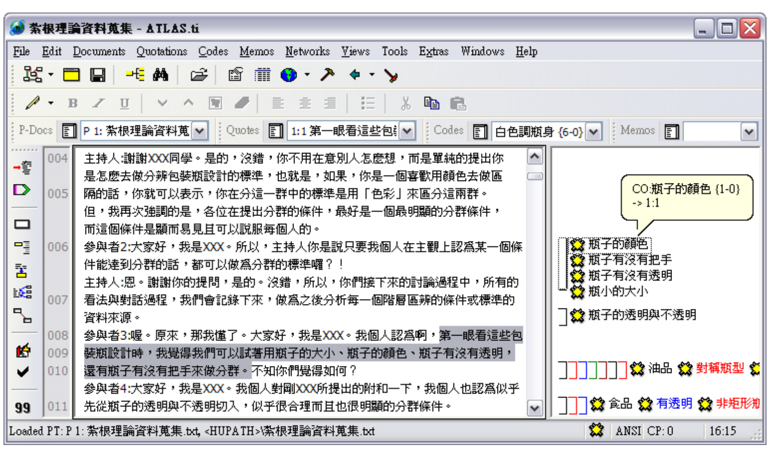

Figure 4 Data sort-out by ATLAS.ti and the decoding process

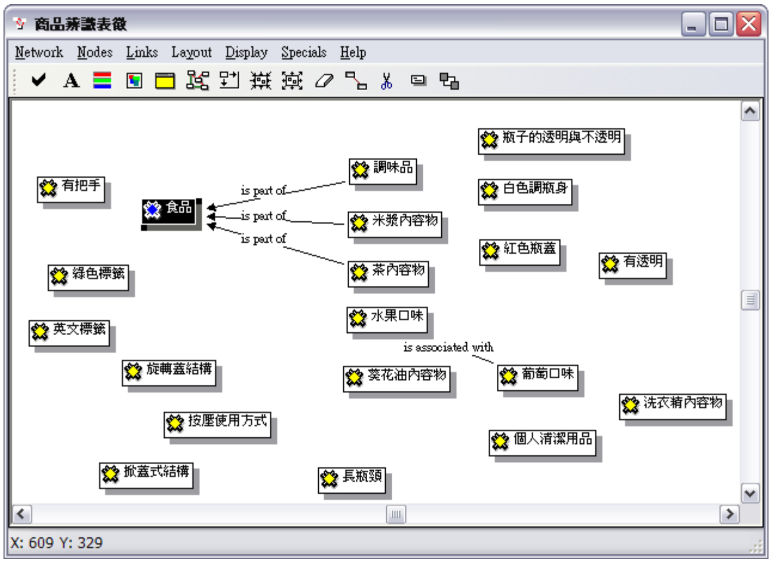

Figure 5 Grounded conceptual network

Establishment of the Grounded Analysis Model

There are three relevant grounded theory designs: open coding, axial coding, and selective coding. Open coding is a process designed to find the conceptual and attributive faces of the defined data. It can be used in conceptual categorization, induction, and transforming and focusing data. Axial coding deals with correlative categories and sub-categories, while selective coding involves a process of integrating and refining to construct a scientific theory needed to interpret the differences in packaging designs.

Table 2 presents the textual analysis results and their corresponding explanations. According to the selective coding in the table, the focus group was influenced by different variables in the identification of the differences among the packaging designs. The group members tended to change their opinions according to their individual perception, memory, association of the package content with the actual product, and the interaction among various visual searching interference variables. Cognitive factors that aided the focus group in determining the differences among packaging designs were further analyzed and generalized. A conceptual framework created to interpret properly the findability of a package is shown in Figure 6.

Stage One		Stage Two		Stage Three	
Open Coding	Instruction	Axial Coding	Instruction	Selective Coding	Instruction
Package content	Identify the contents of the product being tested	Item	Distinguish products through their item differences	property of commodity	Judge the property of commodity to determine package design differences
Users' group	Identify the product being tested				
Product's flavor	Identify the contents of the product being tested				
Usage of product	Identify the use of the test object				
Name of commodity	Identify the information relevant to the name of the commodity being tested	Naming of the brand	Distinguish products by identifying the differences		
Brand name	Identify brand information in the commodity being tested				
Manufacturer	Identify manufacturer information on the test object				
Language	Comprehend the language used in introducing the commodity	Language used on the label	Distinguish products in terms of the language used on the labels	Design of the label	Judge the design label to determine the design differences in the appearanc e of the packaging
Image	Indentify specific images on the test object	Image of volume label	Distinguish products through image differences		
Abstract graph	Indentify the abstract graph on the appearance of the test object				
Color matching on the label	Indentify the color matching on the appearance of the test object	Color of the label	Distinguish products according to differences in label colors		

Predominant color of label	Indentify the predominant color of the entire test object				
Size of the package bottle	Indentify the appearance or capacity of the testing object	Capacity of the bottle	Distinguish products by capacity differences	Shape design of the bottle	Judge shape designs to determine the design differences
Length of the bottle's neck	Determine the length of the bottle's neck from its appearance	Height of the bottle's neck	Distinguish products through the length difference in bottles' necks		
Length of the body	Determine the length of the bottle's body from its appearance	Height and width of the bottle's body	Distinguish product in terms of the size of the bottle		
Width of the body	Determine the width of the bottle's body from its appearance				
Angle of the bottle's shoulder	Determine the angle of the bottle's shoulder from its appearance	Angle between the shoulder and neck of the bottle	Distinguish product by the angle of the shoulders of the bottles		
Lifting-type bottle cap	Identify the lifting-type cap used near the bottle's mouth	Usage of the bottle's mouth			
Bottle mouth with press structure	Identify the press structure designed on the bottle's mouth				
Nozzle bottle mouth	Identify the nozzle designed at the bottle's mouth				
Turning-mold cap	Identify the turning-mold cap set near the bottle's mouth				
Bottle without a handle	Identify the handle designed near the bottle's mouth	Practicality of the handle	Distinguish products through the structure of the handles		
Bottle with a handle	Identify the handle designed on the body of bottle				
Color of the bottle cap	Identify the color matching on the bottle cap	Color of the bottle cap	Distinguish the products by the differences in the color of bottle caps		
Color of bottle's body	Identify the color matching on bottle's body	Color of the bottle	Distinguish the products by the colors of the bottles (body)		
Lines on the bottle's body	Identify the shape lines on the bottle's body	Shape of the body	Distinguish the product by the differences in bottle shapes		
Shape of bottle	Identify the external shape of the bottle's body				
Popularity	Acknowledge the popularity of the test object	Memory	Distinguish the products by popularity and memory	Interfering factors	Identify the factors influencing the recognition of packaging designs
Familiarity	Acknowledge the testee's memory of the test object				
Association	Associate the information about the images of the test object	Cognition	Distinguish the products through the differences in relevant design		
Distinguishing sequence	Arrange the actions stimulated by the test object	Attraction	Distinguish the products by the attraction they generate during a visual search		

Table 2 Overall instructions for open coding, axial coding, and selective coding

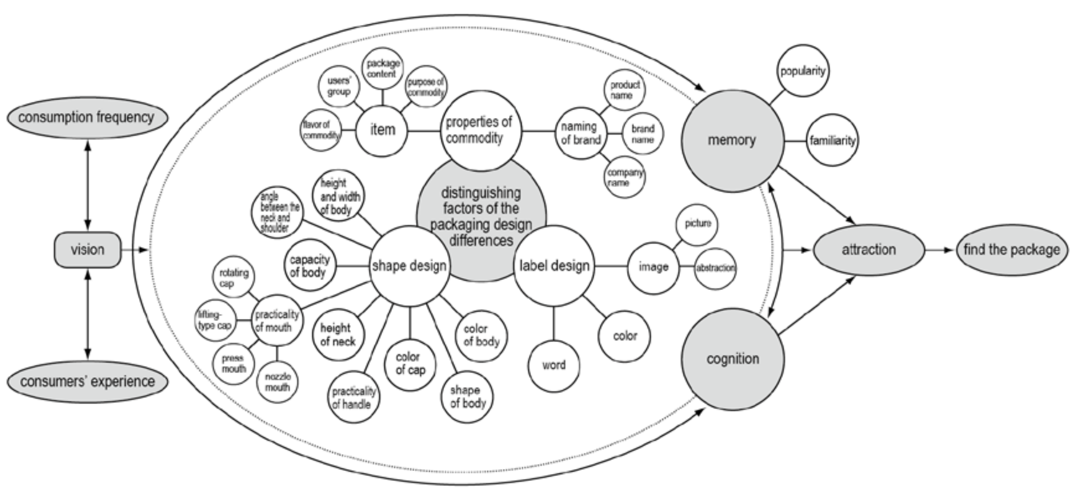

Figure 6 Conceptual framework of the focus group's interpretation of the packaging design differences

Results of the Investigation on the Factors Affecting Package Design Differences

Property of commodity, label design, and design of bottle shape in selective coding were defined as “trade dress" in this research. Based on these codings, statistical analysis was employed to determine the factors affecting package design differences.

Hierarchical Summarization of the Distinguishing Factors

After being identified by the focus group, a single independent sample was separated until it reached the fifth stage when pairing groups were distinguished one by one (see Table 3). As observed from the hierarchies tested, the total samples were up to 300 from the 5th to the 9th hierarchy. The distinctions were completed at a qualifying rate of 70%. From the result, it can be seen that the finished hierarchies were influenced by the quantity of the commodities when the consumer identified the differences among packaging designs from a heap of complex commodities. However, it does not mean that distinguishing the differences in the packaging designs would be easy with fewer commodities.

Number of Hierarchies	1	2	3	4	5	6	7	8	9	10	11	12	Total
Number of Samples	0	0	0	0	4	33	54	99	110	71	36	21	428
Proportion (%)	0	0	0	0	0.93	7.71	12.6	23.1	25.7	16.6	8.41	4.91	100

Table 3 Number of testing samples completed in each hierarchy distinction and their proportions

Summary of Classifications of Trade Dress in the Differences in Packaging Design

The quantity of classifications of trade dress was further explored when the focus group distinguished the differences in packaging designs (see Table 4). There was no absolute standard in grouping the focus group, but the distinguishing trade dress was found in the design differences among various groups. Therefore, similar items of trade dress could be adopted for grouping. The distinguishing factors of the different classifications of trade dress were only adopted in the statistical computations.

Layer	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Number of the Sample	0	0	29	113	132	92	52	10	0	0	0	0	0	0	428
Proportion (%)	0	0	6.78	26.4	30.8	21.5	12.1	2.34	0	0	0	0	0	0	100

Table 4 Amount of classification of the testing samples and their proportion after distinguishing in each hierarchy

Five trade dress classifications were employed by the focus group to complete their distinction of 132 pieces of test packaging samples in this research, accounting for 30.8% of the total test sample. Four trade dress classifications were then used on 113 pieces, accounting for 26.4%, and then six trade dress classifications were adopted on 92 pieces, accounting for 21.5% of the total test sample. These three numbers of trade dress classifications added up to 80%, which clearly indicated that four to six items are inclined to be used in distinguishing packaging design differences.

To illustrate the outline of the packaging design differences, proportions of trade dress classifications leading to the differences used by the focus group as distinguishing factors were calculated. “Item” in the classification of trade dress has the highest frequency of employment at 65 times. This means that “item” is used by consumers as a distinguishing factor 24.90% of the time. Subsequently, “shape of bottle” was used 46 times (17.62%) and “color of bottle’s body” was used 44 times (16.86%). Other classifications of trade dress were employed for less than 10% of the time (see Table 5).

Based on the above analysis, three classifications of trade dress (i.e., item, shape of bottle body, and color of bottle’s body) are inclined to be used as the axis of distinction by the focus group, accounting for 60% of all the classifications of trade dress. On the contrary, words on labels and image on the labels were ignored by the focus group; both of these classifications were below the usage frequency of 1%. This phenomenon reflects the consumers' personal experience and habit. The transparency of the package bottle was also noticed by the focus group. The color of the package bottle was deemed an important factor in its findability. If a product's color is more different from that of the rest, then it will be found more easily.

Classification of trade dress	1	2	3	4	5	6	7	8	9	10	11	12	Frequency(n)	Proportion (%)	Preference sequencing
Item	-	1	1	5	4	9	10	11	14	6	3	1	65	24.90	1
Shape of bottle's body	-	-	-	-	-	4	10	15	9	3	3	2	46	17.62	2
Color of bottle's body	1	-	-	2	7	10	5	9	5	4	1	-	44	16.86	3
Naming of brand	-	-	-	-	-	-	4	6	5	2	2	1	20	7.66	4
Color of bottle cap	-	-	-	-	2	2	5	1	1	5	1	2	19	7.28	5
Height and width of bottle body	-	-	-	-	-	-	2	5	3	3	3	2	18	6.90	6
Usage of bottle	-	-	2	1	1	3	3	-	2	2	-	-	14	5.36	7
Capacity of bottle	-	-	-	-	-	2	2	3	2	-	2	-	11	4.21	8
Color of label	-	-	-	-	1	-	2	2	-	1	-	-	6	2.30	9
Practicality of handle	-	1	1	-	1	-	-	2	1	-	-	-	6	2.30	
Angle between shoulder and neck of bottle	-	-	-	-	-	-	2	-	2	1	-	-	5	1.92	10
Length of neck	-	-	-	-	-	-	1	1	-	1	-	-	3	1.15	11
Language used on the label	-	-	-	-	-	-	-	-	1	-	1	-	2	0.77	12
Image of volume label	-	-	-	-	-	-	-	1	1	-	-	-	2	0.77	
Total													261	100.00	

Table 5 Classification table of trade dress in distinguishing the differences among packaging designs by the focus group

Summary of the Trade Dress of Package Design Differences

All the frequencies were summarized to compare with the importance of trade dress represented by each classification (Tables 6 and 7). Based on the proportion of trade dress, the "shape of bottle" is the key factor in distinguishing packaging design differences used by the focus group, accounting for more than 50%, which is greater than "property of commodity" and "label design."

In Table 5, "item" is used with the highest frequency in the classification of trade dress. But this doesn't make "item" inferior to "color of bottle" as a distinguishing factor in the first hierarchy of distinction. It can be explained that various kinds of commodity packages cover diverse categories and items of many products. This leads to their complexity, and thus they cannot be divided simply by item classification. On the contrary, whether or not the bottle is transparent is distinct on the first stage as a distinguishing trade dress classification. In the second stage, the property of commodity and shape of bottle compete with each other during the course of distinguishing packaging design differences.

Classification of trade dress	Usage frequency (n)	Proportion (%)	Sequencing of usage preference
Commodity's property	85	32.57	2
Shape design of the bottle	166	63.60	1
Design of the label	10	3.83	3
Total	261	100.00	

Table 6 Classification table of trade dress for distinguishing packaging design differences by the focus group

Trade dress/ Classification of trade dress	1	2	3	4	5	6	7	8	9	10	11	12
Property of commodity												
Item	-	●	●	●	●	●	●	●	●	●	●	●
Naming of brand	-	-	-	-	-	-	●	●	●	●	●	●
Design of the label												
Words	-	-	-	-	-	-	-	-	●	-	●	-
Image	-	-	-	-	-	-	-	●	●	-	-	-
Color	-	-	-	-	●	-	●	●	-	●	-	-
Shape design of bottle												
Capacity of body	-	-	-	-	-	●	●	●	●	-	●	-
Length of bottle's neck	-	-	-	-	-	-	●	●	-	●	-	-
Height and width of bottle	-	-	-	-	-	-	●	●	●	●	●	●
Angle between shoulder and neck	-	-	-	-	-	-	●	-	●	●	-	-
Usage of bottle's mouth	-	-	●	●	●	●	●	-	●	●	-	-
Practicality of the handle	-	●	●	-	●	-	-	●	●	-	-	-
Color of the bottle cap	-	-	-	-	●	●	●	●	●	●	●	●
Color of bottle's body	●	-	-	●	●	●	●	●	●	●	●	-
Shape of bottle's body	-	-	-	-	-	●	●	●	●	●	●	●

Table 7 Distribution table of the classifications of trade dress for distinguishing packaging design differences by the focus group

Conclusion

This research investigates how consumers sense and distinguish differences in package designs from the commodities on sale. This thesis is creative based on two points. First, a focus group interview was employed to distinguish the differences among various packaging designs comprehensively. This thesis was not confined within the design elements. Second, hierarchical relations between the trade dress and the classifications of trade dress were assessed based on grounded theory designs. The property of commodity includes two classifications of trade dress, label design includes three classifications of trade dress, and the shape of the bottle includes nine (see Table 7 for details). The items of packaging design included in this research are more specific, and the results are more focused than those of previous research.

Significantly, label designs are worth our attention. When the focus group distinguished the differences among packaging designs, item or brand name, as a factor for distinguishing the hierarchy of two pairs of groups, was not emphasized (not included in the label design). Item and brand name were only emphasized when the groups with high homogeneity elements on the label, such as different words (Chinese vs. English or Japanese), different images (specific and abstract), or different colors, were taken as the distinguishing factors. However, there is a close relationship among item, brand name, and label design. None of the classifications of trade dress can exist on the bottle independently. However, the focus group was habitually inclined to regard them as a whole. Thus, the significance of the label design remains unclear.

As to the association with the commodity, consumers most easily and directly associated the item and brand name with the product content. Next, they associated the image, words, and color on the label with the product content. Finally, bottle shape was associated with the product content. Thus, with respect to the association between packaging design and product content, the trade dress is ranked from highest to lowest as property of commodity > label design > design of bottle shape.. More importantly, the distinction lies in the relationship between "trade dress" and "classifications of trade dress," which can better reflect the differences in packaging designs.

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Interdisciplinary Design: The need for collaboration to foster technological innovation to create competitive and sustainable products.

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Abstract

This paper explores an integral relationship between industrial design, advanced technologies, science, economy, and the environment to realize a logical trajectory for the future of product design. Through an investigation of current literature, key aspects and critical factors of interdisciplinary collaborative work are explored. By realizing the benefits and obstacles, this paper suggests a framework in which scientists, engineers, and designers can work together successfully to create innovative solutions for product design. The paper discusses the possibilities of material synthesis through the scientific field of biomimetics. It also suggests that the Industrial designer's role must evolve into a position of project facilitator and communicator. To conclude, this paper mentions technologies utilized currently in this fashion and ideas are proposed to further guide this framework.

Keywords

Synthetic Biology, Interdisciplinary Design, Cross-Functional Teams, Biomimetics, Industrial Design, Product Design, Advanced Technology, Sustainability.

As the world's population grows and and the amount of resources that are available to be extracted from the earth does not, there is going to be an inevitable and drastic difference in the supply and demand of energy and resource for product manufacturing in the years to come. For example, "conventional crude oil production in the United States is forecast to terminate by about 2090, and world production will be close to exhaustion by 2100" (Edwards, 1997). This threatens the environment, the global economy and in turn social well-being. Either consumption and production of industrial and consumer goods cease or we must find new ways to produce or to create materials and technologies. The former is unlikely to happen. The latter is what is probable and is in flux. As material scarcity threatens the world and its inhabitants, environmentally incompatible material production processes threaten them also. The world's industrial nations must find solutions to reduce the burden that is being placed on our earth through the removal of finite stores of resources and the creation of harmful industrial effluents.

This paper is concerned with the role that scientists, engineers, and designers will have in finding solutions to the problematic relationship between consumption and resources, environment and production. Not only is this paper concerned with these individual disciplines, it is primarily concerned with establishing a framework for these diverse schools of thought to interact in a cooperative fashion to reach the solutions necessary to address the problem effectively. Interdisciplinary approaches to knowledge creation are crucial to solving problems of this magnitude. Only through the synergy of disparate schools of thought will the world render the creative solutions necessary. Interdisciplinary work between scientists, industrial designers, and engineers holds great potential for dealing with environmental issues concerning new product development. Biomimetics, a broad scientific approach, has great potential to bring dissimilar schools of thought together to form such solutions.

Overview

This paper begins with a literary overview of works by relevant scholars. This investigation explores:

1) How an interdisciplinary design approach is paramount to finding innovative solutions.
2) How critical factors of group dynamics and theoretical knowledge about interpersonal communication foster such research.
3) How interdisciplinary work between designers, engineers and scientists, representing the most advanced technologies plays an integral role in imagining and engineering the best product solutions.

Following the literary overview, in section 2, is a discussion of the findings. Section 3, based on these findings, will suggest solutions, a framework for future interdisciplinary design, and possible interdisciplinary trajectories.

Key Aspects of Interdisciplinary Design Collaboration

Combining disparate schools of thought is crucial when dealing with complex problems. We have drawn from several academics who support this notion. There are a few terms that are used to define these types of teams: these include interdisciplinary teams, multidisciplinary teams, and cross-function teams. For the purposes of this paper these three terms will be used loosely. Each is similar in the sense that they define teams that have a relationship within an organization. What is most important and shared among these classifications is the sense of team. Holland and Gomes (as cited in Cohen & Baley, 1997) define it as:

> A team is a collection of individuals who are interdependent in their tasks, who share responsibility for outcomes, who see themselves and who are seen by others as an intact social entity embedded in one or more larger social systems, and who manage their relationships across organizational boundaries” (Holland, Gaston & Gomes, 2000).

This paper is most concerned with concepts of togetherness and common goals. These are critical factors that are the crux of collaboration towards an agreed upon end. Other critical factors will be discussed in the following section.

An interdisciplinary project according to Professor and Director of the School of Industrial Design, Carleton University, T. Garvey, (2009) consists of disparate disciplines or professions involved in tackling a problem with the application of new knowledge. Each is an equal stakeholder. The difference according to him between interdisciplinary and multidisciplinary is that the latter does not integrate the disciplines. Each discipline is responsible for individual results and the knowledge represented will change contingent to the proposed challenge.

Many academic institutions and commercial enterprises are currently practicing some form of interdisciplinary learning approach. In Canada, Carleton University presently is in its second year of its MDes program which focuses on interdisciplinary design research. In the United States, Stanford and MIT have their specific brand of interdisciplinary design research. Delft Technological Institute, in The Netherlands, also has a program that focuses on strategic design planning, heavily slanted toward multidisciplinarity. The transnational corporation Nortel, in its hey-day, had a faction of its organization called Design Interpretive delegated to cross-functional product design development that helped pave the way for this type of thinking (Frankel & Tsuji, 2005). These organizations have realized the need for collaboration among disparate disciplines to come up with innovative ideas. Academics discussing the subject suggest it is crucial. Relevant to the context of this paper Persson and Warell (2002) not only suggest there is a need for integration of industrial design and engineering functions but also assert that it is a prerequisite to render innovative solutions that will successfully meet market and environmental needs.

Benefits of Cross-Functional Teamwork

Nations are built from the contribution of many. Governments, Hollywood film crews and championship baseball teams only function due to the contribution of many participants in which strengths fill in for others' areas of weakness. For collaboration in the area of product design the requirements are the same. Sonnenwald (1996) suggests participation in group design efforts from different domain representatives is widely accepted as a prudent approach to developing innovative and competitive products while at the same time reducing costs. Furthermore, the benefits to this type of organization are plentiful. Holland et al. (2000) attribute nine benefits to cross-functional teams. Increased speed is perhaps the most important. When dealing with competitive markets this benefit cannot be overlooked. A teams' ability to deal with complexity is also important. When taking into consideration the complexity that environmental and economic issues have, which this paper is concerned with, simple solutions are not likely. Professor Bjarki Hallgrimsson (personal communication, November 18, 2009) claims interdisciplinary or cross-functional approaches increase in importance as a project increases in its complexity. When dealing with such complexity, single points of contact, informational quality, and learning within the organization--so everybody is 'on the same page'--are pertinent to the teams success (Holland et al, 2000). Holland et al. (2000) attributes these three benefits to cross-functional team approaches. A fostered intrapreneurial and entrepreneurial culture within the organization is important. This supports healthy competition integral to innovation which will extend beyond the walls of the particular organization. Another benefit suggest by Holland et al. (2000) is that of motivation. Whether it is team or individual motivation it can be encouraged through a competitive organization. Enhanced creativity and customer focus are the last two benefits suggested by Holland et al. (2000). Both are important to the scope of this paper.

Obstacles Confronting the Collaborative Design Approach

As benefits are apparent, there are hurdles to interdisciplinary design teams that can vitiate successful outcomes. The literature recognizes communication problems as a major issue to be dealt with in collaborative design teams. Berryman (2002) recognizes that there are often daunting hurdles faced by interdisciplinary teams and one of them is language.

It is currently recognized within the field of interdisciplinary design research that there should be a unified body of knowledge (Love, 2002) that fosters an understanding for all disciplines that participate. This further supports the issues of language barriers facing interdisciplinary design team efforts. Unifying a body of knowledge in this field is not as easy as one may think. As the field grows in its scope and more disciplines participate in this type of organization, it becomes difficult to create vernacular that can support such an endeavor (Love, 2002). The issues that can arise due to this lack of a unified body include theoretical conflicts between researchers, lack of theory validation, unclear scope, and an inability for new researchers to identify sound epistemology (Love, 2002).

Chiu (2002) recognizes four areas of communication, which can lead to less than the desired effect. These include:

I) The media problem in which design information must be conveyed properly.
II) The semantic problem where symbol transmission is lost due to noise.
III) The performance problem that deals with issues in receiving intended information and reaction of the receiver as the sender wished.
IV) The organizational problem where information is lost or reduced in integrity through its travel within the hierarchy i.e. ‘broken telephone’.

The larger the group the more intricate the hierarchy and thus the more chances that information is altered. This challenge of communication effectiveness is not the same significant issue when communicating face-to-face. Usually it is not the lack of know-how or expertise that creates the problem. It is the non-representation of information that is lost. Safoutin & Thurston (1993) refer to this as failure in design mechanisms. Many design failures are attributable to commonly understood mechanisms, suggesting that they are not due to a real lack of expertise within an interdisciplinary design team but rather to communication errors at key decision points (Safoutin & Thurston, 1993).

Hurdles faced by interdisciplinary design teams cannot be attributed to communication functions alone. Sonnenwald (1996) claims “knowledge exploration can be difficult for design participants.” Unique experiences and confidence in ones’ skill can lead to what Sonnenwald calls “contested collaboration.” This happens when individual perceptions vary and participants challenge or contest another’s contribution.

Holland et al. (2000) identifies six areas that hinder cross-functional efforts. These include conflicting organizational goals, competition for resources, overlapping responsibilities, conflicting personal goals, no clear direction or priorities, and lack of co-operation. Kim and Kang (2008) (as cited in Wall & Lepsinger, 1994) also identify obstacles that overlap and confirm what other researchers are finding.

> The key issue, affecting 80%...was the tension that exists between team goals and functional priorities, surfacing in the form of: conflicting organizational goals; competition of resources; overlapping responsibilities; conflicting personal goals; a lack of clear direction or priorities; and a lack of cooperation (Kim & Kang, 2008).

Safoutin and Thurston (as cited in Steiner, 1972) add that “process loss always occurs in real groups, and stems from informational, behavioral, and organizational factors that impede the application of existing group resources to the problem at hand.”

Group dynamics have not changed much over the last few decades. This paper assumes that is because people, for the most part, have stayed the same. However, it is the application of this honed knowledge about interdisciplinary teams towards solving complex issues that is the focus of this paper. Through this and other investigations, this field of study comes closer to pinpointing the critical factors that increase the chances of successful interdisciplinary design efforts.

Critical Factors Affecting Collaborative Approaches

There is much to learn about interdisciplinary approaches to knowledge creation. Although it is a popular topic among academics, there is still a lack of insight into what is critical to the success of teams comprised of dissimilar disciplines. Holland et al. (2000) suggest that "the emergence of cross-functional teams is one of the most dramatic recent trends in organizational design." Although, it seems interdisciplinary practice is exceeding the amount of scholarly research, There is plenty of room for error within organizations that are intending to successfully implement these types of design teams. As interdisciplinary design research and product development is crucial to solving complex issues, these teams do not always function as they should. Noted above are hurdles teams face on a regular basis. To excise these impediments researchers suggest factors that teams must possess that are critical to successful outcomes. As failures in communication are common and are what is most responsible for negative outcomes, quality communication is one of these critical factors. Dr. W. Wehrspann (2009) asserts personal relationships do not operate properly without effective communication. This being so, it is unlikely that business relationships within a complex organization will operate succinctly. Holland et al. (2000) and Frankel and Tsuji (2005) discuss the critical factors leading to successful interdisciplinary or cross-functional design team efforts. Their findings among others are reviewed below.

Management

Holland et al. (2000) suggest quality management, shared goals, quality communication, organizational structure, creative output, constructive conflict, psychosocial traits, and resource availability as some of the critical factors. This paper is concerned with these because they best reflect its scope. "The fish stinks from the head down,'' is a common chide on bureaucracy. It stresses the need for good leadership. At the tip of the organizational iceberg, leaders or managers must perform functions successfully to assure other critical factors are met. Shared goals by disparate members are possible but it can be better fostered through quality management. Berryman (2002) suggests that collaboration can be a struggle. However, this struggle can be effectively managed "with a solid strategy involving basic tenets of good project management" (Berryman, 2002). The organizational structure is also quite dependent on the management. Holland et al. (2000) suggest leaders to be educators and communication facilitators. This will allow for a flexible but structured organization in which roles are not rigid and responsibilities do not overlap. If this is not so, innovation qualities are greatly lost. As innovation is important, so too is creativity. The literature review suggests there is a strong co-dependent relationship between the two. Dankbaar and Vissers (2002) suggest innovation is supported by an organic structure and creativity is fostered by group autonomy. Within an organizational structure, which allows for fluidity of information, creativity is spawned and creativity begets innovation.

Social Factors

Often people attempt to avoid conflict. This investigation suggests that there is functional conflict and dysfunctional conflict (Holland et al. 2000). Conflict cannot be avoided. However, there are positive conflict outcomes. For this to work, ideas must be expressed freely and team members must be willing accept constructive criticism. This relies heavily on the psychosocial traits of the team members. It is suggested that embracing characteristics such as empathy, active listening, overall emotional intelligence, and "a sense of humor as a group...to shed stress" (Frankel & Tsuji, 2005), can put a positive spin on conflict. Though each individual's personality traits affect the overall psychosocial dynamic of the group, it is up to management to support an organizational structure that develops a team which is greater than the sum of its parts.

Within Nortel's Design Interpretive team, Frankel and Tsuji (2005) explain the need for self-motivated members who carry mutual respect for one another. They suggest an organization that functions horizontally rather than a vertical hierarchy. Their investigation supports notions about sensitivity to constructive criticism. Team members must also be experts and all should be mutually responsible for the outcome.

Resources

Holland et al. (2000) mention resources as a critical factor. Not enough resources and a team cannot have the appropriate organizational structure. Members take on too many roles and have too much responsibility. This can affect team tenure (Dankbaar & Vissers, 2002) and spoil overall outcomes. It must be noted that though there is lack of resources, at times it can spur innovation.

The above investigation mentions some of the significant factors that would contribute to the successful outcome of interdisciplinary teams. What is noted here, is that all teams cannot function using a universal template. Critical factors will depend on complexity and nuances of the project itself.

Interdisciplinary Teams and Advanced Technology

The previous sections have discussed ways to support interdisciplinary design efforts and outlined what is needed to increase chances of succeeding. We now review interdisciplinary approaches within the context of advanced technology. The professions that most concern the scope of this paper are industrial design, engineering, and science. Each plays an important role in finding solutions for prescribed issues for this paper. The industrial designer is responsible for vision and communication. Scientists represent the most advanced technologies. The engineer's role is the application of that technology. Specifically within engineering and science this investigation is interested in the roles of material engineers, chemists, biologists, physicists, and environmental scientists.

As designers who are part of an international community, there is a realization that greater and more complex issues are arising in new product development with respect to resource availability, environmental health, economic stability and sociocultural environments. Frances Bronet states,

> There is a growing recognition that significant challenges await us in the years ahead if the nation is to compete successfully in a highly competitive global economy, while also seeking to share social well-being and restore the natural environment upon which all life and technology depends (Bronet, 2003).

The designer's role is changing to take on more responsibility. This responsibility lies in envisioning future products and facilitating the disciplines that are necessary for developing advanced product solutions. This requires an industrial designer to be well-versed within their own discipline, requiring artistic and engineering abilities, and have a deep understanding of the sciences and economics. Having a degree in Communications would not detract from a designers ability.

Interdisciplinary study within the realm of science is not a novel or groundbreaking concept. The idea that industrial designers are integral to this interdisciplinary approach to the science of materials, is.

All the scientific disciplines we are aware of today stem from an original parent discipline. Whether it is alchemy or physics, there is cross-pollination of knowledge all along the board. It is not a stretch to suggest interdisciplinary scientific research is beneficial to advance material processes and product design. Montgomery (1999) realizes this. He asserts scientists and engineers have a crucial role in these activities. Other research unveils the benefits of such interdisciplinary efforts in science. Fox and Rohlich (1967) view “interdisciplinary inquiry as essential for the solution of certain kinds of environmental problems” (Fox & Rohlich, 1967).

Biomimetics

The field of biomimetics in essence is interdisciplinary. “The well-organized multifunctional structures and biogenic materials found in nature have attracted the interest of scientists working in many disciplines” (Rao, 2003, pp.660). Rao (2003) defines biomimetics as a “field of scientific endeavor, which attempts to design systems and synthesize materials through biomimmicry” (Rao, 2003, pp.659). Bio means life and mimesis means imitation. Fish (2009) defines biomimetics as an approach that seeks to incorporate design research from living organisms into engineered technology by mimicking organic processes.

Prior research strongly supports the idea that biomimetics--which includes but is not limited to chemistry, biochemistry, geologists, physics, biology, material engineers, material scientists, and environmental scientists--holds strong potential in dealing with complex environmental and economic issues. For example, Rao (2003) explains that “material scientists view biomimetics as a tool for learning to synthesize materials under ambient conditions and with least pollution to the environment” (Rao, 2003). Geologists are interested in the biomineralizaton of biomimetics. Biochemists are interested in biomimetics because of the interaction of biopolymers with ions of metals, which leads to mineralization in living organisms (Rao, 2003). This paper is thus concerned with advanced technologies derived from scientific discovery within the scope of Biomimetics. The study of biomimetics offers the greatest potential in the creation of materials and technologies that are benign to our environment.

In the first half of the 20th century researchers found insights into complex physical and chemical phenomena. This led to the current day understanding of nanoparticles and marcroparticles which are termed synonymously with colloids and polymers respectively (Fish, 2009). These are the building blocks for miniature stable tissues. There are also multicellular and single-celled organisms have the ability to produce structure tissues like bone, teeth, shells, skeletal units, and spicules (Sarikaya, 1999, as cited in Lowenstam, 1981). “Natural materials are mostly constituted from organic, inorganic crystals” (Rao, 2003). These crystals give rise to materials that can be used practically to produce products that fulfill human needs without extracting finite resources from Earth.

The following are advanced technological processes that have similar capabilities. Synthetic biology can construct biological systems through manipulation of genomes to construct novel biological systems (Fish, 2009). Bionanotechnology can create materials via peptide-based production (Rao, 2003). Reticular synthesis is the construction of crystalline solid-state materials from molecular building blocks (Yaghi, O’keefe, Ockwig, Chae, Eddaudi & Kim, 2003). It is this synthesis of materials via manipulation of biological means that holds the potential solution to solving the issues relevant to present day production processes. Although these technologies are not without their controversies, they suggest production means that do not have harmful effluents. They are compatible with the ecosystem. Yaghi et al. (2003) claims that the synthesis of new materials is recognized as a crucial stepping-stone in the advancement of technology.

The main idea behind the science is to create inorganic particles that can ultimately produce technologically stable materials for creation of solid-state products. Yaghi et al. (2003) confirms to date these materials have been used for medical products and electronics. There is potential to create other materials that can branch apart from these products into other industries. These materials include silk, ceramics, and other materials with elastic fibers (Rao, 2003).

Possibly the most interesting work in the field today is that of Neri Oxman and her founded Materialecology. Being an architect--MIT Phd Candidate--a medical scholar and computer engineer, she is internally interdisciplinary. Her work spans many disciplines in which biomimetics is at the heart of her innovation.

> Materialecology was formed in 2006 by Neri Oxman as an interdisciplinary research initiative that undertakes design research in the intersection between architecture, engineering, computation, and ecology. As such, this initiative is concerned with material organization and performance across all scales of design thought and practice. As such, it seeks to promote and define a design research agenda which is ecological in nature, in ideology and in material practice; it aims at embracing the evolving elements of change in both social constructs and environmental descriptions of the ever changing built environment. Materialecology undertakes research in advanced digital applications for architectural practice and pursuits using their contribution to design a paradigm promoting generative design processes (Oxman, 2006).

Oxman's efforts exemplify the design leadership needed in this vastly complex world of products and resources. These types of interdisciplinary examples are becoming more popular as we move into the murky future. As suggested by this paper, there will be adversity to overcome. But this adversity is far outweighed by the benefits of such collaborative and advanced approaches.

Discussion

Collaborative effort into scientific knowledge creation has been a continual process that parallels the evolution of man. It is evident that these efforts are integral to moving forward into the future of product design. Interdisciplinary approaches vary depending on the complexity of the project. When it comes to environment and economy which balances an inexhaustible amount of needs and vested interests, the complexity of the issue is unimaginable. This means a coherent body of knowledge detailing how best disparate disciplines should work together is paramount to future design and engineering efforts. Benefits to interdisciplinary design efforts are numerous. The most important benefits being that of speed and an ability to deal with complexity. Strength in numbers is also a benefit. Members' strengths supplant for others' weaknesses. The positive contributions of a team are evident. Goal orientation and group motivation become catalysts for innovation and creativity. Though there are benefits to interdisciplinary design teams, there are also hurdles to be reckoned with. Failure of communication mechanisms is a major hinderance. Lack of unified understanding also vitiates interdisciplinary team efforts. Murky organizational goals do not help the process. If resources are scarce, roles and responsibilities are compromised. There can be a loss of information when it transfers down and upstream. This goes back to the failure of communication mechanisms mentioned above (Safoutin & Thurston, 1993).

Currently the practice of interdisciplinary approaches exceeds the research. Vernacular is difficult to pin down. Theories become unclear. These impediments give rise to a necessary set of critical factors which are relevant dependent on the complexity and details of any given project. Holland et al. (2000) and Frankel and Tsuji (2005) give us examples of these important factors. These include high quality of leadership, mutual respect between members, group accountability, flexibility, humor, and organic but structured organization. Insensitivity to constructive criticism and emotional intelligence among members is important. These factors increase the chance of a successful interdisciplinary team project.

There are several different advanced technologies that have the potential to produce the outcomes that product design needs to fulfill environmental and economical issues that are the concern of this paper. Whether through synthesis of polymers or inorganic materials, the fact that they have the ability to be manufactured biologically is what makes these technologies so promising. This is currently being applied and there is hope for more widespread use within industrial design.

Biomimetics is a long standing scientific field that is interdisciplinary in its nature. Disparate disciplines are interested in its potential for varying reasons. Geologists are curious about biomineralization; while chemists keep tinkering with the genome. On any scale there is vast potential in figuring out and altering biochemicals and processes to create engineered technology.

Proposal/Conclusion

As technologies advance in biomimetics and material synthesis science, industrial designers must become more involved in the process. Industrial designers must look forward to the future and as Wayne Gretzky did (he is considered the greatest professional hockey player ever to play); he went to where the puck was going, not where it was. Scientists will no doubt move forward with technological advancement. It will be up to designers and other entrepreneurial types to envision the future uses of synthesized materials. A framework for an interdisciplinary approach should be created now for the time when these processes are introduced into the mass market. The beginning of such a framework is suggested in Figure 1 on the following page. The four circular domains represent different specialized knowledge. The volume of those domains correlates positively with the amount of information that flows within. Two-way arrows suggest the controlled free flow of information. Disciplines must be communicating within their domains, suggested here, for this model to be successful. The industrial designer's role within this model is, as suggested before, part communicator and part visionary. To do this effectively the industrial designer must be a generalist of sorts. They must posses information from all domains including the critical terminology and cultural awareness of each. This would allow the industrial designer to move in and out of these domains offering and borrowing information for application towards their product vision. If this job of "creative messenger" is done effectively, there would be unmatched synthesis of original ideas that will foster the creation of breakthrough products and processes for many industries.

As mentioned, the industrial designer within this model must be a generalist to do so. This would require a deep understanding of economic principles, advanced scientific theory and of course the artistic and engineering skills that are currently required for the present day industrial designer. This leaves a bevy of educational pathways to be pondered. Suffice it to say, the future industrial designer would benefit from having more than a B.I.D.

This framework is already in flux because relevant disciplines are part of a technological and design oriented continuum that is not separate from the historical and sociocultural fabric. Designers, scientists, and engineers must realize that in the the last half century this continuum has increased in speed to a dramatic degree. Realizing this will allow them to assert control over product, technology, and science, doing so in an interdisciplinary fashion. It is the interdisciplinary nature of these sciences that has moved technology to this point. It is also the interdisciplinary nature of science and its collaborative knowledge creation through which the field will progress. Designers will have to play an integral role in understanding new knowledge of materials, its capabilities and application. They will also need to be savvy communication facilitators, using general knowledge of many different disciplines to foster synergy between those disparate fields of study. It is an exciting but also a dire time wherein innovation and interdisciplinary efforts are pertinent to our future standard of living on Earth.

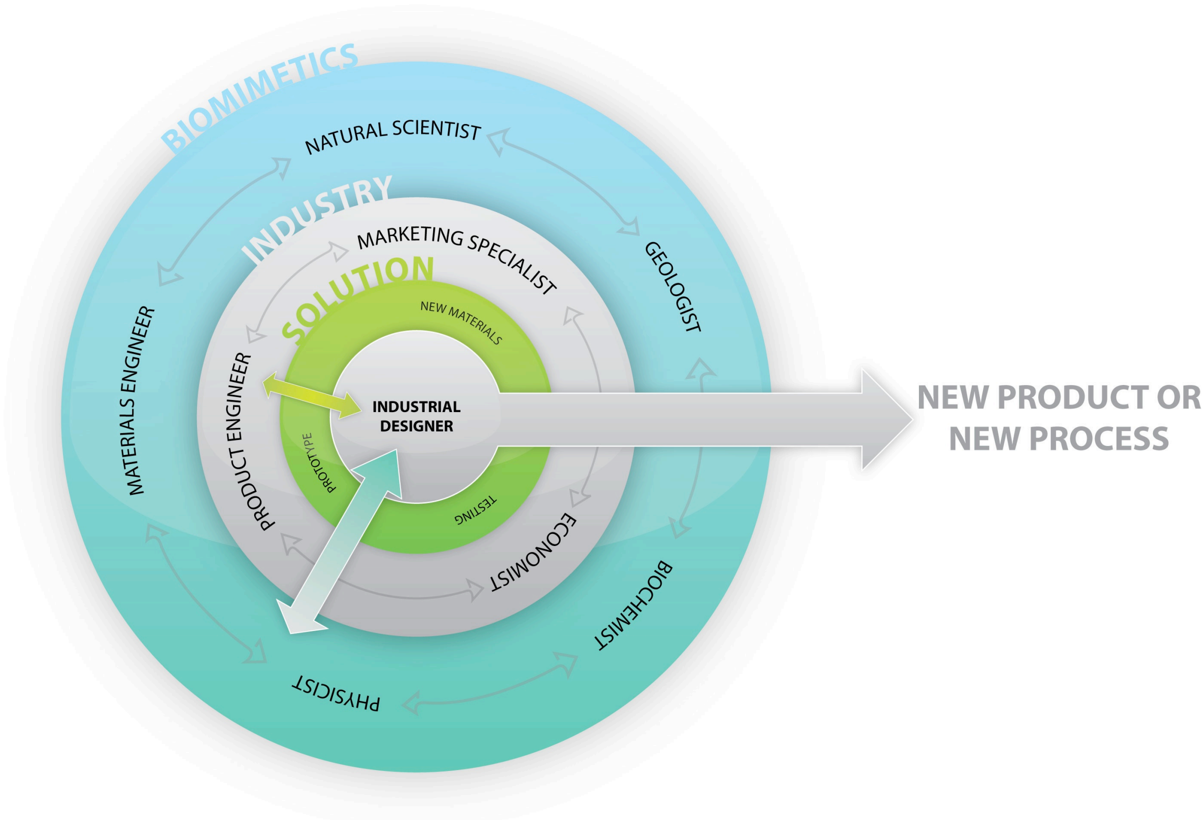

Fig 1. Suggested Interdisciplinary Design Team Structure

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Thinking about design experience: A semantic network approach

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Abstract

Social network analysis software has been used in this study to reveal individual and collective perceptions of space from different perspectives. The paper outlines how to analyse an 'environment-response' semantic network of a user group and that of the architect. The semantic network of the designer was found to be quite different from the users of their designs, a starting point from which to question how far designers of space are able to anticipate what impressions and reactions their designs elicit in users.

Determining what thematic clusters or topics emerge (called 'metatopics' in the study) from the networks is a primary aim. The networks usually contain 4-7 metatopics. A range of network analysis algorithms, calculating measures such as centrality and proportional strength of ties are applied to identify important constructs and help identify metatopics. These metatopics can also themselves be ranked and compared through network analysis indicators. Through these tools, new observations on the structure of collective mental representations of built environments are gathered.

Key words

Semantic networks, network analysis, perception, designed environments, interviews

The assumptions that designers make about the effect their designs have on end users is a vital part of the design process as well as a key part of the design. Social network analysis software 'Pajek' has been used in this study to visualize and analyse the mental constructs toward a particular environment. How people respond to a designed environment has not previously been explored as a network of thoughts, yet this could be a productive use of network analysis given that human relationships with the environment (natural and built) is gaining prominence as a research topic.

The paper discusses two 'environment-response' networks that were derived from a new workplace: one for the user group and the other for the architect. The network of the designer is quite different from that of the user group, thus calling into question in how far designers of space understand what effect their designs will have on users.

The paper firstly outlines why network analysis can be a useful and valid research tool in investigating human responses to the environment. The middle section describes the data used for deriving the networks. The final section, using a case study, discusses analysis of the environment-response user group (consensus) network before showing the designer's environment-response network for brief comparison. Results of this method could be used contribute to discussions on how and why designers conceptualise space differently to users

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(Cross 2006; Lawson 1997) and is an aim of the larger study. This paper refrains from making generalisations of theory in order to present one worked example of a new design research method. The intention is to indicate the utility that social network analysis offers to researchers interested in understanding the thought structure that individuals and groups of people have about a designed environment.

Theorising an environment-response network

This section of the paper provides an overview of key theories that provide a rationale for developing an environment-response network: environmental psychology confirms the existence of a human environmental response; the science of semantic networks explains that thoughts exist as a type of network; an overview of networks as an abstracted set of elements and connections that can be mathematically and algorithmically analysed and represented; and finally, the reasons for applying an environment-response network to a workplace setting.

Environmental psychology

Any environment has a psychological effect on users (Norberg-Schulz, 1980; Rasmussen 1964). Many researchers have attempted to understand what elements of the environment can enhance quality of life (Alexander, Ishikawa & Silverstein, 1977; Gifford, 2007; Zeisel, 1984). The hope is that designers armed with this knowledge could create environments that reduce stress, enhance mental acuity and emotional response and any other desirable outcomes. However, research in this area is generally inconclusive, based on intuition or small-scale studies and has not kept up with scientific advances in other fields.

This year Oxford University Press published *Brain Landscape: The Coexistence of Neuroscience and Architecture* to “challenge neuroscientists to study how architecture affects the brain” (Eberhard, 2009, p.xii). The emphasis the book presents to readers is that the brain, which controls behaviour, is influenced by the environment. Neuroscientists have found that connections between neurons in the brain to continuously ‘re-wire’ to adapt to environmental stimuli all through our adult lives (Gordon, 2000, p.72). Architecture, it is supposed, can change our brains and our behaviour.

Semantic networks

Following on from studies on the network structure of neurons in the brain is a notion that thoughts would also follow a network-like structure. Thoughts about a subject or object (such as architecture), have been considered a type of network in order to “create abstract representations of the general features of input data” (Spitzer, 1999). Spitzer describes these ‘semantic networks’ as relating to associations between words as a form of knowledge representation. Semantic networks were first studied as a concept called *associationist psychology* (John Locke and David Hume) and later *free association* (Sigmund Freud, Sir Francis Galton and Carl-Gustav Jung). Later, it was theorised that words themselves are stored in a network like structure in the brain (Collins and Loftus, 1975). The use of semantic networks as a tool used to examine how thoughts occur has also been used in the context of developing artificial intelligence (Sowa and Borgida, 1991). Concepts underlying semantic networks are relevant to this research project, in which word-associations, extracted from interview transcripts, generate abstract semantic networks that represent respondents’ concepts of architectural spaces. It takes as a starting point the notion that the abstract structural type of the network are tied closely to how subjective ideas about objects such as architectural environments are represented in the brain.

Network analysis

A network refers to any collection of interacting parts, which satisfies certain laws of form and organisation (Buchanan, 2002, p.18). The architecture of networks can be analysed meaningfully and patterns observed where previously none could be seen. To analyse a network its 'parts' are understood as a set of discrete elements (vertices) and connections (edges) between them. Extracting these features provides clarity to a question that would be impossible to answer, were all details to remain (Newman, Barabási & Watts, 2006, p.4). In addition to powerful visualisation capabilities of software, network analysis techniques allows for mathematically rigid measurement of the structure of the connectedness of a network independently of its content.

Sociologists and statisticians have been advancing the field of network analysis since the 1930s, but software for analysing networks really only began appearing in the 1990s when computer scientists became interested in modelling increasingly complex domains. Fields that use network analysis include information technology (including computer networks such as World Wide Web), biology, and the social sciences.

Why look at workplace settings

Many people spend a significant part of their lives at a workplace. Robert Gifford, eminent environmental psychologist, says that "the physical environment at work is crucial to employees' performance, satisfaction, social relations and health" (Gifford, 2007, p.372). Research into people's response to workplace settings focuses on employee productivity and satisfaction (Brill, 1984; Becker & Steele, 1995), but other important areas are to be investigated, especially in an increasingly knowledge-based work environment: collaboration, interaction, social behaviour, being part of a team, control over environment, flexibility, comfort and health (Worthington, 2006). To map out the human response to the workplace environment, Gifford (2007) draws on extensive research to find that five variables of workplace settings primarily contribute to behavioural response: 1) sound, noise, and music, 2) indoor climate, 3) air, 4) light, colour and windows and 5) density and arrangement of space.[1] John Eberhard, author of *Brain Landscape*, also devotes a chapter to workplace design (2009, pp. 135-153). His purpose is to identify areas for further research. It can be concluded that this architectural setting has elicited limited empirical research on the user response, yet is an important architectural type to investigate in terms of its psychological impact on society.

[1] These variables can be observed in the environment-response network, but so do other features, such as technological devices that enable free and easy movement as shown in the later graphs. The usefulness of an environment-response network is that it captures variables in total, so that their relative importance can also be examined.

Fig 1. An atrium inside case study *workplace x*. The environment-response network will reflect the thoughts and feelings of employees that use the space, positively and negatively. (Photo: author)

Data in the environment-response networks

The data was collected from interviews, coded into spreadsheets then transformed into a Pajek readable file.

Data Collection

Data was gathered from in-depth interviews at a series of workplaces (this paper focuses on one, *workplace x*, as an example). Nine to fifteen employees at each case study workplace were asked to talk about their experience of their physical surrounds using metaphors. Metaphors involve understanding one thing in terms of another and are assumed to shape new thoughts (Gibbs, 1992). This technique has been used in the field of psychotherapy to help patients make unconscious experiences more conscious and communicable (Kopp, 1994) and in consumer market research (Zaltman & Coulter, 1995). The use of metaphors is stimulated by a range of images provided to interviewees to help illustrate their thoughts. This technique was used to collect data for the environment-response network as it offers a way to go beyond the interviewee's conscious self-perception of their response to their workplace environment. Once a metaphor, thought or feeling has been stated by a participant they were then asked to elaborate on it and to connect it to an aspect of the workplace that most strongly gave them that response.

Coding the data

Data in the interview transcripts are coded in environment-response pairs, response-response pairs and occasionally, environment-environment pairs. When a thought or feeling is mentioned, its link to the workplace environment or other thoughts or feelings is recorded. Between 40 and 80 pairs are identified for each respondent.

Linguistic research in syntax, the study of the rules of language and sentence structure, is beginning to examine the basis of language as links between words and actions when they share an object of reference. Richard Solé uses this notion to turn linguistic constructs into networks: “two words are linked if they have been syntactically combined in a collection of sentences. Different languages share the same scale-free structure, with most words having few syntactic links and a few of them being connected to many others” (2005). While linguistic theories are being developed, there is not much literature on research methods that translate speech into a network model. What has been done in this study is to assemble networks from meaningful constructs that are connected by association within in a related set of sentences.

Structure of the network data

Each analysed network of a user group has approximately around 100-120 vertices representing meaningful constructs and 600-1000 edges (comprised of 40-80 edge pairs from each individual interviewee). Vertices are either thoughts or feelings about an environment (shown as circles in the network) or workplace environment features (shown as squares). The number of duplicate connections (connections made by several individuals) provides a weighting to an edge. In the visualisations the vertices are sized according to the number of participants mentioning the corresponding construct. The graphs are also undirected as the directions of connections between constructs in interviews are not able to be coded with certainty due to language syntax complexities.

In the consensus network one-off responses are removed so that it only reflects connections about which there is a certain consensus within the respondent group. This consensus data, displayed as a network, provides visual information about the pattern of perception and emotional response to space for the group.

A key feature of the environment-response network is that it demonstrates links between workplace environment features and thoughts and feelings. This allows tracing of how particular responses were generated. While the networks have been abstracted, they demonstrate that responses to any given environment are complex and interrelate with many different parts of the environment. Social network analysis tools enable unpacking and interpreting of that complexity. In reading the networks, caution must be exercised towards the generalisation that certain features will, if installed in a different environment, lead to similar responses. The aim of this paper is instead to demonstrate the potential of analysing the overall environment-response network to observe perspectives on the one environment by different involved groups of people.

Analysing environment-response networks

Analysis of environment-response networks takes, using social network analysis (SNA) terminology, a ‘sociocentric approach’, in which the structure of the entire network is analysed as opposed to focusing on the position of one of the constructs of the network, or an ‘ego-centered’ approach, although this can be done on a case-by-case basis when much more information specific about a case is desired. In addition to the visualisation capabilities of network analysis software, the network analysis operations used for the environment-response network are proportional strength of ties, removal of edges, centrality measures (degree centrality and closeness centrality), cut points and bi-components.

To analyse the environment-response network it was first considered what analysis was desired from the network. Determining what thematic clusters or topics emerge (which we've called 'metatopics') from the networks is a primary finding. The first step is to reduce the number of nodes on the user group network by removing one-off responses. The reduced network is then visualized by drawing vertices with strong connections close together. Important vertices are identified. These include the most highly connected workplace environment features and thought or feeling responses, and the most central workplace environment features and thought and feeling responses. The vertices that, if removed, break the network are found, as they are important links in the overall perception of the workplace as well as possibly indicating the location of clusters in the network. The identification of metatopics follows on from the above steps and through domain knowledge. These clusters can be ranked and compared through number, sizes, values and density of their nodes and the location of the cluster in the network. Highlighting metatopics reveals additional pivotal vertices in the network, such as vertices that connect clusters together, but whose importance as a link may not been so clearly seen without domain metatopic clustering. This section presents these steps using the data gathered from interviewing a user group of case study *workplace x*.

The automatic layout to generate all depictions of networks uses the Kamada-Kawai algorithm. For small networks that have less than 500 vertices it produces regularly spaced and stable results (Nooy, Batagelj & Nooy, 2005, p.17).

Reducing and drawing the network

The vertices are sized proportionally by the number of respondents mentioning it and the edges thickness by the number of respondent mentioning the link. Drawing all the connected constructs or vertices, totalling around 100-120, makes for a very difficult to read graph (Fig. 2). Removing one-off responses makes the graph more valid and helps to focus on items that are important across individual conversations.

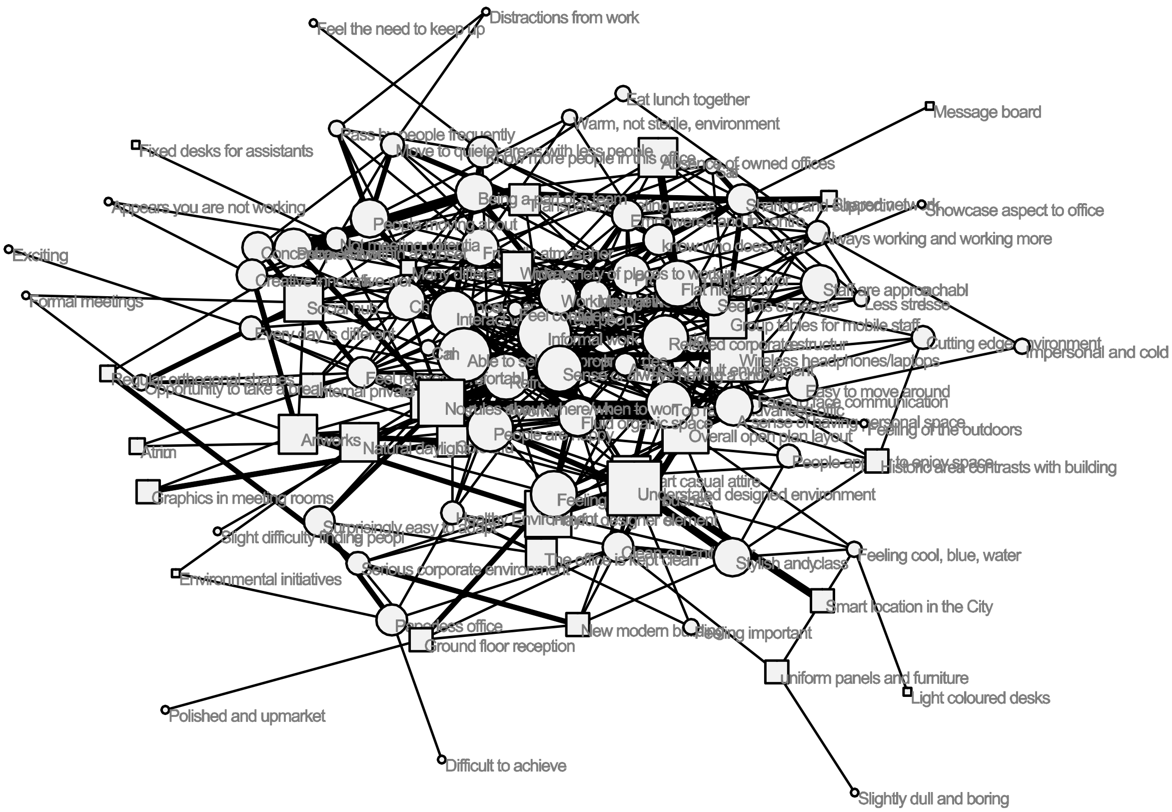

Fig 2. The complete environment-response network for the group of users interviewed in workplace x. The network is difficult to read when all the coded responses are included.

The reduced consensus network is drawn by positioning vertices with strong connections close together using proportional strength of ties (Fig. 3). Visualising proportional strength of ties helps identify categories of themes later, but is shown now so that the same graph layout may be used to demonstrate all the following analysis steps. The calculation considers the importance (or exclusivity) of an edge. It is calculated as the edge weight of a tie to a vertex divided by the sum of all ties incident to that vertex. A tie is not very important for a vertex if it has a low edge weight and is just one of many. For each edge there are two results depending on the vertex the strength is calculated relative to. For instance, in Fig. 3, the ties between *sense of having a choice* and *fluid organic space* have two values. The vertex *sense of having a choice* is one of three ties that *fluid organic space* has and the connection has a value of 0.33. In the opposite direction the tie is much weaker with a value of 0.08 as *sense of having a choice* has many more ties, several of them also having stronger edge values.

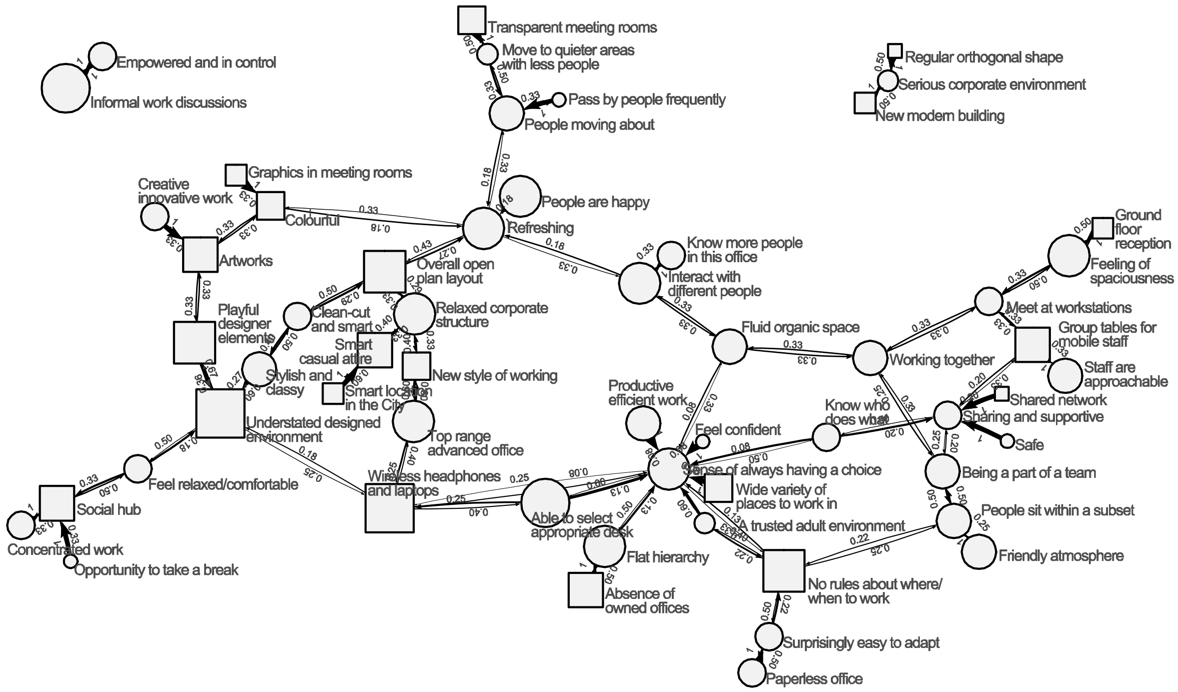

Fig 3. A consensus environment-response network for a user group in *workplace x*. One-off responses are removed and vertices with strong connections are drawn closely together. The squares are workplace environment features and circles thoughts and feelings.

Most highly connected vertices

Highly connected environmental features control a constellation of feelings about the workplace, and highly connected thoughts or feelings are quite permanent and strong. A vertex ‘degree’ is simply the number of lines incident with it. They are likely to be found in dense sections of the network.

The most highly connected workplace environment features (squares) are shown in grey in Fig. 4. These three elements of the workplace (*understated design, wireless headphones/laptops, no rules about where to work*) have the most control and influence over how the user group thinks and feels about the experience of the workplace. Removing or changing these features will have a major impact on the structure of the network, thus perception of the workplace.

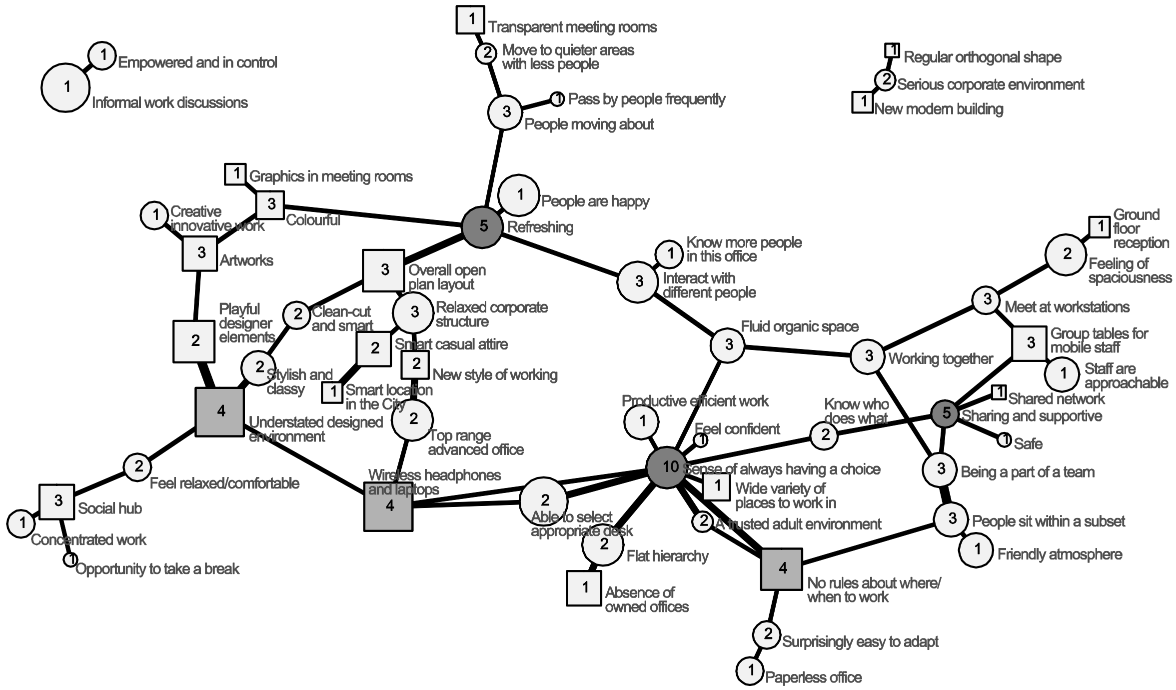

Fig 4. Highly connected vertices (degree centrality). These show the most controlling/influential vertices on the environment response network.

The most highly connected thought or feeling responses to the workplace (circles) are shown in a darker grey in Fig. 4. These thoughts are quite permanent and strong. Many workplace changes are needed to change these thought responses. For example, the feeling that the workplace is *refreshing* is connected to five other constructs. Interestingly, only one, s*ense of always having a choice*, is directly connected to one of these influential workplace features. The degree average for all vertices in the network is 2.18.

Most central vertices

These are the most central or embedded vertices within the network. Their centrality is brought on by often distant nodes in the network, making it difficult to determine the impact changing a workplace feature (square) will have, or what features effect a central thought or feeling (circle). They are found using a closeness centrality algorithm. This is based on the total distance between one vertex and all the other vertices, where larger distances yield lower closeness centrality scores. The closer a vertex is to all other vertices the higher its centrality. The degree centralities for all vertices are given in Fig. 5, with the most central ones in grey. The closeness centrality calculation results in continuous rather than discrete scores, which enables Pajek to draw the vertices according to its closeness centrality value. The arithmetic mean for closeness centrality across all constructs is 0.186 (from a range of 0.035 to 0.296).

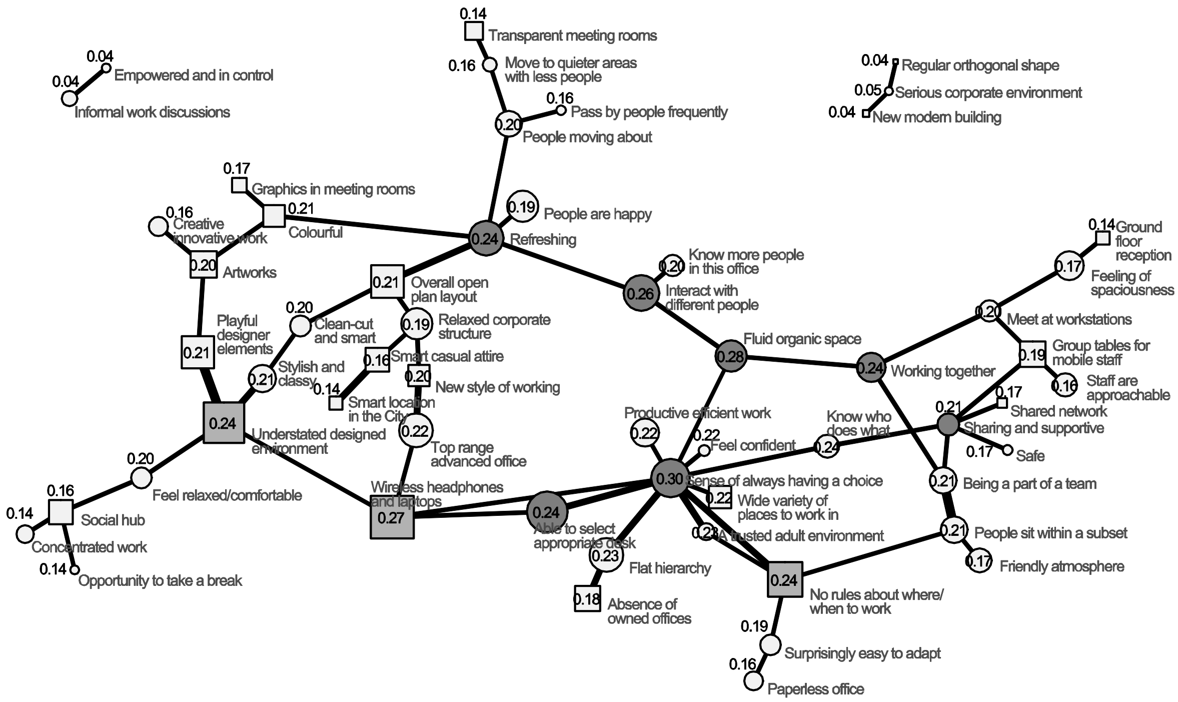

Fig 5. Central vertices (closeness centrality). Vertices are sized according to their closeness centrality values.

Vertices that break the network

Identifying cut-vertices and bi-components can be helpful in locating clusters in the network. Cut-vertices are all vertices whose removal, and all edges incident with it, breaks the network into more than one component. The numbers on the vertices in Fig. 6 refer to the resulting number of components should the vertex and its incident lines be removed from the network. It identifies vertex constructs that are necessary to link constructs (in particular chains or subnetworks of constructs) to the bigger picture. These linking vertices control the flow from one component of the network to another.

Bi-component operations are a subset of cut-vertices. It identifies those vertices that break a network into components whereby each vertex in the subnetwork connects to at least two vertices. They can indicate a more strongly clustering of vertices within the network. No positive result occurs in this example network.

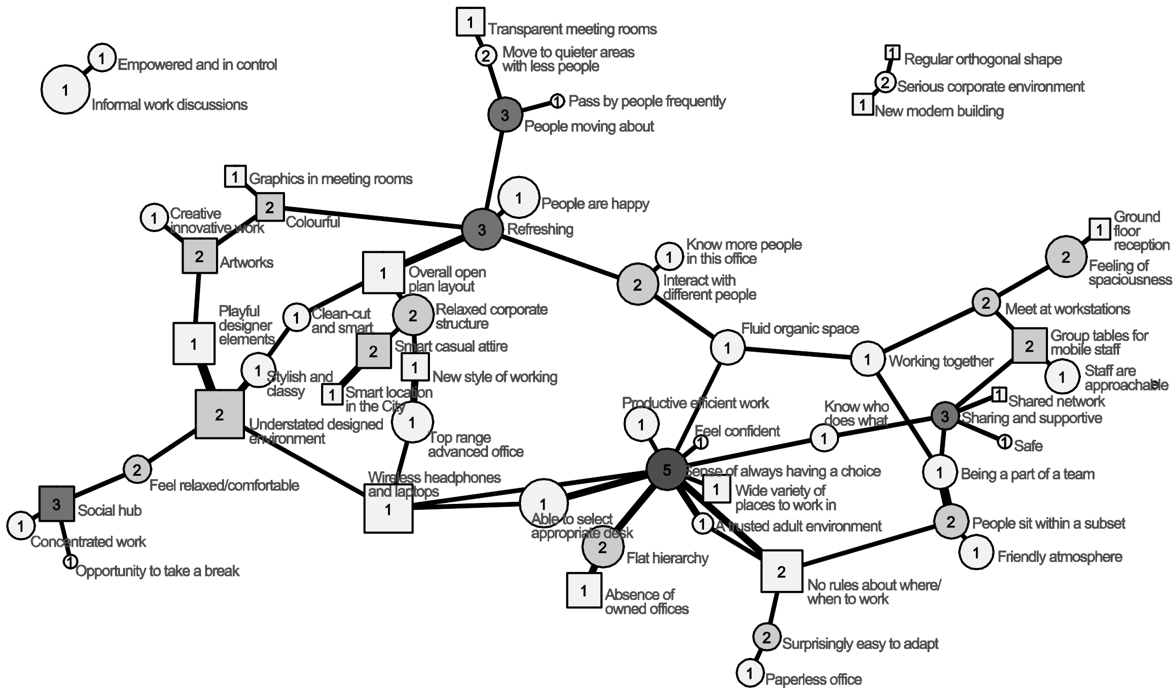

Fig 6. Vertices that break the network (Cut vertex). The vertex values show the number of components that would result should the vertex and its incident lines be deleted.

Metatopics

All previous network analysis steps help to understand where clusters of themes or topics may emerge from the network. But separating vertices into thematic clusters also requires domain knowledge of which vertices can be grouped together in a meaningful way, and to be able to define and name metatopics represented by the clusters.

In the users' environment-response network (Fig. 7) there are six metatopics, labelled *creative*, *stylish and professional*, *social*, *freedom and choice*, *team* and, separate from network, *serious*. The most important metatopics are identified by observing the number of nodes, sizes of the nodes, how closely they are drawn together, their interconnectedness (or density), the centrality values of its nodes, the location of the cluster within the network (does it take a central position by having connections with other clusters?) and the connectedness of the cluster to other clusters.

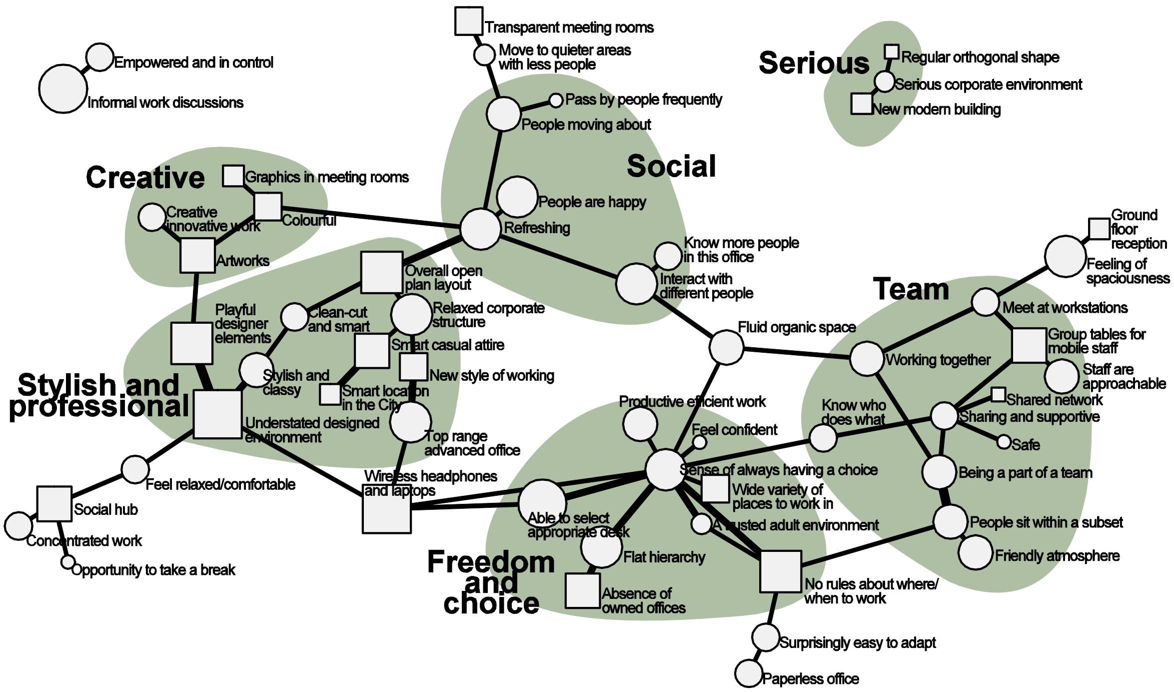

Fig 7. Metatopics for the user group of *workplace x*.

In this network the cluster *freedom and choice* is the most prominent cluster by these measures. Although it is not the cluster with the most vertices it contains the highest scoring vertex on both centrality measures (*sense of always having a choice*), a central workplace environment feature (*no rules about where/when to work*) and a high value closeness centrality vertex (*able to select appropriate desk*). It directly connects to two other metatopics and another indirectly, and its vertices connect to each other with multiple weighted edges. At the opposite end, the metatopic *serious* takes a minor role in the user response. While it is a recurring subject in user responses, it takes no influential role on the other thoughts and feelings that the users have.

One of the most pivotal vertices in the network is *fluid organic space*. It connects to the metatopics *social*, *freedom and choice* and *team*, and at the same time is not a part of any of these categories. While its degree centrality is average, its three edges are key in connecting metatopics. Its significance is better indicated by its closeness score, which reflects its average distance to all other vertices. The closeness centrality score is 0.28, the second highest in the network. Although the feeling that the workplace is a *fluid organic space* is a key finding in the network analysis, this certainly is not something that can be easily seen when visiting the workplace. It would also be a difficult property to be asked to 'design' into an environment. Another notable element is the workplace environment feature *wireless headphones/laptops*. It only connects two categories, but it does rate highly on both centrality measures. This indicates it is influential as to how the workplace is thought about.

Comparing the users' network with the designer's

All the steps mentioned above, involved in the network analysis of the user group, also took place to define the clusters of thoughts or metatopics that the designer has towards *workplace x* (apart for step one because it is an individual rather than consensus network). The same colour coding from the user's network (Fig. 7) is used in the architect's (Fig. 8) to allow identification of similar metatopics, with a dotted grey outline used to indicate themes the architect does not share with the user group. Both networks exhibit themes of *serious*, *team* and *social*. Interestingly in the designer's environment-response network *serious* has become one of the more significant metatopics. In this network it contains a greater number of vertices, with increased density (interconnectedness), and it is, albeit at some distance from the rest of the network, now connected to the network. The categories of *team* and *social* match the user group network reasonably well. The architect does not include the themes of *creative*, *stylish and professional*, or *freedom and choice*. Instead, categories of *uplifting*, *informal*, *cutting edge* and *easy* are added. The fact there is no metatopic corresponding the one the users mostly use to categorise their environment, *freedom and choice,* is quite surprising. In this case the users see the workplace generally more positively than the designer does. Further studies may help to clarify what factors contribute to a discrepancy in this direction.

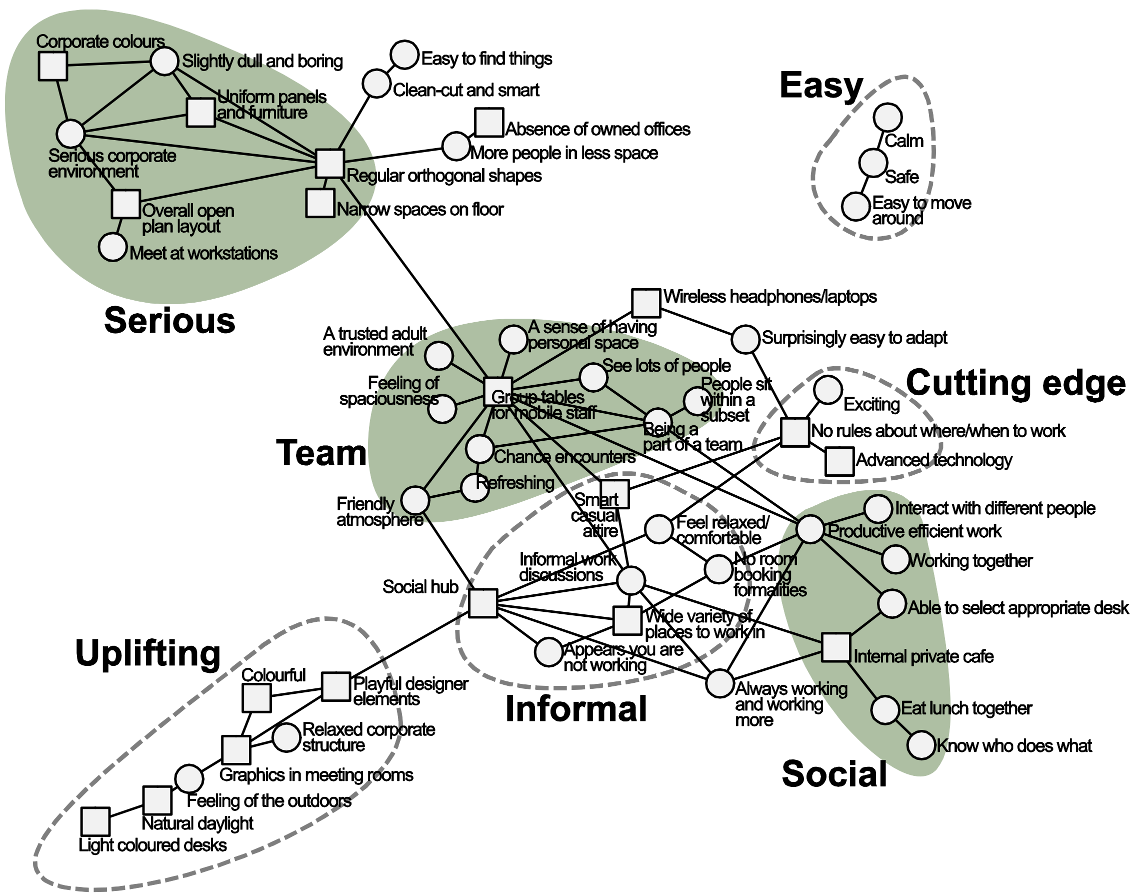

Fig 7. Metatopics for the designer of *workplace x*. The grey clusters indicate metatopics shared with the users' and the dotted clusters are metatopics unique to the designer.

There is no pivotal thought or feeling characterising the environment for the designer. In fact, the construct *fluid organic space* that was so prominent in the user network does not register at all in the designer's response. On the other hand, the workplace environment feature *wireless headphones/laptops* connects, yet stands apart from, two categories in both networks. It also exhibits high centrality within the network of the architect's responses.

Also interesting is that many of the vertices (workplace features or thought constructs) correspond to similar ones in the user group network, but forming different combinations, and thus metatopics. For example, in the user network the workplace feature *overall open plan layout* is allocated to the category of *stylish and professional*, but in the designer network it is connected to very different vertices and is allocated to the metatopic *serious*. In the user network the *social hub* is perceived as somewhat marginal, but for the designer it is an important feature (and has higher centrality values in this network).

It might be expected that workplace environment features would take central positions in the designer's network due to their focus on being on the physical elements of the workplace, with thought constructs taking secondary roles. But this is not the case. In both networks the central elements are roughly equally divided between workplace environment elements and thoughts and feelings.

Conclusion

The application of network analysis to interviewee response constructs demonstrates a way in which networks can be used to visualise 'group think'. The significance of being able to analyse centrality of constructs and identify clusters using network analysis is highlighted in this case by the fact that the user environment-response network is quite different from that of the architect who is professionally expected to predict the implications of design decisions on the users' perception of space.

By using network analysis to help identify central vertices (constructs that control a constellation of themes) and metatopics (collective orientations or themes), observations are gathered on the structure of collective mental representation of built environments. This is considered an initial step towards further research into interaction between designer and users.

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Assessing Creativity in the Context of Architectural Design Education

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Abstract

In a study on architectural education in Australasia, Ostwald and Williams (2008a; 2008b) found that one of the most contentious issues facing architecture and design education is the assessment of creativity. The problem is not new, yet, despite ongoing criticism of the frameworks used to assess creativity in architecture and design, the assessment of students' creative work remains a vexed issue. Central to the problem of assessment is the lack of an unambiguous disciplinary definition of creativity. The concept of creativity has been understood in different and often conflicting ways, and across the design disciplines there is no shared understanding about creative processes and, in particular, how they apply to learning and teaching experiences. The paper briefly outlines the main problems related to assessing creativity before exploring the complexity embodied in the notion of "creativity" as it relates to design education. The research presented in this paper is derived from an extensive and critically framed literature review and forms part of an ongoing research project concerning the question of creativity within design education.

Keywords

Creativity; Assessment; Design Education

The constant and radical changes which are characteristic of the modern world makes it, as Dineen and Collins (2005: 44) observe, impossible

> to base our future on the certainties of the past. Unable to define *what* we need to know, we have begun to focus on *how* we will need to know, on the flexibility and openness which characterises creative thinking. Creativity is now seen to be the wellspring of human adaptability and social development.

Creativity, often defined as the development of ideas or work that have the quality of being both useful and original (e.g. Amabile, Conti, Coon, Lazwnby, & Herron, 1996; Elton, 2006; Mayer, 1999; Paulus & Nijstad, 2003; Sternberg & Lubart, 1999), plays an important role in the process of cultural reproduction, technological advancment, innovation and intervention (Runco, 2004). A significant force for innovation and change is design, of which creativity is considered a key element. Whereas other sciences are concerned with the analysis and description of existing realities, design is about the imagination and synthesising of new realities; that is, central to a designers' work is the search for novel and unexpected solutions to problems. Moreover, in contrast to the arts, design "is essentially guided by human purposes and is directed towards the fulfilment of intended functions" (Alexioua, Zamenopoulosa, & Johnson, 2009: 623), accentuating the importance of meeting requirements and developing appropriate and influential solutions.

Design is often described as pertaining to "ill-defined" or "wicked" problems (e.g. Casakin, 2007; Rittel & Webber, 1984) that require creativite solutions. As Casakin (2007: 22) explains, "the exploration of unfamiliar and unconventional design solutions requires creative skills […] Creativity enables the talented designer to transcend conventional knowledge domain[s] so as to investigate new ideas and concepts which may lead to innovative solutions"; it enables the designer "to perceive a problem from unorthodox and innovative perspectives" (Casakin, 2007: 21). When conventions are challenged, design moves from routine solutions towards innovative, non-routine solutions. Though design activities encapsulate the spectrum from routine to non-routine design, the groundbreaking designs are those which possess innovative and creative qualities; that is, design that changes the design variables in such a way that the results are solutions that were previously unknown (innovative design) or design that introduces new variables and that subsequently produces entirely new products (creative design) (Gero & Maher, 1993).

Judgement of design products will always, even at its most basic level of distinguishing routine from non-routine design, reflect a consideration of creativity. To be more precise, creativity is one of the requirements that design is being assessed against. However, despite the preliminary definitions of the concept, exactly what is meant by creativity remains unclear and definitions of the concept are in many respects vague and ambiguous. This situation has serious implications for design education wherein "creativity" is often a stated learning objective. This paper aims to initiate discussion about the concept of creativity as it relates to the design disciplines. It begins with a brief outline of some of the challenges facing design education in relation to assessing creativity. This is followed by a discussion of the concept of creativity as it relates to education and, more specifically, design education.

The problem of assessing creativity

In a study on architectural education in Australasia, Ostwald and Williams (2008a; 2008b) found widespread confusion and disagreement surrounding assessment practices for design. They identified three key problems related to creativity and design education: firstly, there is a lack of understanding of the pedagogical dimensions of creativity in architecture and design; secondly, there is a lack of appropriate strategies to understand where different levels of creativity occur and how they should be assessed; and, thirdly, there is a lack of appropriate models or tools to support the assessment of the creative component of design. These problems relate to a paradox embedded in contemporary design education; namely the contradiction between Australian universities' quality assurance protocols, which call for objective or transparent assessment of all students' work, and the complex, heuristic nature of design, which require evaluation that is inevitably subjective.

In response to the demands of objectivity and transparency, there has been a growing regional trend to develop marking criteria for design and to adopt a complex combination of quality assurance and assessment protocols to provide a level of objectivity. However, there is a clear distrust within the discipline of this trend and it has often led to further problems. The student participants in Ostwald and Williams' (2008a) study, for example, argued that over-defined learning and assessment outcomes 'stifles' their opportunities to be creative and that teachers fail to recognise their creative efforts. But, where such protocols are not in place students express high levels of stress surrounding the assessment of their creative works (Bachman & Bachman, 2006; Ostwald & Williams, 20081, 2008b) and they experience difficulties in identifying aspired learning outcomes, further causing frustration and dissatisfaction.

The problem facing design education is therefore twofold: it is a legal/administrative problem (how can we assess creativity in a way that meets national standards for quality assurance?), and a pedagogical problem (how do we assure that students receive appropriate and useful feedback, and how do we ensure a common understanding between students and staff with regards to assessment criteria of creative works?). These problems are at the core of the research project of which this paper forms part.[1] Whilst the project as a whole will address the problems and propose solutions, the paper explores the conceptual issue underpinning the problems; namely, the questions of what creativity means in relation to education and, more specifically, design education. The purpose of the paper is not to solve the problems of assessment, but instead to initiate a discussion about creativity as it relates to design education.

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[1] The research project, *Assessing Creativity: Strategies and Tools to Support Teaching and Learning in Architecture and Design*, is funded by the Australian Learning and Teaching Council (ALTC). The project aims to create a conceptual framework for understanding creativity and to generate a set of shared terms and concepts that can be used when assessing the creative component of students' work. The project is set to finish at the end of 2011.

Creativity and education

During the latter half of the 20th century there was an upsurge in research into creativity and, in response, training to support creativity took a new direction. Calls for educational forms of teaching that could encourage creativity were repeatedly made, propagating ongoing discussion about whether or not creativity is a trait of a few individuals and whether or not it can be taught, promoted or fostered (Cropley, 1997: 83). At this point of time, creativity was generally held to be the trait of particularly gifted children. This notion of creativity as a "gift" can be traced back to Immanuel Kant (1724-1804) and the so-called romantic model of creativity. The Kantian notion of creativity portrays the creative individual as someone who possesses "an extraordinary innate 'gift' that is beyond the grasp of mere mortals" (Cowdroy & Williams, 2006: 100). It is a later version of the romantic idea first posited by Plato, who saw creativity as a result of divine inspiration, a process of unfettered and undisciplined "agonised" searching (musing). The romantic belief of creativity as something that lies beyond the rational conscious and that rational deliberation interferes with creative processes (Sawyer, 2006: 15) suggests that creativity is an innate (or divine) force that cannot be promoted or fostered; creativity, as divine inspiration, is the result of an artists' undisciplined and unfettered agonised searching (Cowdroy & Williams, 2006; McIntyre, 2008).

In 1963, in an emotional plea to reconsider current practices of educating "the gifted child", E. Paul Torrance (1981[1963]: 6) argued that gifted children had been regarded as "mysterious, beyond human understanding, evil and unrighteous". He proclaimed that, as a result of an "unwillingness to accept a realistically complex picture of the human mind and personality" (Torrance, 1981 [1963]: 7), gifted children had suffered. During the time of Torrance's writing, a common perception of gifted children was that they held superior potential and should therefore be able to look after themselves; gifted children were seen to "already have more than others" and questions were therefore made as to why society should "be concerned about giving them more" (Torrance, 1981 [1963]: 6). Torrance responded to this belief by proposing that the very complexity of the human mind and the respect for human values demand that education and guidance make room for both convergent and divergent thinking, discipline and creative behaviour. In fact, "order, discipline, organization, guidance, purpose, and direction are necessary, even for creative behaviour, and are not incompatible with creativity" as long as "order, discipline, and organization [… are] flexible enough to permit change and to allow one thing to lead to another" (Torrance, 1981 [1963]: 17).

The level of understanding of creativity and giftedness has changed significantly since Torrance's research was first published. The idea that children should be able to develop their potentialities to the fullest has gradually transformed educational practices to emphasise the role of creativity, both as a *tool for learning* and as a *desired educational outcome* (in terms of enhanced creative ability and performance) (see also Plucker, 2002). Educators have moved away from a narrow view of creativity as a trait of particularly gifted children, to emphasising the psychological aspects of creativity that are present, at least as potentials, in everyone. Despite this conceptual change, the combined issues of creativity and education remain contested. A general view is that the modern school system, with its focus on conformity, may discourage students' curiosity, ingenuity and, ultimately, creativity, and that pressure to conform and to satisfy prescribed standards present obstacles for creative personalities to unfold and develop (Chamorro-Premuzic, 2006). However, as was noted by Guilford as early as 1950, education has a role to play in relation to creativity (Guilford, 1950). Of importance to the development of creativity are knowledge, experience and readiness for ideas (Cunliffe, 2008; Pederson & Burton, 2009), all of which can be expanded through education. Education provides opportunities for students to engage in creative activity and learn about creative endeavours; it broadens their knowledge base and experience, subsequently enhancing their chances of creative success.

The idea that creativity can be fostered and promoted rests on the proposition that, by providing a favourable environment and appropriate learning conditions, the characteristics underpinning creativity can be developed (Cropley, 1997: 83). Accordingly, when speaking about creativity in relation to education, a holistic approach to creativity is required. This means that the romantic idea of creativity must be replaced by a rationalist model, which emphasises creativity as being "generated by the conscious, deliberating, intelligent, rational mind" (Sawyer, 2006: 25).[2] As Cropley (1997: 107) concludes in his discussion of how to foster creativity in the classroom:

> [w]hat is needed is an approach in which all aspects of teaching and learning adhere to basic principles for fostering creativity. These involve […] not only intellectual, but also personal, motivational, emotional, and social aspects of creativity […] children need contact with complexity, ambiguity, puzzling experiences, uncertainty, and imperfection.

In recent years there has been a move away from the traditional teacher-centred approach to learning towards a student-centred approach that emphasises problem-based learning and enquiry-based curricula, this change being particularly evident at the university level.

It is today commonly held that a curriculum that makes the students responsible for their own learning process will encourage creativity. In contrast to traditional teaching methods, where the instructor is responsible for teaching and the student for learning, in the student-centred approach teachers should serve as "facilitators of learning" and support the students in their endeavour (Elton, 2006: 131). As Lindström (2006) maintains, creative ability is developed through investigative work and inventiveness. In the educational context, investigative work refers to the use of assignments that allow students to explore central themes in the domain over extended periods of time. Inventiveness, on the other hand, concerns the need to emphasise process as well as product, and to provide opportunities for research, experimentation and revision. This last point addresses the role of the teacher, who, as Lindström (2006) argues, must be sensitive to students' signals of creative behaviour, such as being adventurous and willing to take risk. The teacher must show appreciation and approval of the students' courage. Moreover, the teacher must encourage students to integrate production with perception and reflection, to engage in self-assessment and to be open to feedback from teachers and peers. The question of self-assessment refers to the need for *criticality* (Elton, 2006); for learning to be possible and creativity to be encouraged, it has to be accompanied by the ability to separate bad ideas from good ones, to assess process, performance and end product, and be open for critique from others. The question of criticality and self-assessment indicate a social, interactive aspect of creativity. An important part of creativity is evaluation; through self-assessment and review, the creative idea moves through stages towards the final product.

Creativity and design education

In contrast to other disciplines, the very essence of architectural and design education is project-based, or problem-based, learning.[3] It does not seek a single correct answer, but instead encourages students to make speculative and exploratory propositions that reflect their competence and knowledge of the field. This teaching strategy is conducive to creative thinking, which, as stated above, is the *raison d'etre* of architecture and design. However, there is an inherent paradox within the traditional teaching models of design. While the traditional model seeks to promote and encourage creativity, the very paradigm on which it is founded defies critical and empirical examination, teaching and assessment.

The traditional teaching methods in architecture and design, including the one-to-one master-apprentice teaching style, the *Beaux-Arts* "neo-classical" teaching method and the Bauhaus "modernist" educational approach, reflect the romantic notion of creativity: the apprentice model of vocational education is founded upon the idea that creativity is a gift, it is innate and cannot be taught; the studio model is based upon the assumption that creativity can be taught in larger

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[2] The rationalist model of creativity can also be traced back to ancient Greece; more specifically, to the writings of Aristotle who emphasised that conscious work, rationality and deliberation is required in order to complete creative inspiration. In Aristotle's view, creativity was potentially more humdrum than previously anticipated and it included the creation of uncomplicated or predictable objects. It was, however, first during the English Renaissance that the romantic idea of special talent or unusual ability, a manifestations of an outside spirit, was seriously challenged. This epoch valued reason above all, and the emerging rationalist model emphasised reason, knowledge, training and education as essential to creativity.

[3] The word "problem" is used in this context to refer to wide range of situations, some of which may be framed as opportunities, open-investigations, or as "wicked" or "ill-defined' settings."

groups, though only by long and direct association with a talented patron; and, the competency-based teaching models of vocational education reflect a reproduction model of creativity which suggest that creativity can be taught *en masse* but only by reproduction of the work of past masters (Cowdroy & de Graaff, 2005; Cowdroy & Williams, 2006). Whereas these models emphasise different stages of the design process (schematisation and execution), they do not focus on the imaginative conceptualisation, which, according to Cowdroy and de Graaff (2005: 511), is "the highest level of creative ability". This is problematic as "conceptualisation is of the essence of creativity […] if it is neither taught nor assessed, then it must be accepted that creative ability as a whole is neither taught nor assessed" (Cowdroy & de Graaff, 2005: 511).

This conclusion rests upon a particular hierarchical definition of creativity that emphasises the cognitive processes underpinning creative works. The definition presented by Cowdroy and de Graaff (2005) is developed further by Cowdroy and Williams (2006) in the article, *Assessing creativity in the creative arts*. They argue that there are three "agreed" types of creative ability, each representing a progressive stage in the movement from initial idea to realised work. The three hierarchical stages are conceptualisation, schematisation and actualisation, each of which require a particular type of memory (emotional, declarative, and procedural) and thinking skills (imaginative, originality; recollection, orientation, extrapolation, planning, innovation, inventiveness; and, development of abilities to accommodate innovations and inventions). Creative abilities, they argue, require

> combinations of particular types of memory, particular types of thinking skills and particular crafting skills. At the schematization and actualization stages, the thinking and behavioural aspects could be considered separate. At the conceptualization stage, however, only thinking is clearly involved [...] high-level creativity involves progression from conceptualization to schematization to actualization, and [...] a decision (commitment) must be made (perhaps unconsciously) in order to progress from one stage to the next stage, and a further decision on how to maintain continuity of the originating idea must also be made (Cowdroy & Williams 2006: 107).

Cowdroy and Williams (2006) identify the connecting thinking points as "facilitative thinking" and they conclude that this form of thinking is intentional and directional and, as such, represent a strategic thinking behaviour.

This definition of creative ability proposes a framework within which teaching, learning and assessment strategies can be developed. The definition, set within a cognitive psychological framework and "tracking the psychological processes of inspiration and complex decision-making" (Cowdroy & Williams 2006: 97), represents an innovative approach to creative design education. It illustrates the importance of the creative process as an object for teaching an assessment, and it moves beyond the generic definition of creativity according to the descriptors "originality" and "appropriateness". Understanding, teaching and assessing design creativity require a definition of creativity that transcends these descriptive nouns; whereas it allows judgement of creative products, it is problematic when considering other aspects of creativity, in particularly the creative process.

Although definitions of the creative (design) process exist, there is no consensus within the design disciplines as to what creativity really is and exactly what is being taught as creativity remains unclear. The romantic model of creativity and individualist approaches that perceive creativity as spontaneous, unconscious or as an inner spirit retain their influence on conventional understandings of the concept, despite scientific evidence that reject such notions as inaccurate or misleading. Lacking a clear disciplinary definition of the concept of creativity, these, as well as other myths and popular stereotypes, further complicate an already complex field. As stated earlier in this paper, exactly what constitutes creativity—as an object for teaching and assessment—remains vague, and a lack of stated, recognised standards suggests that the teaching and judgement of design creativity inevitably relies on the instructor's subjective understanding of creativity. This, in turn, may potentially diminish transparency and consistency in teaching and assessment practices, and students may find themselves confused as to the requirements of their creative tasks.

The design process is a dual procedure that involves two continuous dimensions; namely *problem solving,* wherein the process begins with a set goal, and *concept generation*, wherein the process begins even when the goal is absent (Yukari, 2009). Creativity has often been defined as a process of problem solving, but, as is suggested by the parallel process of concept generation, there is more to the process than this. Creativity and creative processes are as much about *problem definition* as they are about problem solving. This is identified by Sternberg and Lubart (1993) who argue that there are three insight processes that may lead to creative thinking, namely (a) *selective encoding* (noticing what is potentially relevant to understand and solve problems), (b) *selective comparison* (relating new and old information), and (c) *selective combination* (correlating appropriately connected information). These processes require knowledge and familiarity of the relevant field and domain.

These assumptions suggest that when teaching and assessing design creativity, it is necessary to consider, not only the final product, but equally the creative process leading up to it. The definition of creativity as the production of original and useful work emphasises the tangible outputs of creativity, but fails to consider the creative process, the creative person and the creative environment. Whereas the process and product are of main concern to design educators, attention should also be paid to the creative person (personality traits, intuition, intelligence, values, personal attributes, intrinsic motivation, experience and skills) and the creative environment (external motivation, social dynamics, pressure on the creative process or on creative individuals). The four aspects (person, process, product and press) have often been considered independently in the literature. However, as Margaret Portillo (1996) argues in her study of implicit theories of creativity in beginning design students, these four are interconnected. Portillo defines creativity as a multidimensional construct involving person, process, product and place (environment/ press). She argues that an understanding of the creative person and how personal factor intercedes with the three other aspects of creativity is essential to understanding creativity. Understanding creativity requires an understanding of cognitive characteristics as they relate to the creative process (aesthetic taste, imagination, integration and intellectuality, decisional skills and flexibility), motivational attitudes as they relate to the creative product (goal-orientation and seeking recognition for creative work), and personality traits as they relate to place (being unorthodox, challenging societal norms).

Portillo's theory can be classified as a confluence theory of creativity. Confluence approaches form part of what is often referred to as contextualist approaches to creativity, distinct from the individualist approaches characteristic of much of the psychological work on creativity. The contextualist approaches to creativity emerged during the 1980s when a group of psychologists turned to other social sciences such as sociology, anthropology and history with the aim of expanding the notion of creativity. They moved beyond the psychological emphasis on the individual and considered how creativity, creative abilities, creative processes and creative products reflect an interactive engagement between the individual and the social environment. In contrast to other contextualist approaches that emphasise the manipulation of environmental variables to increase creative production, confluence approaches perceive the sociocultural milieu as only one of many variables that form part of the concept of creativity. An example of such a theory is Mihaly Csikszenmihalyi's (1988; 1996; 1999) system theory. Csikszenmihalyi argues that:

> [i]f creativity is to retain a useful meaning, it must refer to a process that results in an idea or product that is recognized and adopted by others. Originality, freshness of perception, divergent-thinking ability are all well and good in their own right, as desirable personal traits. But without some form of public recognition they do not constitute creativity (Csikszenmihalyi 1999: 314).

Creativity is a phenomenon constructed through the interaction between producer and audience; that is, creativity is the product of "social systems making judgements about individuals' products" (Csikszentmihalyi 1999: 314).

Central to Csikszentmihalyi's theory are the concepts of domain and field. These concepts refer to two salient aspects of the environment within which individuals operate; namely, the cultural, or symbolic, aspect (domain) and the social aspect (field). Creativity occurs when an individual makes a change to the symbolic system and when this change is adopted by the social organisation of the domain (the field). That is, creativity as a product occurs "at the intersection where individuals, domains, and fields interact" (Csikszentmihalyi 1999: 314). Csikszentmihalyi summarises the system view of creativity as follows:

> For creativity to occur, a set of rules and practices must be transmitted from the domain to the individual. The individual must then produce a novel variation in the content of the domain. The variation then must be selected by the field for inclusion in the domain (1999: 315).

Csikszentmihalyi's system perspective maintains an emphasis on the contribution of the person to the creative process through an emphasis on cognitive processes, personality traits and motivation. It also identifies how these personal characteristics are insufficient (perhaps not even necessary) and that beyond the rules of the domain and the options of the field creativity cannot exist.

Csikszentmihalyi's theory represents only one example of many confluence theories that can help bring light on the question of creativity and establish a framework for teaching design creativity. It suggests that, although individual traits such as self-esteem, tolerance for ambiguity, risk-taking and willingness to persevere are linked to creative production (Gallagher, 1994: 175), more tangible factors which may be developed, improved and assessed are also part of creative performances. Moreover, Csikszentimihalyi's theory identifies the protracted nature of creative thinking and, accordingly, provides a framework for assessment in which creativity requirements reflect the educational stage of design students. This pragmatic definition of creativity is important to design education. As Jeffries (2007: 487) contends, the outcome of a design education is, ideally,

> that students produce historically original work; ultimately, designs that are fresh and new to the domain. Pragmatically though, in terms of educational development, there is a hierarchy of attainment: achieved personal originality first then build towards historical originality with educational progression.

Conclusion

As previously identified, further research is required into the concept of creativity, the teaching of creativity and the subsequent assessment of students' creative outcomes. Creativity is a focus of design education and it is a stated learning outcome of the discipline. Accordingly, the need to confront the issue of creativity, including the challenge of defining it and developing strategies to facilitate its development, is a priority.

The above discussion illustrates how academics are only starting to fully appreciate the complexity of the concept of creativity. It has become apparent in recent research that creativity cannot be dismissed as being simply an innate capacity which happens, despite intentions and purposes. The evidence presented above identifies that creativity can be enhanced through effective teaching and learning strategies and their supportive assessment frameworks. The task in the coming years is to enhance the development of such teaching and assessment practices through the application of research-lead teaching.

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Insights into insight – How do in-vitro studies of creative insight match the real-world complexity of in-vivo design processes?

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Abstract

This paper presents approaches to study insight in the context of creative (design) processes. Evidence for the discrepancies between experimental and observational studies of insight moments is collected from the literature. Implications for conducting integrative research that addresses the complexity of real world design environments are discussed. Preliminary results from two case studies looking for insight moments of design teams working on real world design tasks at a medical appliance manufacturer and within an interior design project are reported. A multi-methodological framework inspired by in-vivo-in-vitro research together with ethnographic and practice based approaches is developed and applied.

Keywords

Creativity; Insight; Design Process; Engineering Design; Interior Design

Innovations and the creative processes of coming up with "novel and useful" ideas, products and services in various areas have gained increased attention in political, societal and economic arenas during the last couple of years (EU Commission, 2008; OECD, 2009). A central element in reports about experiences on the path of creating something new that qualifies to be considered as a profound innovation later on is the phenomenon of insight. The experience of insight or an "AHA-moment" describes situations where in an instance suddenly and unexpectedly the solution to a problem becomes apparent together with feelings of clarity and satisfaction (Seifert, Meyer, Davidson, Patalano, & Yaniv, 1996, p. 66f). "Insight is thought to arise when a solver breaks free of unwarranted assumptions, or forms novel, task-related connections between existing concepts or skills." (Bowden, Jung-Beeman, Fleck, & Kounios, 2005, p. 322)

Since the publication of the still often cited early process model of "productive thinking" by Wallas (1926) the field of creativity research has developed rapidly into a variety of approaches. Narrative accounts by distinguished scientist and artists were soon complemented with experimental studies that developed into a wide range of paradigms and tasks (Weisberg, 1996). Other strands of research focus at the context and personality traits of creative persons with historiometrical and correlational methods (Simonton, 2000) or try to observe and describe creative processes in "real world" environments with ethnographically inspired methodologies (Dunbar, 1996).

If one looks at these more and more specialised and distinct approaches, it becomes quite apparent that terms are frequently vaguely and incongruently defined, and what is studied in lab experimental paradigms has often little to do with the complexity of the real world settings in which the experiences behind the narrative accounts of creative insight were originally encountered (Simonton, 2003). Most of the lab paradigms are structurally different from the real world problems of interest and operate on different time scales for reaching the solution which is considered to be an insight (Csikszentmihalyi & Sawyer, 1996).

The aims of this paper are:

1. Collecting and presenting evidence from the literature on insight studies for the gap between lab and real world studies on creative processes.
2. Discussing the (im-)possibilities of overcoming the challenges in linking the data from (in-vitro) lab studies of insight problem solving and (in-vivo) real world reports of creative insights.

3. Compiling suggestions for more integrative approaches to understanding insights in creative processes that are capable of matching the real world complexity of the phenomenon.
4. Introducing two field studies set out to explore insight moments in real-world design settings.
5. Presenting some preliminary results from the early stages of these studies.

The following sections contain a discussion of the phenomenon of insight and how it has been studied previously, the context dependence of both lab experiments and real world observations, the research design that we are experimenting with in our ongoing studies and two examples from these studies. We conclude with a discussion of these preliminary results and an outlook on future work.

Approaches to studying insights and creativity

In this part we present an overview of selected contributions to the literature of studies of creativity and insight that are vital to the illustration of our further argument. We briefly summarise the development of approaches observing respectively describing insights embedded in creative processes in real life settings and experimental approaches in the lab. Due to the scope of the paper and limited space we refrain from discussing correlational studies on e.g. personality traits here.

Comprehensive compilations of the current state of the field of creativity studies can be found in Sternberg (1999), Weisberg (2006) and Sawyer (2006). A specific focus on different approaches to studying insight and insight problem solving is present in Sternberg and Davidson (1996). Knoblich and Öllinger (2005) provide a rich description of the chronological development of insight studies during the 20th century which we used as the temporal framework for most of the following mapping of selected key ideas and protagonists.

Insights embedded in creative processes

Anecdotes about flashes of insight as the origin of solutions to tough problems can be traced back to the ancient Greek, namely the story of Archimedes and his proclamation of “Eureka!” after understanding the principle of specific weight while entering his bathtub. During the 18th and 19th century more and more of these anecdotes especially about the origins of scientific ideas and concepts can be found in the literature. Attempts of generating descriptive models from these stories and introspective accounts were following (Knoblich & Öllinger, 2005).

One of the historical roots of scientific studies of creativity in the 20th century times can be traced back to Graham Wallas who suggests in his book “The art of thought” (1926) a 5-stage model of the creative process. This early but still well cited model is based on narrative accounts by Helmholtz and Poincaré on arriving at some of their most memorable scientific ideas as well as his own experiences of thinking about challenging self-chosen problems. He distinguishes preparation, incubation, intimation, illumination, verification stages but focuses mainly on the incubation, intimation and illumination stages in the further course of his book, with the question how new insights can be obtained and elaborated at the core of his considerations.

The idea to conceptualise creative processes in stages has become a common theme in research ever since, even though they might include iterative, repetitive or recursive movements. A recent and quite comprehensive overview of process models stemming from a psychological background in that tradition and linking them to process models from the field of (engineering) design is provided for example by Howard, Culley and Dekoninck (2008).

From observational to experimental studies of insight

A first wave of experimental studies of creativity and insight was performed by key figures of the “Gestaltist”-movement mainly before the Second World War (Duncker, 1935; Köhler, 1921; Wertheimer, 1959). They performed observational and experimental studies with animals (chimpanzees) and humans trying to solve problems that require somewhat novel approaches and tool usage. The idea of restructuring of the problem in order to obtain a solution is considered an essential trait of insights by these researchers (Mayer, 1996).

In his book “Productive thinking”, Wertheimer (1959) tries to inquire beyond purely logical and associationistic concepts. He distinguishes between “sensible thinking” and problem solving that is achieved solely “by recall, by mechanical repetition of what has been drilled, by sheer chance discovery in a succession of blind trials” (Wertheimer, 1959, p. 11) cited in (Knoblich & Öllinger, 2005). This can be considered as an early manifestation of what later turned into the debate between advocates of “special process” vs. “normal thinking” approaches. Even though Wertheimer provides little suggestions for experimental settings to test the ideas and concepts brought forward based on a lot of observational and phenomenological material, his accounts are still a source of inspiration. His emphasis of the importance of being able to perceive the structure of a situation and discover gaps and tensions as prerequisite for success in endeavours of “productive thinking” seems to be still a challenge for researchers, designers or managers seeking profound innovations.

Karl Duncker, a student of Köhler and Wertheimer, esteemed to develop a complete theory of insight. He was very imaginative in developing numerous clever experimental set ups to study his theories and ideas (Duncker, 1935). His distinction between partial and total insight provides a first framing of what is currently studied as analogical thinking. The description of conflict analysis, material analysis and goal analysis as three central heuristics of thinking anticipates ideas from Newell and Simon´s seminal book “Human Problem Solving” (Newell & Simon, 1972).

Most of the contemporary experimental studies can be traced back to the problem solving paradigm brought forward by those two authors. The theory of a “problem space” or “possibility space” in which a solution is sought for by algorithmic or heuristic means is one of the central ideas. Structurally it is assumed, that if the problem is defined and the desired goal state is defined, problem solving is creating a search path through the problem space to the desired solution (Perkins, 1996, p. 508ff). The underlying goal of this approach is to develop a “general problem solver” which is open for computational, algorithmic implementations. Herbert A. Simon´s proposal to distinguish between problems in the natural sciences and problems in the realm of artificial human creation is of specific interest for design and studies of design practices (Simon, 1996).

From new experimental tasks back to ethnographic observations

Within the framework of “insight problem solving” cognitive psychologists have developed a number of experimental tasks that they use for their lab studies (Weisberg, 1996). Besides some newly developed tasks (e.g. matchstick arithmetic (Knoblich, Ohlsson, Haider, & Rhenius, 1999), coin moving (Chronicle, MacGregor, & Ormerod, 2004)), most of the studies on incubation and insight rely on somewhat traditional paradigms (Sio & Ormerod, 2009).

Application of new neuroscientific visualisation methodologies like fMRI spark some innovations in the experimental tasks (e.g. Puzzles with Chinese characters (Luo, Niki, & Knoblich, 2006) or newly developed compound remote associates (Bowden & Jung-Beeman, 2003)) recently. It is important to note that the transfers of experimental settings from cognitive psychology into the realm of neuroscience favour tasks that specifically suit the technical requirements of the brain scanners (Bowden & Jung-Beeman, 2007).

Studies conducting ethnographically inspired observations of creativity and insight in real world tasks and practices try to (re-)evaluate the theoretical concepts that underlie experimental settings for researching creative problem solving or even get ideas for new experimental paradigms. An interesting suggestion to capitalize on the cross-pollination of ideas between lab and real world settings exists in Kevin Dunbar´s “in-vivo-in vitro methodology” developed in the realm of studying scientific creativity (Dunbar, 1996; Dunbar & Blanchette, 2001). Since then there have emerged an increasing number of protocol studies of design meetings and semi-natural/artificial tasks (McDonnell & Lloyd, 2009).

Critique and call for integrative approaches

Even though we have just presented new developments and pathways of the evolution of the study of insight in the context of creative processes, most of the debates about "The Nature of Insight" (Sternberg & Davidson, 1996) are still unresolved. Ill defined concepts and discussions around seemingly opposing conceptualisations e.g. "special processes vs. normal thinking" are still subject to criticism and call for further integrative efforts. The prior chronological overview shows that from the initial narrative descriptions of the phenomenon of insight and creative processes very different approaches were developed to study the phenomena under scrutiny in the laboratory as well as in real world settings.

Insight as (too) broadly defined concept

When working with the concept "insight" one faces the challenge of varying and rather broad definitions. How extraordinary should a leap in a creative process be to qualify as an insight? Does an insight have to be useful, or can any surprising new idea be considered as an insight? And what about seemingly irrelevant insights that cause another and more useful insight – or even a series of insights that redefine the problem and/or the solution space? Disputes continue with the question whether insights should be considered as originating from special cognitive processes or as results of normal thinking.

Structural differences between "insight tasks" and real world experiences

Most lab experiments use tasks for which the solutions are known upfront. For creative problem solving in real world settings most of the time the solution is not known before it has been found as the outcome of a creative process. The underlying assumption for many tasks to study insights in the lab is that they per se cause insights if and when a "right" solution is reported. Solving the insight task is equated to having experienced an insight and thereby forming a somehow circular justification. Such assumptions are neglecting the possibility of other "non-insight" ways of getting to the solution. Another structural difference concerns the timeframes of the tasks in use. Whereas in lab settings most tasks are performed in the range of seconds or minutes, narrative accounts of insight problem solving are talking of hours or days of engagement.

Group Creativity as Blind Spot

Studies investigating individual performance in insight problem solving are neglecting to investigate how new ideas emerge from interactions among group members. "Unfortunately, most laboratory experiments on this subject use unrepresentative participants (viz., college students) and unrepresentative problem solving tasks (e.g., ones that require no division of labour or special expertise), thereby undermining their ability to be generalised to real-world problem-solving groups." (Simonton, 2003, p. 488) In recent years a movement to elucidate this blind spot and to investigate "group genius" (Sawyer, 2007) has started though.

Call for integrative approaches

Simonton concludes from his studies in the field of scientific work, that "the creative process is far less logical and deterministic than often claimed" (Simonton, 2003, p. 488). According to him, creativity has three essential components which should be integrated: the products that contain the creative ideas, the persons who conceived those ideas and the processes the persons involved used to do so (Simonton, 2000). This argument is well suited to encourage the quest for new integrative approaches.

We are convinced though, that such integration should be informed by Neurology and Cognitive Science and consider physiological plausible models of creative processes and insight moments. Socio-cognitive approaches could provide access to the experiences, states of mind and structures of thought that build the foundation for the abilities to perceive and associate items of relevance in processes of knowledge creation (Ringberg & Reihlen, 2008). The integration of experimental and observational approaches remains a crucial topic also for these considerations.

Matching lab experiments with observations of real world complexity

When setting out to study insight, two main approaches were considered so far: (1) Ethnographic studies of the phenomenon in context of real life practices and (2) laboratory experiments seeking to isolate the phenomenon to study it in a controlled environment. As we soon realised, both of these approaches have their challenges when it comes to study an “in flux” phenomenon. Studies of the real world are not necessarily reproducible outside their original context, and results from the lab are only valid for the controlled and stable conditions under which the experiments were carried out (Robson, 2002).

In this sense, both approaches share a general challenge: they are context dependent. If you change one factor in the context of the study, for example a team member, a time constraint or design company, the results from the study are questionable. This is as crucial for lab studies as it is for real life studies, and we concluded that lab-experiments or real world studies alone are unsatisfying for understanding the complexity of insights. From a more philosophical point of view, the relationship between the universal and the particular can be seen as interdependent: ”It is, ..., the fundamental principle of cognition that the universal can be perceived only in the particular, while the particular can be thought of only in reference to the universal” (Cassirer, 1955, p. 86).

In cognitive psychology, the same challenge has been described in relation to studying design of technological artefacts by Ball and Ormerod (2000) amongst others. They suggest developing and applying “cognitive ethnography”, first introduced by Hutchins (1996), as a method to study technological change. Hutchins develops the idea that cognition in real world settings can and should be conceived as being distributed way beyond individuals and including other actors as well as artefacts, thereby meshing up a complex system which as a whole is responsible for the outcomes of the cognitive processes (Hutchins, 1996).

In the study of insight we have therefore set out to design our studies based on a combination of the two perspectives, the particular (the lab) and the universal (the world). If we explore the structurally possible combinations the following options appear:

1. Either – or:
   We could stick to the historically developed disciplinary and methodological camps and either do observational or experimental studies.
2. Both at the same time:
   We could deploy studies on the same task in the lab and in real world settings simultaneously.
3. Integrating/mixing:
   We could perform experiments in real world settings (field experiments) resp. bring “real” tasks into lab settings - an approach that some of the current video/protocol studies are taking.
4. Jumps between both:
   We could move back and forth between the two modes and perform a couple of iterations in one project of longer duration.
5. Neither nor:
   We could come up with something completely different or move to another field of study, which e.g. Knoblich (2009, personal note) decided to do, based on the ill defined character of many of the concepts and the problems for experimental research in cognitive psychology due to that.

From the presented option we feel most inspired by the option to go for integrating/mixing respectively jumping between experimental and observational studies. This calls for crafting research settings that are able to meet up to the promises of an in-vivo-in-vitro-strategy.

Crafting and exploring integrative research settings

Obviously we should try to integrate findings from different approaches and even disciplines to account for the complexity in design thinking and practices (Cross, 2001, 2007) rather than trying to boil it down and reduce it to the extent that the phenomenon might vanish. Methodology wise it seems fruitful to play with observational, reflective and experimental approaches and look for possible combinations in one project to increase the richness of the knowledge created (Müller, 2008). The challenge is here too, to work with 1st, 2nd and 3rd person perspectives and accounts of insights at multiple levels simultaneously, and collecting them "in vivo" in an unfolding open ended process without too much interference and disturbance.

As epistemological assumption we are thinking about "embodied, situated cognition in relations to other actors and things" and thereby looking for distributed cognition, construction of meaning and sense-making. Such an epistemological stance is very well aligned with practice based studies (Corradi, Gherardi, & Verzelloni, 2008; Gherardi, 2000, 2009) integrating a range of ethnographically inspired and action based approaches. With the "practice lens" for our observation we want to lay the groundwork for studying the complexities of design processes in an "in-vivo-in-vitro"-manner (Dunbar, 1999; Dunbar & Blanchette, 2001). Concerning the format we follow Weisberg´s suggestion to use extensive case studies (Weisberg, 2006, p. 592ff).

Our motivation for conducting exploratory case studies is to get a first hand personal experience how well current theoretical accounts and concepts fit evidence from self-collected data. We are specifically interested in a better understanding of creative design processes including the tools in use as well as conversational and cognitive heuristics and patterns applied in the surrounding of insight moments. We will conduct our observations along the following lines but still keep the openness for unexpected surprises and

- follow the unfolding process
- look for claims of insight moments and analyse the circumstances (close to the event) especially the expression of the content of the insight at this point of time in order to be able to distinguish them from later stages of verification and refinement
- try to trace and accommodate past memories and experiences, environmental cues, random surprising events and coincidences as possible triggers
- look for openness and constraints in the process at the same time
- inquire into motivation and intention to select and pursue a challenging problem that calls for insight solutions.

Experiences from two case studies

In the following we present two case studies (Study A and Study B) exploring insight moments in real world design processes that are currently in progress. For each of both we provide a short outline of the context of the study, the layout, methods in use as well as preliminary results of the observations. We then discuss the implications and further potential for the study of insights in real world settings and the transfer of findings into improved lab settings and research paradigms.

Study A

Context

Study A is conducted at a major international corporation specialized in medical plastics (Company A) and aims at understanding the evolvement of design requirements in an engineering design projects as a consequence of insights in the design teams. The project is looking at process level from early stages of defining new markets to the stages of finalizing new products. Especially in the early stages the project is focusing on the role insights play on defining design requirements.

Set up of study

To achieve a better understanding of the role of requirements and insight in engineering design, the following strategy is tried out in Study A:

1. Ethnographic study: Real world engineering design in Company A
2. Laboratory experiments 1 (Lab 1): Based on observations from Company A, laboratory studies with design teams are used to compare different situations observed. Using both experienced and novice designers, the experiments might also reveal some variances between the preferences for the two groups.

3. Laboratory experiments 2 (Lab 2): This series of experiments seeks to optimise the most successful strategies observed in Lab 1 and finally to conclude what strategy to implement further on.
4. Real world testing: After Lab 1 and Lab 2, the results are taken back to "the real world" and implemented in a controlled setting in Company A. The satisfaction with the suggested changes will be explored through interviews and questionnaires.

The project starts from research question(s) grounded in experience and theory. Based on the research questions, field observations are made, followed by relevant theory, which feed back to the observations and potential new observations. Based on this mix of theory and observations, a hypothesis is made and then tested in experimental settings. The testing feed back to the formulation and scope of the hypothesis, and the final results from the tests are evaluated – and form the fundament for future research questions.

Methods in use

In Study A, the following methods are in play: Participatory research, field observations, practice-based research, experiments, video and voice recordings, interviews and data analysis.

Observations so far

Below, one example from the case study that might be relevant for Lab 1 will be presented:

The researcher is participating in an early-stage innovative process in Company A as a member of an interdisciplinary design team consisting of 5 other members. The task for the team is to define an initial product profile for a new solution to a physical problem related to a specific medical condition. The team members are all from different backgrounds (engineering, marketing, sales, management, manufacturing, design) and from different departments (R&D, marketing, concept, design) within the company, and with limited prior knowledge regarding the medical condition the product is meant for. Since the project start-up, the team members have been finding and sharing knowledge in such a way that the team has a more or less common knowledge base regarding the condition.

In the third meeting, the team was interviewing nurses with special education and long experience with the relevant medical condition. The team asked questions to the nurses, based on the collected and shared information about the condition. Late in the meeting the following occurred: One of the nurses stood up and, using an existing product from the user category, demonstrated a specific user challenge with the product. At a certain point in her demonstration she was suddenly interrupted by the design team, as almost the whole team (at least 4 out of 6 team members) were excited about what she was presenting to the group. As it turned out, several members of the design team had got the same idea for a new way to solve the initial problem.

The product demonstrated in the meeting solved the initial problem in a comprehensive way, while the new idea generated in the group represents a very different and way simpler solution to the problem. The novel idea can be considered as an example of a shared insight amongst the team members as it does not have any similarities with the solution to the problem embodied in the product that was demonstrated first. This insight was seemingly triggered by a cue in the demonstration, possibly a combination of gesticulations and oral descriptions, and based on the fact that despite their varying backgrounds the team members had a shared knowledge related to the initial problem and medical condition.

The situation described above is in itself an interesting observation about a shared insight moment, but it might also be used as input to a controlled experiment studying shared insights. By giving a multidisciplinary group a problem definition and a shared knowledge base, can one use cues to trigger shared insights that will lead to ideas that a similar group will not be able to produce? The observation described is just one of several examples from the case study that might be used in the following experiments.

Study B

Context

Study B follows the interior design process for a shared office space for social entrepreneurs in Vienna, Austria. A 400 m² loft is transformed from an empty space into an up and running office during a 4 month period form December 2009 to March 2010. The project is currently in an early stage but progressing fast: The loft was emptied in calendar week 2/2010 and renovation just started. The work with the designers on the interior design started December 2009 as soon as all contracts for renting the place were signed.

At the centre of the investigation is following/shadowing the core team of two Vienna based designers and the two entrepreneurs owning the place/office space together with a designer from the London based global network organisation, linking similar places all over the world. During the planning and realisation process a number of workshops with potential users/clients and interested people are conducted to discuss the existing plans and get additional ideas.

Set up of study

The set up is exploratory and evaluates the development of key ideas and their implementation in the course of the project along a number of mile-stone-meetings. Between those meetings participatory observations are undertaken.

Methods in use

Mainly participatory observation (ethnographic field work, notes) and interviews at different stages throughout the process (audio recordings) were performed, taking a “reflection of action” (Schön, 1983) approach towards analysing the activities and circumstance of the development of key ideas and possible insights. Some basic introduction to the methods of those reflective practices was undertaken for the people involved (Schön, 1987).

The second level of observation is based on a collection and analysis of sketches, notes/meeting minutes and produced artefacts/prototypes in relation to the reflection of the design process in the interviews. The designers were additionally asked to do a basic self ethnography resp. use their working diaries for capturing potential insight moments focusing at the experience as such, its content and its circumstances.

The possibilities for video analysis of selected workshops/meetings are currently explored.

Observations so far

So far interviews on the initial ideas for the room layout and functional areas were undertaken and several rounds of walking through the loft and talking about the different functional areas to be designed and equipped with furniture were observed as part of the renovation/emptying out activities. The conversations observed so far were centred on efforts to combine new ideas and elements that worked in other situations as well as ideas from prior projects of the designers and applying them to the empty space. The content of the conversations focused in the early phase on desired atmospheres and functional settings in different areas of the loft.

Currently the next phase of building things is about to start. The room concept was transformed into a general plan. An iterative design process and rapid prototyping for elements of the installed furniture is planned for the upcoming weeks.

Additionally to the artistic and technical level it will be interesting to observe how the rather tight budget constraints will affect the quality/originality of ideas. This could mean ruling out some ideas and at the same time a call for additional creativity in terms of finding smart ways to cope with this very fundamental framework. As a result a lot of do-it-yourself and re-use of what can be obtained from sponsors or bought on flee markets (as opposed to catalogue shopping) is expected to be happening.

Concerning the phenomenon of insight so far situations of shared ideation can be reported. At this early stage the people involved seem to be building a common understanding of the different requirements for the various areas in the space. Discussions and conversations are focused on bringing together various ideas, elements observed at other places and matching those ideas with the functional requirements and possibilities of the location. Some evidence for combinatorial/associative practices is available.

Summary, conclusions and outlook

In this paper we have presented an overview of approaches to study insights and collected evidence for discrepancies between experimental and observational studies of insight moments. We discussed implications for conducting integrative research that addresses the complexity of the real world design environments. Preliminary results from our efforts to get a personal perspective and feeling for these tensions and debates were reported: Two case studies with design teams working on real world design tasks are in progress where we are applying a multi-methodological framework inspired by in-vivo-in-vitro research together with ethnographic and practice based approaches.

With our work we try to follow the call for interdisciplinary and integrative approaches which are able to connect and bridge different zoom levels and perspectives for a more comprehensive understanding of the phenomena at hand. We very much look forward to further exploring what we will be able to observe and learn about insights in the further course of these studies. Some of the challenges that we anticipate are revolving around the following questions:

- How to obtain further data on insight moments in-vivo and account for the complexity around these events from 1st, 2nd and 3rd person perspectives?
- How to trace back the hints leading towards the observed insight moment?
- How are we going to be able to introduce experiments in the real world environments without compromising the role as participant observer?
- To which extend will we be able to abstract input from these case studies to further advance theoretical models?
- How far does the transferability of observed heuristics and patterns reach to other settings – e.g. analogous argumentations between design practices and management challenges?

Overall it seems to be crucial to embed insight phenomena in a plausible neuro-physiological working-model that will be able to help structuring the accounts from different disciplines as well as experimental traditions and paradigms. In order to get inspiration for the realm of experimental paradigms it seems promising to look again at some of the early work related to the insight phenomena (Duncker, 1935; Wertheimer, 1959). In terms of practical applications we hope to be able to generate some insights ourselves of how to increase the likelihood for profound insights to emerge. When trying to get beyond some of the debates about seemingly opposing theoretical accounts it should be helpful to take the slightly paraphrased title of Weisberg´s journal-comment on a target paper by Simonton (Weisberg & Hass, 2007) seriously: “They are all partly right…”

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Designing Contemporary China: National Design Identity at the Crossroads

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Abstract

China is an ancient civilization rapidly developing in a globalized post-modern context. The country now finds itself at a crossroads, with outside ideologies and forces of “Americanization” and “Westernization” competing against its cultural heritage and communist economic system to form a national design identity for contemporary China. This paper uses the rise of modern design in China, design examples from Hong Kong and Taiwan, the 2008 Beijing Olympics opening ceremony, and Victoria & Albert Museum’s *China Design Now* exhibit to investigate questions of national identity as they pertain to design. It argues that, with the whole world watching China’s rise as a global economic power, the real challenge facing Chinese designers is how they can create a “new” image of China to present to the rest of the world, particularly the West, if they don’t wish to be stereotyped by images from the ancient past.

To discuss the potential impact of Western design and economic influences on the development of a contemporary national design identity, this paper first investigates the relationship between a designer’s ethnic background and creative work to search for a possible direction of development of a contemporary national design identity for China. It concludes that cultural factors do not play a key role in every design project undertaken by Chinese designers in the Greater China region, but rather that decision depends on the nature of the design job. However, the author recognizes the importance of studying the cultural artifacts of this great civilization, as well as the urgent need to establish design curricula with Chinese elements, in order to discover how to establish a modern international style with a contemporary Chinese touch – that is, its contemporary national design identity.

Keywords

China; National Design Identity; Globalization; Design and Culture; Chinese Design; Asian Design

China, one of the four ancient civilizations and today one of the largest countries in the world, has finally opened up to the rest of the world thanks to the Reform and Opening (gaige kaifang 改革開放) Policy the country instituted in 1978. Since then, the communist regime that controls the People's Republic of China (PRC) has initiated tremendous changes in all walks of life, including the creative arts and design. Today, the government no longer condemns the “evil spirit” of commercial arts as Shou Zhi Wang (1989), a Chinese design history scholar once point out, and even embraces the important role that design plays in promoting vital business activities. This paper uses the rise of modern design in China along with work by designers in Hong Kong and Taiwan, the 2008 Beijing Olympics opening ceremony, and Victoria & Albert Museum’s *China Design Now* exhibit to investigate questions of Chinese national design identity.

The designer's ethnic background and visual style in relation to national design identity

According to Woodham (1997), national identity is a conscious construction but is largely "myth" rather than an "accurate" inventory of distinguishing qualities. With a long and rich history of civilization to call upon, Chinese designers and students should have no difficulty finding unique qualities to represent China's national identity in their design work. However, the way in which these historical representations speak to younger generations, so eager to embrace the modern, globalized world, may present potential problems due to "the recrudescence of previously declining cultures, and even cultural resistance" (Knight, 2006, p. 4). As a relative newcomer to the world of design, China's design industry and professionals face the challenge of catching up to international standards. This paper argues that, with the whole world watching China's rise as a global economic power, the real challenge facing Chinese designers is how they can design a "new" image of China to present to the rest of the world, particularly the West.

To begin the discussion of China's national design identity, I will first examine the relationship between a designer's ethnic background and his or her creative work. After centuries of diaspora, it is now common to find designers of Chinese and Asian descent living throughout the world, often without much knowledge of the Chinese culture of their ancestors (Kim, Yang, & Lee, 2009). Having grown up under the increasing influence of Western values like individualism and consumerism since 1980, younger Chinese citizens do not necessarily share the ideological beliefs of previous generations, and it is now possible for young people to live in a Westernized society with little knowledge of traditional Chinese values and practices, much like people of Chinese ancestry growing up in diaspora communities. By examining the relationship between a designer's ethnic background and creative work, it may be possible to forecast the future development of China's national design identity.

In 2007, I published a conference paper investigating the relationship between a designer's ethnic background and creative work by conducting a case study of *Communication Arts*, one of the foremost graphic design trade journals in the United States and with a worldwide circulation (Wong, 2007). I traced award-winning work by designers with Chinese names over the ten-year period from 1997 to 2006 to try to discern whether or not the ethnic background of each designer is reflected in his/her published work, along with questions pertaining to the relationship between design and culture.

For that study, I borrowed Bari Kachru's concept of "three concentric circles" (quote from Bolton, 2000), developed to describe the spread of English language usage in the global context. I applied Kachru's concept to define "Chinese" in the contemporary international context, applying the "inner circle" label to locales where any Chinese dialect (such as Mandarin, Cantonese, and Taiwanese) is the first spoken and written language; examples include China, Hong Kong, Taiwan and Macau. The outer circle would represent countries where a majority of the population uses a Chinese dialect as their first language, such as Singapore, Malaysia, Indonesia and Thailand. The extending circle, then, applies to countries where Chinese has the status of a "foreign language" and that have a visible ethnic community of Chinese origin. Examples of this extending circle are the United States, Canada, the United Kingdom and Europe.

A wide range of work by Hong Kong designers appeared in the *Communication Arts Design Annuals*, including corporate identity, book design, editorial design, self-promotion, and poster design pieces, and the submissions are a mixture of commercial and non-commercial work. Kan and Lau, Alan Chan, Tommy Li, Eric Chan, Michael Miller Yu, and Paul Lam are among the individual designers/art directors/design firms from Hong Kong whose work was published, while J. Walter Thompson and Token Workshop are two agency/design firms that appeared in the

Figure 1: Self-promotion by Lee Ken-Tsai, Taiwan

Communication Arts Design Annual from 1997 to 2006.

Kan and Lau, Alan Chan, and Tommy Li are the three designers/art directors/design firms who received the most entries in the publication. Kan and Lau is the design firm of partners Kan Tai-keung and Freeman Lau, two of the most prestigious designers in Hong Kong. Although most of the Hong Kong designers whose works appear in the publication do have their own unique signature styles, not every piece included reflects that style due to the differing needs of the projects. By examining the submissions by Alan Chan Design and Kan & Lau Design, we can see that the lead designers, Alan Chan and Kan Tai-keung, separated their personal signature styles from the commercial work according to the nature of the projects.

Must a designer always include his or her own signature style and ethnic cultural elements in design? In the cases just mentioned, the designers obviously intended that the design solutions should first serve the nature of the project and the clients' needs, rather than the designers' own personal aesthetic interests. We can find similar design values in the work of Hong Kong designers; it is becoming rare to find so-called "authentic" and "exotic" cultural elements in their work.

A self-promotion piece by Lee Ken-Tsai of Taiwan, who has never been studied overseas, went to New York several years ago to study English and discovered himself while in the midst of the city's rich multi-cultural environment. This self-initiated project was, to a certain extent, a search for self-identity. Lee asked many friends that he met to write his name in their native languages, and then graphically combined the writing with photos he took in New York to create this self-promotion piece (figure 1).

Another interesting work, by designer Chun-Liang Leo Lin, is a poster created for the thematic poster show *Korean Image* held in Taiwan in 2001. Thematic poster shows in the Greater China region became very popular in the mid-1990s; this particular show invited designers from Taiwan and Korea to participate and create work based on the theme, Korea. Lin created this poster using the colours of the Korean flag and an image of a pair of shoes, resulting in a piece heavily embedded with cultural elements.

As for design in mainland China, pieces by designer Wang Xu appearing in *Communication Arts Design Annuals* are mainly his publication design pieces from the *Design Exchange Magazine* (figure 2) and *Master Designers* book series. Unlike Kan Tai-keung and Alan Chan, Wang does not consciously use Chinese elements in his work to establish a signature style. It is difficult to say whether he has taken this approach due to the nature of the work or because of his intent to construct an image of "modernism design" for the Chinese audience looking forward to a

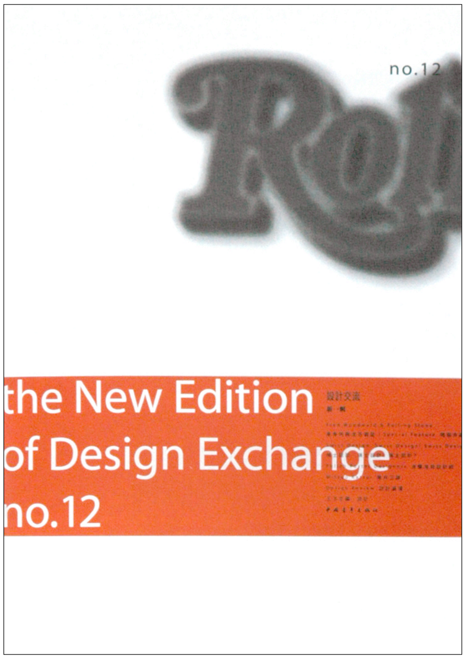

Figure 2: Design Exchange Magazine, designed by Wang Xu

Western lifestyle.

World design development is still dominated by European and North American countries, with Japanese designers also starting to play a major role in shaping the world's "modernism design" landscape. Designers from Asian countries with different cultural settings or from an Asian ethnic background have difficulty asserting their own cultural touches without rational justification for their choices. This is the observation that we can make from studying the pieces created in the "inner circle" Chinese countries.

In analyzing the work assembled from the "outer circle" countries such as Singapore, Malaysia, Indonesia and Thailand, it is difficult to identify the "cultural design identity" of the individual countries. Singapore has the highest design standards in this region and designers from Singapore did pretty well, based on the number of submissions included in the *Annuals*. In 2001, Singapore had four pieces of work selected; it had five pieces chosen in 2005.

What does "Chinese" or being "Chinese" mean in a contemporary global context? In the "extending circle" category, art directors/designers with Chinese names are mainly from major cities such as New York, San Francisco, Seattle, and Los Angeles in the United States, and Toronto, Vancouver, and Montreal, Canada. After almost two centuries of diaspora, people of Chinese ancestry can be found in many parts of the world, and Chinese in North America are no longer restricted to a few vocations, such as railway laborer, mine worker, and laundry or grocery store owner. New generations of Chinese born outside China and with little or no knowledge of Chinese culture are, together with non-Chinese designers, creating a new landscape of "international Chinese."

The works by art directors or designers with Chinese names included in the *Annuals* reveal no distinguishable differences in visual style. Like the examples found in the inner and outer circles, Chinese cultural elements are used when it is appropriate for the project. For example, Vivien Sung's design for Chronicle Books, titled *Five-fold Happiness*, appeared in *Annual 2003* and illustrates the application of design theory to the editorial design of Chinese objects. Chinese elements in this book are found in the contents and the cultural product for selling and consumption. Perhaps the meaning of "Chinese" in a contemporary global context may refer only to cultural products at the consumption level. Being "Chinese" might be only skin-deep.

Another example is a package design for a Chinese takeout food client in Minneapolis, USA, created by a non-Chinese designer, Jillian Frey. Because of the client's needs and the nature of the product, her design solution skips "obvious" Chinese elements, relying instead on different typefaces for the phrase "Asian to go" composed in a pattern. The only Chinese element that is used is the character Chin 陳, a Chinese surname. Although you do not see stereotypical Chinese elements in the pattern, you are left with the sense that the Asian world is full of variety and choices (figure 3).

We began our survey of the works from *Communication Arts* with the question: is there a relationship between a designer's ethnic background and his or her design work? Based on the examples discussed above, we can see that Chinese cultural factors do not play a key role in

Figure 3: Lee Ann Chin, Asian to go, designed by Jillian Frey, Minneapolis, USA

every design project that inner circle Chinese designers undertake; whether or not Chinese elements appear depends entirely on the nature of the project. Chinese elements might be used if they are suitable for the project needs, and their use is not exclusive to designers of Chinese descent, as seen in the work of Minneapolis designer Jillian Frey. And designs created for Chinese clients do not need to use Chinese elements solely.

Jillian Frey's example proves that a designer without any Chinese cultural background can be very successful using Chinese elements. Another success is Henry Steiner, who has been in Hong Kong since the early 1960s and is widely regarded as the father of Hong Kong graphic design (Wong, 2001). Steiner is well known for his "East meets West" style; his 1969 work for the *Hong Kong International Music Festival* demonstrated a new possibility for modern Chinese design after the 1930's Shanghai style.

In this poster, Steiner used a pair of pearls to represent Hong Kong, known as the "Orient of the East," as a set of earrings on ears posed as if a butterfly; together these two images are suggestive of the beautiful, delicate music of the East. This visualization and conceptual approach to modern poster design may have been common at that time in the West, but it was groundbreaking work in the Eastern context. Steiner's achievement became a source of direction and inspiration for Hong Kong designers. What the designer did was simply search for creative direction within culture and everyday life, yet his design solution has a timeless quality that is still refreshing 40 years later.

If design naturally has a close relationship with culture and everyday life, is it difficult for designers and clients to keep cultural elements from appearing in works designed for the global market? The biggest challenge facing many young Chinese designers today is the necessity to catch up to international design standards to promote commercial interests and consumption, not to use design as a tool to improve the everyday lives of people. In order to achieve business objectives for marketing products globally, it is often necessary to produce creative works devoid of cultural elements and, often, without distinct characteristics.

For example, Xie Yong of China was a finalist in the British Council's International Young Design Entrepreneur of the Year award in 2006. The General Manager and Director of E-madesign Co., Ltd. in Beijing, Xie's goal, according to his statement, is to be a "one-stop design service market in China." His selected work clearly reflects his own definition of design as a "service" to the market, rather than any deeper contextual meanings of design to culture and society. On the contrary, a finalist from India, Ramesh Manickam, sees design as a service that should meet the "multifaceted requirements of the Indian market" (British Council, 2006).

Both this designer's statement and his selected work demonstrate the concept of meeting the needs of different segments of society. Manickam's work is an interesting contrast with that of Xie Yong, as the Chinese designer's product is not embedded with elements reflecting the culture and everyday life of his homeland. It is apparent that the young Chinese designer's approach is to promote commerce that is in sync with trends found in the developed Western countries, while the Indian designer's work reflects his consideration of the largely rural and agricultural lifestyle of the Indian population. Perhaps the Chinese designer is responding to globalization trends, trying to minimize the cultural flavor of his work so it will be accepted internationally; the Indian designer may have no such concern.

Questions of national identity in art and design

The very concept of identity is a fluid term, and China is undergoing rapid change and modernization in all aspects of life. But the question of national identity in art and design is not a new one; the debate between scholars and artists can be traced all the way back to the 1930s, when the 1937 publication by the first professional design organization in China, China Commercial Artists Association (Zhongguo Gongshang Meishu Zuojia Xiehui 中國工商美術作家協會), lamented that the mainstream commercial arts (gongshang meishu 工商美術) in China at the time was full of "Western style" imitation work and questioned how ancient Chinese art and craft (gongyi 工藝) could adapt to the modern context (ZGMZX, 1937).

In response to this criticism in the 1930s, pioneer artist Lin Feng-mian (founder of China Academy of Art) advocated design using the best from both Western and Chinese cultures. To achieve this balance, he advocated four main ideas: 1) introduce Western Art; 2) review Chinese Art; 3) balance Chinese and Western Art; 4) rebirth of contemporary oriental art. The ancient civilization of China has been exposed continuously to Western art since it was first opened to foreign powers in the 19th century; the other three ideas, however, are the unfinished business of generations to come, making Lin Feng-mian's suggestions relevant to works being produced by Chinese designer's today (Wong, 2005).

In 2000, I published a conference paper called *Exploring Chinese Graphic Design theory and Pedagogy*, hoping to discover a generalized creative logic and visual system encoded with Chinese elements and Western design principles (Wong, 2000). Most of my examples were based on work from Hong Kong, Taiwan and Macau, with only a few pieces taken from China. In that study, I recognized six creative directions in the work found in the Greater China region, including: 1) Re-invention of Chinese typography; 2) Integration of bilingual typography; 3) Formulizing the mixture of Eastern and Western images; 4) Rethinking Chinese calligraphy and Shiumo painting; 5) Inspiration from folk arts and popular arts from the past; and 6) Appropriation of contemporary everyday life objects.

Since 2000, the increasing scale and volume of works produced by mainland Chinese designers have opened up more potential creative directions for Chinese design; however, if a majority of young Chinese designers want to emulate the work of Western designers as seen in the international design annuals, what will the future of design in China look like? Before China instituted its Reform and Opening Policy in 1978, designers from Hong Kong and Taiwan, conscious of incorporating Chinese elements in their designs, were creating and shaping the contemporary Chinese design landscape. But there is every possibility that these values may not be shared by the younger generation of designers from China, and the number of professional designers in Hong Kong and Taiwan is small compared to mainland China.

With the new creative power of designers from mainland China joining Hong Kong and Taiwan designers, I was very optimistic that a new visual style with a Chinese touch could be established internationally (Wong, 2003); this could be at the surface, symbolic, or even abstract levels as found in the 1930s Shanghai-style works as well as works of Henry Steiner, Kan Tai-keung Wang Xu, Chen Shaohua, Jiang Hua and others. This new visual language using touches of Chinese culture may be the only way for Chinese design to be established internationally.

Designing a national identity for contemporary China

The past couple of years saw a plethora of amazing work produced by the young generation of designers born in the 1970s and 80s. The sheer volume of work produced has diversified and enriched the visual language. Some of them may use a Chinese touch when it is warranted; together, they are producing a new visual language of graphic design in China. Although these young Chinese designers show great potential, they are causing the Chinese government some concern regarding the construction of a national identity through popular media (Wang 2002), including design. As Knight (2006) points out, "a prominent theme in the Chinese discourse on globalization is that China's culture must not be allowed to become 'Americanized' or 'Westernized,' for this would constitute a serious challenge to the integrity of the Chinese nation" (p. 19). China's leaders are cognizant of the important roles popular media, design, and globalization play in China's economy and culture, and have thus set up a ten-year plan to handle the transformation from a traditional economy to a knowledge economy. The country's stated ideological position, the establishment of "a socialist country with Chinese characteristics," makes it clear why China's leaders don't wish to see a "Western" design identity coming to represent China.

A perfect example is found in the opening ceremonies of the 2008 Beijing Olympics, an image of modern China carefully crafted by the country's leadership. The ceremony arguably was the product of design, a mixture of creative concept, branding, props, costuming, lighting, and so on. Carefully planned and crafted under the strict ideological guidelines handed down by China's leadership, the ceremony was executed by world-famous film director Zhang Yimong, with support from Hong Kong action director Chin Siutong. The stunning result was a movie-set constructed identity, with astounding visual effects aided by cutting-edge technology, massive choreographic coordination of thousands of performers, and props and costumes effectively reconstructed to present a glorified picture of the Chinese civilization's ancient heritage.

Scenes of the four ancient inventions, Confucius chanting, torches flying across the cityscape and breathtaking fireworks displays educated viewers worldwide about the knowledge and symbols of Chinese civilization. These constructions not only fit the perceptions of Western viewers who imagine the East to be quite mysterious, but also aroused the national pride of Chinese viewers. As Woodham (1997) reminded us, national identity is a conscious construction, and China will have no problem finding unique qualities to represent its national identity. However, with contact with the outside world an inevitable part of the process of globalization, the great Chinese civilizations can no longer stand still but must accept the fluid nature of cultures in the modern era.

If the extravagant 2008 Beijing Olympics opening ceremony had a weakness, it was in the apparent lack of a modern, contemporary identity for the civilization, unlike the Tokyo Olympics of 1964, in which graphic designer Yusaku Kamekura shocked the world with his contemporary design absent any obvious national cultural symbol (Art Directors Club, n.b). Japanese design at that time had already found a way to develop a sophisticated contemporary national design identity. Although Kamekura's 1964 poster design did not borrow any iconic symbols, viewers could nonetheless feel the Eastern aesthetic from the composition. The Japanese experience of hybridizing East and West and old and new can provide a possible framework for China's national identity development; however, because of the vast ideological differences between the countries, China's leaders will not wish to see its culture or identity developing in an "Americanized" or "Westernized" direction. Nevertheless, after three decades of reforms and development, design in China is now at a cross-road reflecting the absence of long-term planning once advocated by Lin Feng-mian.

The *China Design Now* exhibit held at the Victoria and Albert Museum from March to July 2008 may have best summarized the landscape of design in China over the past three decades. This exhibit took a contemporary approach to explore "China's hopes and dreams – from the entrepreneurial spirit of individual designers, to society's aspirations at a moment of tremendous change, and the global ambitions of a nation" (Zhang and Parker, 2008, p. 19), displaying artifacts from graphic design, industrial design, architecture, fashion design, toy design, new media, branding, and so on. Rather than embracing stereotypical symbols and icons, as seen in the 2008 Beijing Olympics opening ceremony, this exhibit showed the intermingling of elements of traditional heritage, socialism, and global influences from the West with the creative energy of contemporary China that is barely known to the world. Due to its very nature, this landscape has been a chaotic one, causing the curators to acknowledge that, “[w]ithin a globalized post-modern context, China’s process of modernization – the overlapping of state and market, the co-existence of both formal and informal economics – has, however, broken free from classic paradigms of modernity, either capitalist or communist” (Zhang and Parker, 2008, p. 29). This chaotic context makes the construction of a national identity for contemporary China through creative media more challenging.

Possible future directions

To tackle the currently chaotic context for the construction of a national identity, I suggest that current design education should play a great role in the future development direction of Chinese design. Since China implemented its Reform and Opening Policy in 1978, design schools have had no shortage of overseas experts and academic scholars to lend their suggestions. Design students in China are potentially a very valuable commodity for overseas design education institutions looking to recruit students from abroad. To a certain extent, design at the commerce and marketing levels is a skill that can be transferred without coding and cultural values. The introduction of overseas design education curricula and practice will certainly help Chinese designers and design students to catch up in the world design scene, like the latest design education program announced in Shanghai in April 2009, a partnership with the world-renowned Studio Dunbar of Rotterdam (Bustler, 2009) (figure 4).

Figure 4: New design educational program in Shanghai and Rotterdam Launched, April 2009

However, these joint-educational programs with overseas institutions do not necessarily understand the translation of cultural factors into design education in China. The issues confronting Chinese design education are enormous and require in-depth research into how to produce "design with Chinese characteristics" in the contemporary context. In a journal article published in 2001, two professors from the Hong Kong Polytechnic University proposed that China address the “endemic problems” for their future design education development without acknowledging the struggles of traditional arts and crafts heritage with the modern education system over several decades (Fung & Lo, 2001). I support this critique and look into the possibilities of developing a cross-cultural communication approach in teaching design, in which students are required to understand and apply their knowledge of at least two cultures to their designs, which is basically what Lin Feng-miang once proposed.

Today, people in China are not lacking information from the outside world and the Reform and Opening Policy will ensure that this influence from the West continues. The overarching question is how a balance can be struck between Chinese and Western art/design. These questions are not new and were debated as far back as the 1930s, when China was full of design and designers imitating Western style. In the contemporary context, the definition of "Chinese touch" must remain fluid and inclusive, as proposed by film scholars Wang and Yeh (2005) in their studies of globalization and hybridization of Hollywood-produced Chinese film titles.

Conclusion

The past two decades have seen the explosive growth of business opportunities in design and design education, beginning with graphic design and progressing to Industrial Design, fashion design and, most recently, animation and new media. The boom is no longer restricted to the large urban centers like Shenzhen, Shanghai and Beijing, but is also spreading to inland cities (Xu, 2007; Zhang and Parker, 2008). Because of the publicity given the design professions by a wide variety of leisure magazines, along with mass media coverage of prominent, financially successful artists and designers, Chinese parents don't hesitate to support a child's interest in pursuing a career in design arts. Professor XU Ping of Central Academy of Fine Arts estimates that, in 2006, there were at least 1.1 million students enrolled in Design-related programs at university/college level in China, with another 2.7 million prospective students failing to gain entrance to those programs (Xu, 2007).

I believe design education in China needs to explore a pedagogy that includes teaching how to use cultural symbols in design in a global context. Students need to be educated on the importance of respecting their cultural heritage and learn how to incorporate their cultural symbols into their design output. I am confident that the desire among young Chinese to find a unique national design identity will only increase as they gain more opportunities and exposure to the outside world. It is in this process of searching that a contemporary national identity will most likely emerge. Finally, I would like to conclude this paper with by restating the urgency of creating design curricula with Chinese elements, or the future design identity of China will become even more challenging to develop.

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Creating an Electronic Patient Held Health Information Card

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Abstract

In many areas of health care, professionals rely on patients to provide information about their medical history. However, patients may not be able to remember details or communicate essential information relating to, for example, current conditions, medication and allergies. Currently no central system exists which serves all the UK .Therefore, an electronic, patient held health record system has been proposed as a way of improving patient safety. This development has been driven by a user centred process, from requirements capture to iterative development, longitudinal trials and dissemination. Through this process the project has raised debate and awareness amongst the public and medical professionals about power relationships within the health service and the need for the public to take a greater responsibility in matters related to their own health.

Keywords

user centred design, health, IT systems

Although it has been suggested that patients taking responsibility for their records could improve safety, few studies in the UK have considered attitudes towards this, the design of such a system or potential barriers to use. An American study by Ross *et al* (2005) found widespread support for shared medical records across a broad range of ethnic and socioeconomic groups. In the UK, a study by the Department of Health (2008) reported that although the majority of participants were in favour of electronic records, reassurance was needed that records would not be viewed by other organisations.

For many years, paper forms of patient held health records have been successfully used in the maternity care (Phipps, 2001) and child health (Hampshire et al, 2004). These are rarely extended to other areas of health care. A patient held electronic record system was successfully trialled in the UK, between 1989-1992 (NHS, 1990). 13 000 patients were provided with smart cards containing health information that only they and the professionals treating them were able to access. Although the trial was successful, technological limitations meant that this was not continued or extended.

In terms of the design requirements for patient held records, Jones *et al* (1999) found that almost all the patients who participated in the study thought that a patient held record system should include information about medications, allergies and vaccinations. Liaw's (1993) study of doctors showed that allergies, adverse drug reactions, relevant medications and immunisations should be included. Giglio and Papazian (1986) conducted a trial with four types of patient held record devices in the USA, finding that a wallet sized card was most preferred because it was the most portable.

The aims of the current study were to assess the public's and medical professional's attitudes towards a patient held, electronic health system, with a view to informing policy and the development of a prototype device. The project therefore followed a *research through design* approach, with the development of the My*Care* card (see Figure 2) acting as a catalyst to discussions about the content and ownership of health care records and how such a system could work in practice.

The user centred approach adopted meant that the starting point was not prescribed at the outset. Instead decisions on the form of the device and the interface were informed by the attitudes and user requirements of patients and health professionals. This information was fed into the design of prototype systems, which were evaluated in the laboratory through the development process by usability experts, health professionals and representative end users. User trials were concluded with a month long, limited real world trial to discover how the cards might be used by people who have different health needs. Finally, dissemination activities were undertaken via roadshows to demonstrate the project to the wider public and discuss the implications of such a system for the health service. The paper provides an overview of all stages of the project

The *MyCare* Project

Stage 1: Attitudes towards patient held records and user requirements

The aim of this stage was to collect information about attitudes towards and requirements for a patient held electronic record device and to

- assess levels of support for patient held records
- identify potential barriers to the acceptance of patient held record devices
- identify what form of device would be acceptable as a means of carrying electronic health records
- determine what information devices should contain and who should be able to access this

Separate surveys were conducted with 258 members of the public and 260 health professionals. In the public survey, participants had to be over 16 and visitors to the pharmacies used for data collection. These were situated in different socio economic areas of London and the Midlands. Pharmacies provided the opportunity to collect data from participants with a wide range of demographic characteristics and who were concerned with their health at the time of the survey. The age range of the participants was 17-89, with a mean age of 45 years. 43% were male and approximately two thirds were of white European origin. 61% of the participants lived in the Midlands, 39% in London. 26% considered themselves to have a long term health problem and 13% had been given part of their records to look after.

The survey of health professionals included doctors, nurses, ambulance staff, pharmacists, physiotherapists, occupational therapists and others. Collection was carried out at their places of work in different areas of the UK, including the Midlands, South West and Wales. 50% had used a form of patient held record in their practice. 85% of the public and 94% of the health professionals thought that patient held electronic record devices could be helpful for sharing information. Over 60% of all participants stated that they would prefer a device in the form of a smart card.

More detailed comments were provided in focus groups, such as`*Patient records seem to be a good way forward in both giving patients responsibility and ensuring information is passed on*.` Another participant thought patient held records would be useful for anyone who had a serious allergy, saying, `*Well, I`m allergic to penicillin and if I ever had to go into hospital and was unconscious and didn`t have anything with me, they wouldn`t know I was allergic to penicillin and they would probably give me penicillin so I think that`s a good idea if you had a card with all the details on*. ` The findings from earlier studies were confirmed, with the most common concern for the public being that unauthorised people would gain access to the data (64% were worried about this).

94% of the health professionals said that they would find a patient held record device useful, with the most common benefit being `*to overcome communication problems'*. 75% of the health professionals were worried about data security, 80% were concerned that devices might get lost and 74% that the information might not be kept up to date.

The most popular pieces of information that the public participants thought should be recorded were current medication, name, allergies, blood group and long term conditions. The informational requirements of health professionals was not significantly different, including allergies, current medication, name, long term conditions, age, current and previous health problems and next of kin. For both groups, the majority thought that all health professionals should be able to access important pieces of information, but that some form of role based access was necessary to restrict access to highly personal information.

62% of the public and 60% of the health professionals indicated they would prefer a smart card with little preference being shown for other designs (such as computer, key fob or jewellery). 68% of the public indicated that they thought the device should be provided free of charge. Only seven people were willing to pay over £20 for the service.

The present survey replicates the findings of previous research (see above) regarding the type of information which should be included on the device, the form of the device and the level of support for shared medical records. The most common concern for the public related to unauthorised access to the data (64% expressed concern about this). Health professionals were concerned about devices being lost and the currency of information. This is a real concern as a patient held, card based system, requires card owners to take responsibility for the provision of accurate, up to date information and for carrying the card with them at all times. Without such buy in, and widespread adoption, this system will fail as valuable time will be lost searching for cards, reading out of date or inaccurate information, which could have life threatening consequences. Indeed, part of the rationale for having a wallet sized card was that people were familiar with, and used to carrying information in this format.

It is therefore imperative for both members of the public and health professionals to understand and value the potential usefulness of this service and for the device to be easy to use by all demographics regardless of IT and health literacy. For most people, the type of details included on the card will not need changing often. Although this means a reduction in the onus of keeping items up to date, it may mean that they will forget about the card, or not remember to update it when circumstances change.

Advantages of the wallet sized card over other design forms are portability, familiarity and it being inexpensive to produce. A ‘card’ format may also be more acceptable as an input device (e.g. as opposed to a piece of jewellery) as it can be accommodated into existing readers. Additionally the design of the card could convey essential medical information in a visual format – immediately alerting the health professional to emergency conditions.

The survey also revealed that the public had misunderstandings about the operation of the current health service, assuming that all health professionals had access to their records at all times. In the UK, this is not necessarily the case, especially in emergency and out of hours care. It is only relatively recently that a computer based, central system has been introduced. Paper based notes completed by medical professionals still form a major part of the health record system. They may not include detailed information relating to health and well being, which could provide vital information about the overall condition of the patient. For example, it may be useful to record the use of alternative medicines (especially where these might have notable side effects), or patterns of migraine, insomnia or allergic reactions etc.

Accordingly, members of the pubic without long term medical conditions may not understand the need for such a system or how such a system would benefit them. This could be indicative of a narrow conceptualisation of health and wellbeing, a reluctance to participate in a dialogue about health or to understand wider issues around health literacy. Similarly, not all health professionals thought the issue was of relevance to them.

From the survey a set of requirements were established for the software designer. Other users groups (such as the elderly, those with disabilities and communication difficulties) were encouraged to take part in the evaluation of the prototypes.

Stage 2: System Development

System development took place over 18 months, with the release of concepts, semi functional and fully functional prototypes for evaluation. An early prototype is shown in Figure 1. A detailed account of the technical development has been presented in Rybnovik et al (2009). In order to meet the requirements of the users and convenience/ease of use, a traditional smart card was combined with a USB stick as shown in Fig. 2. The USB/ card design combines the advantages of both smart card and USB media types. USB mass storage devices are supported by most computers.

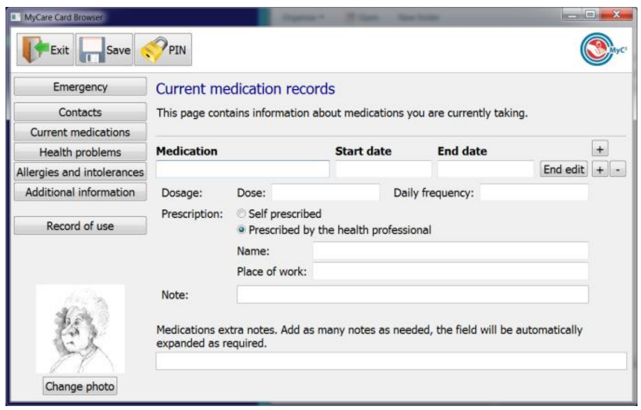

Figure 1: Example of early *MyCare* interface

The *MyCare Card Browser* aimed to be user-friendly, Open Source and community driven, easily extensible, cross-platform, portable, stable, secure and achievable with reasonable development resources and time. To reduce the cost of the development and to minimize dependency on major computer systems manufacturers, Open Source software tools and programmatic libraries were utilized.

Mindful of user concerns about security and unauthorized access, conventional USB mass storage protocol was utilized to store user's medical data, security and authentication data, and the browser software itself on the *MyCare Card*. All data is stored on the card in files, which are available to the operating system services via standard portable disk drivers. The system runs off the card, and information is stored on it. This is different from government initiatives, where data is held centrally and uploaded by health professionals. In the *MyCare* system all data is stored on the card, and entered by the users who type in their pin number to open the system. Medical professionals can access the material on the card by entering their own health number. If the card is lost, the pin number acts as a deterrent to ward against misuse. As the system is standalone, it is not possible to access to user data in other systems.

In further development, for security reasons, additional USB device protocols will be implemented. to protect MyCare Card user medical data and software files from unauthorized access and from accidental corruption. Therefore, files access algorithms implemented in the *MyCare Card Browser* are isolated into interface classes to allow future embedding of security protocols, without affecting other software parts or the overall source code structure.

The welcome page of *MyCare* allows the entering and changing of passwords. The system then comprises a small number of pages in which the user can fill in personal details (including next of kin and GP), allergies, current medication, medical problems and medical history. An access log shows when and what information has been updated and by whom. As the system has been designed to be used by members of the public with limited levels of computer literacy and medical expertise, of central importance was ease of use, learnability and memorability (as the system may not be used regularly).

Stage 3: Evaluation

The evaluation programme aimed to:

- inform the development of the interface and the device
- uncover emergent requirements
- include groups which had not been consulted in the initial survey

A mixed method approach was adopted to the evaluation. Participants were required to verbalise as they used the interface (with breakdown analysis (Woodcock and Scrivener, 2003) being used to focus on usability issues). This was followed by semi-structured interviews and a SUMI questionnaire (Kirakowski, 2007, 2008). Transcripts were thematically analysed (Aronson, 1994). The three main stages included;

1. Evaluation of the early device designs using focus groups. Taking an inclusive design approach, focus groups included participants who had communication difficulties due to disability and language barriers, who would have had difficulties completing a questionnaire or taking part in a walkthrough evaluation. Separate focus groups were conducted with older adults, people with disabilities, people who did not speak English, and people who were not confident about using computers. Several of the participants who had disabilities would have to rely on others to help them to use the system, or in the case of the older adults and those who were not confident about using computers, would require training and assistance to do so. The focus groups provided an opportunity to discuss how such assistance might be provided.

2. Evaluation of early versions of the software commenced with a walkthrough method with five usability experts. The feedback was used to amend the prototype which was then evaluated with 20 members of the public and 10 health professionals

3. A month long user trial of a working prototype in a real-life environment with members of the public. The information entered on to the devices was assessed by five health professionals in order to gauge its potential usefulness.

The initial evaluation occurred on a system with limited functionality (and no help system). Although the system was rated as average on all SUMI scales, participants felt that it was a system they would use if available. Usability issues included:

- Lack of on-line help and support for conducting tasks
- Lack of system feedback (especially on save)
- Use of inappropriate or unfamiliar computer and health terminology
- Poor structure to the forms
- Failure to automatically update information on the summary form
- Inappropriate task formulation for entering medications and health problems.
- The page allowing restriction of access to certain groups of health professionals was poorly received by both health professionals and end users. End users could not understand how to do this; health professionals were worried that they might be denied access to important information. Following discussion this was dropped. By keeping a card, the user acknowledges

that its contents should be accessible to all medical professionals (with an authorized pin number)

An emergent need from the later usability sessions was for an additional form where other information could be entered – almost like a health diary. In the final system this was a free form text field

For the final stage evaluation, 49 *MyCare Card* units were tested in a real life trial. The front of the final wallet sized card is shown in Figure 2 below. This contains spaces for the patient's name, photograph and NHS number. The hole in the top left of the card can be used to attach the card to a key fob or chain. The series of circles along the bottom can be used to visually indicate important medical conditions.

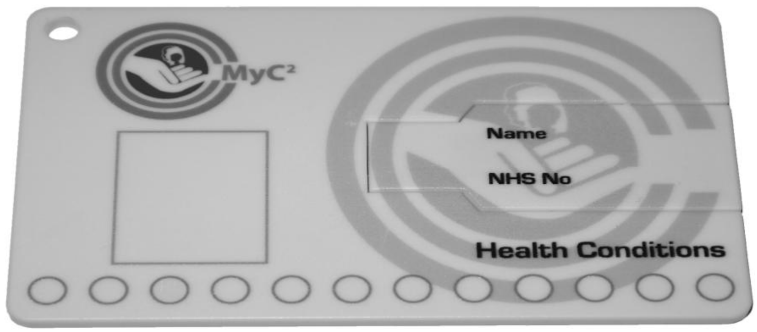

Figure 2: The final version of the *MyCare card*, with integrated USB

Participants were trained to use the cards, asked to input health related information (which could be their own or follow a fictional scenario), and to carry the card for one month, updating the information as necessary e.g. when they went to the doctor, or took medication. They were asked to keep a record of any problems they experienced and discuss these in an interview at the end of the trial.

Not all the participants were able to use their device the whole time. Difficulties experienced are considered to be representative of those that real users would experience, including forgetting the Pin number, detachment of USB stick, inability to easily insert the USB in the computers, preferred computer suddenly failing to recognise the device, loss of device. Five people declined to take part in the trial as they were not PC users.

The age range of the participants was 18 to 94, with a mean age of 41 years. The sample included 57% women. 29% were students, 39% had professional jobs, 8% had manual jobs, 18% were retired and 6% were carers. 55% of the participants considered themselves to have a long term health problem. 16% were parents who used a card on behalf of their young child. 18% were classified as having low computer ability, 22% had medium ability and 59% a high ability. 24% stated that English was not their first language.

At the end of the trial the majority of the participants thought that the system had been useful. Those who had long term health problems were more likely to state that they would use such a system in the future. Suggestions were made for additional features and the improvement of both hardware and software.

In the second stage of the trial, five health professionals reviewed the information contained on a sample of the cards and assessed its potential usefulness. They also made recommendations on design and usability and where the system could add value to current services e.g. by showing where medicines may adversely interact with each other or if the interface could warn the patient that he might be allergic to the medication.

Although they all felt that the card provided a useful guide to information and would be particularly helpful where no other patient information was available, they all expressed concern over the accuracy of the information. One nurse said, `*The more information you have on a patient, the better care you can give.*' All the professionals stated that they would check the information with other sources if this was possible. As one pointed out, `*Patients don`t know what is relevant or important. People may not want information known and withhold information*. `

Concerns were also expressed with regard to the amount of time it might take to help patients to maintain their records. Two professionals did not think they would have time to do this. As one of them said, `*I can`t see how you could sit down with the patient to see if they have added it correctly.*` Another stated '*I don't think it would work in hospital*.' Additionally if professionals did not receive any direct benefit for helping the patients input information, they might not be persuaded to do so. One of them was also concerned that the necessary equipment, training and organisational support might not be available.

This final trial was seen as providing valid information on how the system would be used in the real world. Additionally it generated usability and design problems with both the hardware and software, and new design requirements and features. This part of the evaluation revealed a number of barriers to use, which although in some cases had been anticipated, had not been regarded as insurmountable.

Stage 5: Public Dissemination

Dissemination to the general public was carried out though a small roadshow featuring banners, leaflets and a software demonstration, as a means of attracting people in libraries and shopping centres in various UK cities (Milton Keynes, Preston, Coventry, Redditch, Nottingham and Bristol). Questions used to stimulate discussion included:

- Do you think you would use the *Mycare* system?
- What problems would you have with this?
- What sort of things would stop you or other people using the system?
- Would you be interested in recording your health details on a card, even if you were well?
- What sort of information would you include?
- How do you feel about being responsible for providing health information?
- Do you think the public and health professionals should work together as partners to manage health problems?
- Do you think that you know enough about your health to be able to record useful information?

Informal discussions enabled a range of views to be expressed without the restrictions of a formal interview or focus group, although people were encouraged to contribute their opinions by filling in comment forms. Results were analysed thematically. 122 people participated, their comments confirming many of the prior findings, for example, those with long term medical conditions, or who had relatives with health problems were more likely to see the value of the system.

Problems with current NHS systems included the failure of information to be relayed between medical professionals and failures to be able to remember medical details when needed. One participant with several health problems stated that he was more worried that people would not know about his health problems when they were treating him than about the risk of a breach of confidentiality. Another participant stated, `*I have experience with consultants. You see many, never the same one. And they look on the computer but the information hasn`t been uploaded yet, and it is frustrating. With this, it can be all there, wherever you go, whoever you see. Everything is kept together'*

A community support officer thought, `*it would be good for the police if somebody is collapsed so we could get their name and know about any health conditions*.` A police officer confirmed that she often had to find out information about people who were unable to provide it themselves, such as those who were intoxicated or had been involved in accidents. In these circumstances she would look in their pockets. If she could find information that could be read from a card, detailing the person`s identity and their existing health conditions, that would be very useful.

Reasons for not wanting to use the system included not being able to use a computer and participants not seeing the benefits of the system for them. As one of them said; `*If you had health problems you would probably be more inclined to carry it. I`m healthy so I don`t know if I would bother.* `Others had a general, deeply-held mistrust of electronic data systems. As one said ` *I would not trust any kind of electronic record and I intend to get out of the government database. There is no way of making this kind of thing properly secure'*.

Most participants were ready to take responsibility for their health information. As one o said, `*this is good because you can put on the information that you want; it puts patients in control*.` Another said she would be more confident about the information being accurate if she had provided it, saying `*It would be good to get people to put the information in; there would be fewer mistakes. You could always get someone to check it.* ` Another participant said that she liked the *MyCare* system because, `*it would change the power balance with doctors*.` She went on to explain that she thought it was wrong that doctors were considered to be all powerful and patients expected to accept their views. However concerns were expressed regarding whether the system would provide information in a usable form, and whether the level of cooperation required between the public and health professionals to make *MyCare* work was possible.

Discussion

The study has shown the potential of an electronic patient held health system to improve communication between the public and health professionals. A user centred iterative approach ensured that the design was based on user feedback. However, for any new system to be accepted, it must work with those already in use. The integration and interoperability with central health services was beyond the scope of this project. However, uptake of an 'independently developed' system will depend on the development of appropriate infrastructure, co-operation from from the central system and education and training of users. Adoption of a card system would require the public to take on new responsibilities and knowledge and health professionals to support them and adopt new working practices. A full scale trial with buy in of the NHS and associated healthcare services, support staff, and members of the public, would identify how *MyCare* and other systems could be used in conjunction with existing and future health care information and record systems.

In conclusion, one of the main aims of the project was to assess whether the UK public and medical profession were ready to accept and use a patient held system. Although there is support for sharing medical information, attitudes expressed by participants revealed mistrust of government initiatives towards centrally kept records and an unwillingness by healthy individuals to appreciate the need to keep their own personal records Health professionals were concerned about the currency of the information, and its accuracy as revealed by their unwillingness to accept the accuracy of information entered by their patients without it being verified by other sources.

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Jackie worked as a nurse before becoming a research assistant and then as PhD student at Coventry University. She is in the final year of her PhD, which is concerned with the attitudes of the public and health professionals towards the use of patient held health records.

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Pupil Participation in School Design

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Abstract

Over the last decade, UK policy interventions relating to the (re)design of schools have stressed the importance of pupil participation in programmes such as Building Schools for the Future, Academy Schools, and Primary Capital Funding. A two year project was conducted to explore the possibilities for, and present state of, pupil involvement in classroom (re)design and design decision-making. Through in-depth qualitative data drawn from pupils, school staff, Local Authority officers and other stakeholders, the relationships and tensions between the ideals of participatory design as expressed in national policy statements and the ways in which such participation is happening in practice was investigated.

Keywords

Participatory design, schools, children, ergonomics.

The design of school environments affects the activities and outcomes of teaching and learning. School buildings should make a positive contribution to the academic wellbeing of students, and prmote social interaction, a sense of community and inclusiveness. The Commission for Architecture and the Built Environment stated "*…we know that good design provides a host of benefits. The best designed schools encourage children to learn.*" (DCMS, 2000).

Price Waterhouse Cooper (2001), found a positive relationship between capital and performance and more specifically between the physical school environment and pupil performance, stating that "*The general attitudes, behaviour and relationships amongst pupils and staff are more conducive to learning in those schools which have had significant capital investment*".

Whilst acknowledging the importance of school environmental design on those who spend a large proportion of their time there, UK (and worldwide) legislation has also recognised the need for children to be involved in the design of the spaces they inhabit. UK policy shows (i) greater recognition of the diversity and distinctiveness of children and young people's needs; (ii) a growing imperative for children and young people's participation in decision-making and practices regarding their everyday lives and contexts.

Three major lines of capital investment for school buildings have been provided (i) academy schools; (ii) Building Schools for the Future (BSF); (iii) the Primary Capital Programme (PCP). User involvement forms a cornerstone of these initiatives, as evidenced in the following quote.

> *"Putting the user experience at the heart of all we do is not the same as saying we simply respond to user demand. Our and our partners' role is to prioritise, ensuring resources are used efficiently and effectively in the wider public interest. We need also to be aware that service users have very different capacities to shape services. …..The key lesson for taking forward the Five Year Strategy is this: failing to understand users in the way we design and deliver services means we are less likely to deliver aggregate improvements in outcomes across the system because we are less likely to be meeting the needs of individual service users"*(DfES, 2006, p.36*).*

In addition to the statutory requirements, pupil participation is fundamental to the UK Government's vision for all schools post-*Every Child Matters*:

> "*There isn't a design blueprint for a school of the future: a variety of models will emerge. The main design challenge facing LEAs and schools is to balance the needs of different users, creating inspiring buildings with functional spaces that are appropriate for new educational developments and new technologies but adaptable enough to cater for the changing needs of the future"......... "[The user is] a key player in the success of a building project. It is very important that right from the*

beginning of a school building project there is proper consultation with the staff and pupils of the school and the wider community. The school and its community must decide what they need and want both for the immediate and longer term future… All potential users in the community should be consulted in order to assess local and individual needs… This approach will help to encourage greater use of the building, develop trust between all parties and add to the feeling of community and ownership… Consultation and feedback should continue through the construction period...... Where work is taking place at an existing school, finding ways of linking the project to the curriculum can benefit pupils and encourage a positive attitude to the work taking place" (DfES/SBDU, 2002, p.63).

Project Overview

This research appraised the extent to which the BSF programme delivered its commitment to pupil participation. The programme asserts that pupils and staff have an active role in the development of the design brief, down to the level of what is needed in each room (DfES, 2004a, p.6). However the guidance relating to the PCP suggests the approach to participation may be more tokenistic than implied in the policy documents.

The following sections provide an overview of the results from interviews with representatives of Local Authorities, observations and interviews in 11 schools at different stages of the BSF programme. The results show tension between the ideals expressed in government policy and the reality of participation; both optimism and skepticism towards participation; the importance of the wider school ethos; and the need for better support for schools undertaking pupil participation.

A qualitative approach was undertaken to understanding the situation in schools, with ethnographic observations, attendance of design consultations or design events and interviews with key stakeholders including Local Education Authorities, pupils, architects and teachers.

Results

Examples of Perceived Benefits of Pupil Participation

Interviews with teachers and architects indicated that those engaged in the process saw the benefits of successful participation as relating to:

1. Improvements to the spaces and day-to-day running of school buildings.

   "*.......pupils come up with really perceptive ideas, that can genuinely improve a space. And a lot of things that come from the pupils are mostly cost neutral. They are not asking for the earth – they are very realistic in what they want"* (Architect)

2. School buildings with local 'character'.

   "Getting the pupils involved was crucial – they're the ones who've really helped us to bring a local 'stamp' to the project" (Headteacher)

3. Greater user satisfaction with the school environment.

   "it is particularly good for pupils to be involved… it gives pupils ownership – you know it makes them feel good because it's their school, their role in that kind of decision-making… It makes them feel more at home in their school" (Teacher)

4. Fostering a culture of trust and collaboration.

   "[This] has been a kind of…. bonding exercise really. It does encourage everybody to be enthusiastic about every aspect of a school… It has brought people together" (Headteacher)

5. Reduced vandalism and 'anti-social behaviour'.

   "Giving the pupils something new, something they have a stake in – it's treating them with respect. It's saying 'we trust you'. Our pupils have responded magnificently. They really take pride in it" (Headteacher)

   "Basically – there's no graffiti in the corridors any more!" (Teacher)

6. Opportunities for teaching and learning.

"We've started to link [the school redevelopment project] into the curriculum in all sorts of ways – numeracy, design… learning about the history of the building and looking at old photos and maps" (Teacher)

7 Enhanced design literacy.

"[Involving pupils in school design] gives them a bit of an insight into different parts of the process – design, budgeting, strategic decisions… It expands their knowledge and hopefully helps them to understand things in a different way" (Architect)

8 Raising learners' self-esteem.

"The input [into the development project] made him [son] feel important. He'd come back and tell me what they were talking about in school: they had discussions… I really noticed a difference" (Parent)

' [a group of disaffected students] realised perhaps for the first time that they could have a voice and they could come up with ideas and that people could listen to them' (Deputy head teacher)

9.Familiarising pupils with new school environments.

"You see a psychological impact of consultation as you start to involve children: it has engendered a sense of ownership, and there was no shock for pupils of moving into new environment, because they already knew a lot about the new building, were prepared to move" (Headteacher)

These comments accord with the vision expressed in government documents. However, the following sections reveal a different impression of the practice of pupil participation.

Interviews with Local Education Authorities

15 semi-structured telephone interviews with conducted with LEA officers responsible for school (re)building and (re)design in randomly sampled geographical locations. These representatives held posts directly concerned with school (re)building programmes – such as Head of Planning and Building for Children's Services, BSF/Private Finance Initiative (PFI) Project Manager, School Site Development Manager. These job titles emphasised the connection between children and education, on the one hand, and asset development and building on the other. Interviewees worked on the (re)building of schools cooperating closely with the school's management team, architects and various consultants.

They were responsible for the development of the project brief and oversaw projects to their completion. Thus, these professionals could comment on the ideal of pupil participation as articulated in policy documents and its operationalisation. From a qualitative thematic analysis of the 15 interviews, four major trends were identified (den Besten et al, 2008).

(1) Pupil participation was disappointing.
LEA representatives were optimistic about the benefits and rationale for engaging pupils yet disappointed with the results of participation. They had more modest and realistic aspirations contrasting with the lofty ideas expressed in policy documents. Examples of comments included:

Pupil participation is hugely desirable and we are striving to achieve it. But so far, the level of influence pupils have had on the final design is probably quite limited.

We realise that both pupils' and teachers' participation is desirable – in general, but it has not been possible to a big extent yet.

Pupil participation is desirable but I'm afraid we have only managed it to a very limited level so far.

(2) *Pupil participation was multiply foreclosed by the complexity of the programmes.* The principal barriers to participation included tight financial budgets and timescales; the complexity of the

programme, funding and stakeholders which meant that participation became lost; lack of clarity and guidelines about how to engage pupils;lack of trained facilitators; large number of pupils in the school who could be involved.

Examples of comments include:

> *The overall process is incredibly complex and very competitive. If pupils were involved to a large extent, the process could have taken a significant amount of their curriculum time. There are a whole lot of criteria of how a school building should be, including guidance from DfES concerning which sort of space should be here and there, what areas of children's outside play should be like, etc.*
>
> *We have planned and built mostly nurseries and early year schools, where children are too young to contribute to the process.*
>
> *Children will not see the benefits as they will have moved on.*
>
> *Students move on, so continuous involvement of one group is difficult.*
>
> *If you talk with one group of students they'll come up with one thing; if you talk to another group of students the next year – they could come up with something completely different.*

LEAs, schools and architects showed a clear willingness to engage children in school (re)design, yet the barriers inherent in the multistakeholder, multi stage, protracted school (re)design process inhibited meaningful engagement with user representatives.

(3) Pupil participation was 'modest'.

Interviewees found that pupils' abilities and interests compromised their participation. This led to negative comments. Suggested improvements were regarded as banal, small-scale, predictable and superficial typically regarding social areas, toilets, and paint colours – but little else. Pupils were viewed as showing little creativity in their recommendations or understanding of design techniques, processes and legislature. This could have been overcome by reframing and extending the questions and information asked of pupils. In order to become more creative, pupils required more guidance, direction and knowledge of constraints. Pilot projects have demonstrated that children can understand complex considerations about finance, engineering, design and planning, and that their learning is neither time consuming nor resource-sapping.

Example of comments included

> *In the issues that came up, there was no real surprise. For example, pupils raised the usual issues of uncomfortable environment: that it is cold here or there….; discussed social areas and toilets. The teachers knew those issues already*
>
> *Pupils contribute mostly to their spaces, such as dining spaces, toilet spaces, indoor and outdoor social spaces: for example, playgrounds and common rooms.*
>
> *In one school, the head teacher got pupils to design toilets – it's very important*

(4) Pupil participation was contingent and local.

Interviewees highlighted a number of locally based issues which presented opportunities and challenges for participation, such as the diversity of schools, school attitudes towards pupil participation, the need to manage expectations. Many LEAs used 'advocacy' (by teachers or other professionals) to replace participation where the latter was deemed inappropriate or impossible.

Examples of comments

It [role of pupil participation] varies from project to project and depends on people involved. In many cases, pupils were consulted and notes of their needs made, but it's a bit of hit-and miss probably, it is not a standardised process.

Pupils fed into the vision side of things and that has altered some decisions.

To summarise, LEA respondents identified a number of barriers to participation which stemmed from two sources. Firstly, the financial, organisational and legal processes inherent to school (re)design. Secondly, the positioning of pupils – and their participation – within those processes, both at national and local levels.

From School Observations

The team spent extended periods in each school, talking to staff and pupils, observing the design and use of facilities and attending design meetings. Results supported interviews conducted with the LEAs concerning the individual nature and ethos of the schools, the varied nature of participation, the complexity and protracted nature of build programmes which means that consultation with a wide variety of end user pupils is unlikely.

Taking as an example the experience of one primary school, Newman and Thomas (2008) related found the following typical strategies used to engage students:

- consultation throughout the visioning process;
- a 'Design your school day' where gifted and talented students led other students in designing and making a model of a chosen part of the new school. This method was also adopted by a secondary school which involved a group of disaffected students, on the verge of exclusion, who produced a design of a bridge they wished to see incorporated into the new school design. There was a clear intention to be as inclusive as possible. An assistant head teacher commented that this group ' *realised perhaps for the first time that they could have a voice and they could come up with ideas and that people could listen to them.*'
- PSHE (Personal, Social, Health and Education) lessons used for discussion about student aspirations for the new build;
- the school council acting as a conduit for student voice;
- questionnaires sent home to encourage family discussion about the school in an attempt to involve the wider community.

Studying these events and similar activities has shown that direct or indirect participation is occurring using different methods such as questionnaires, comment boxes, involving different groups of pupils (such as vertical groups, workshops, student councils) and deals with different design issues – from concept design through to the design of specific spaces, or pieces of equipment (such as window locks). The use of these initiatives is felt to add local character, such as the use of natural occurring materials and local design forms. However the extent of participation is determined by the enthusiasm and knowledge of the staff and the school ethos. Unfortunately, the organisation of consultation and participatory exercises was mostly ill structured, with little continuity observed between consecutive meetings

Despite teachers and school management wishing to use the opportunities afforded by BSF to provide a different approach to curriculum delivery, students found it difficult to engage in questions about how they learn best during consultation. Instead they focussed on more tangible, social aspects of the school, such as dining rooms and common rooms. One head teacher said that this was frustrating but not surprising, as it was difficult even for teachers to imagine what education would be like in the future.

Despite the 'design your school days' having positive outcomes, at the two secondary schools involved , students received no design parameters, for example financial constraints or site information. This often led to the creation of inappropriate designs. For example one group spent the day designing a swimming pool, only to be told at the end that a pool would not be funded. This led to cynicism on the part of many students.

Special needs schools visited other schools to see which aspects their children liked/disliked. The school council visited recently built special needs schools, where adults took pictures of things the children appeared to enjoy. The images were based on adult perceptions of children's enjoyment. Here advocacy was used in preference to participation where staff stressed the need to design for children, using their expertise to interpret the needs of pupils who could not verbally express themselves. In some mainstream secondary schools teachers believed that they knew children's requirements better than the children themselves.

Staff and architects frequently cited 'ownership' as a key benefit to children's participation in school design. Involving children in the process was believed to increase the sense of pride in the school building. As vandalism was a problem in several of the schools it was hoped that this could be reduced by involving pupils in decision making. For example one teacher said

> *'It makes them feel that they've had a part of it, an ownership of it….. we're constantly saying to them this is where you belong, this is your school, we want you here. And I think to be part of it, for any child really, they feel they have some ownership, a stake in it and want to look after it better and maintain it better. I get the impression at the moment that they have no respect for the environment that they're in'*

The idea that participation would foster a sense of belonging was an important perceived benefit of participation, although for the schools in the early stages of BSF it was too soon to say whether this would be achieved . Related to this is the belief that inclusion in design activities may also foster a sense of ownership and involvement in the wider community especially when schools are in deprived areas and are required to act as a community resource. For example one school attempted to involve parents and the wider community by sending out questionnaires to families of students asking how their community needs could be fulfilled in the new school building.

Both architects and teachers felt that participation could provide a valuable insight into young people's perspectives on their experience of school and their needs for new builds. A deputy head teacher explained

> '*I think the advantages are as you get older, we don't see, we're not as familiar with what they find, what young people find, attractive and what their needs are'*

This recognises that children are experts regarding their own experiences and needs, and could offer innovative solutions to issues of particular significance to them. For example, an architect related an occasion where a primary school pupil had approached his head teacher with an idea for a design for a covered area in the playground where children who did not want to be involved in boisterous activities could play quietly. He explained that this solved the problem experienced by many children who felt marginalized when the majority of the playground was given over to football. The boy's experience had led him to suggest a solution that was adopted by the school.

Teachers and architects felt that the involvement of young people in the design process would raise awareness of design issues such as empathy. This was demonstrated at one school which was to be rebuilt as a broad spectrum school, accommodating children who had previously attended a special needs school. Children who participated in a 'design your school' day were keen to provide an inclusive environment, meeting the needs of all users. They attempted to address the issues that children with particular physical impairments would encounter in their daily activities. For example having the school on one level to ensure access for everyone, or to include lifts for wheelchair users.

Lastly, the involvement of young people was believed to foster a sense of achievement which may otherwise be unattainable. This was particularly important for children who do not achieve in more traditional ways. As one architect said

> *'The non-academic kids who will never achieve academically but may achieve lots of other good things, that's where greater engagement should be fostered'*

Perceived Drawbacks

However participation was not without its drawbacks. Many staff and architects were concerned about the raising of expectations and that pupils would be disappointed if their inputs were not realised in the final build. This was exacerbated if only selected children were involved or there was no systematic was of including the student voice. This concern was shared by the management team and pupils at two schools involved in 'design a school' day. Despite the success of the day in terms of inclusion and the production of high quality models, there was a danger that this particular mechanism may promise more than it can deliver as students become immersed in producing imaginative, creative and ingenious ideas that are ultimately undeliverable. One student commented:

> *'I didn't see the point when they said to choose ideas and contribute to what you would like in the school…I thought because we are just students at the end of the day and I don't think that they'll actually take our ideas very seriously.'*

He went on to say that the designs would have benefited from constraints to allow for more realistic designs

> *'It would be nice for someone to actually to say "Oh yeah, we've got this budget, we'd really like some realistic ideas that could, you know, we could actually use" instead of people saying "We'll put your ideas down, we want to know", it's a big vague, you don't actually have things to say "Oh, we could get this". They could get to say one idea and it would completely unrealistic, you haven't got enough money to do this.'*

The young people expressed a quite sophisticated understanding of constraints. For example,

> *'they say they're asking for ideas and saying that our ideas will be taken in to account but then if we've been promised a certain amount of something…and then they've kind of let you down saying that you're not going to get it any more because they haven't got enough money to do it or because they haven't got the time or because they don't find that it is necessary or something'*

There is a risk that if young people are asked to produce plans that are later rejected because they are impractical, unworkable, and too expensive or do not fit in with a broader vision, this will lead to further disengagement from the process and the educational system.

The view was expressed that pupils' experience is too limited to enable them to envisage change to the delivery of education. There was little evidence of pupils contributing to discussions about the curriculum or learning styles, as they may not have experienced working and studying in innovative ways. As one head teacher indicated

> *'We've done some work but in my opinion that work is fairly limited, because the students don't know what they don't know. So they're victims of their own experiences and environment.'*

Further problems in meaningful participation may be caused by the time scale involved in building a school, because many children involved in the design process will have left it by the time it is completed.

In many of the interviews, young people exhibited a degree of cynicism about the design process, expressing dismay at what they see as empty promises. This was particularly so in one school in an affluent area where staff believed the school to be a low funding priority compared to more deprived schools. Students and staff expressed the opinion that there was little point in becoming involved, because they believed funding would be withdrawn before the school was built. One example was cited by the school's business manager

> *'Everything we try and bid for we don't get because we're in the wrong area. I spent nearly 2 years putting a lottery bid together to try and improve our school facilities and the reason we failed was because we weren't a priority. Despite the fact that the particular facilities we were looking at, there is none in this area…They still turned us down'*

Such cynicism was reflected in responses from students. One sixth former was asked how much she knew about the proposed rebuild, she commented

> *'I knew they were thinking about rebuilding it... I wasn't really sure and I was like "Yeah, whatever". But you hear certain things, I was in Year 9 and they said that everyone's going to get their own laptop, they were going to get this they were going to get that. But nothing actually ever happened so you just take it on and think whatever.'*

This attitude was not found in other schools, indicating the contingent nature of participation and the extent to which it is dependent on the practices and ethos of each individual school.

Conclusions

The research indicates that schools are not being provided with sufficient guidance or methods to enable pupil (or teacher) participation in the design of new schools. This is problematic given that involvement in the creation of large-scale community projects is believed to increase feelings of ownership and co-operation, the level of investment being placed in the building programme and the belief that this will improve the educational system.

Through observations of typical (as opposed to flagship or academy) schools and interviews with LEAs, we have found that the protracted nature and complexity of the design process severely limits the possibilities for pupil participation. Participation is further hampered through the lack of time and expertise in involving pupils in design on various levels, a lack of trained facilitators and absence of a good-practice guide. Although the type of participation should not be prescribed, guidance should be provided for those new to the process and participatory discussions should go beyond addressing superficial and marginal areas, without unnecessarily raising expectations. Young people can understand budgetary and time constraints, and whilst some of their ideas may be aspirational and unrealistic, they can work with design constraints.

The results show that in many cases, in 'ordinary' schools, the ideal of pupil participation may be foreclosed by contingencies, budgets, issues, debates, personalities and events at grassroots level. Not only are pupils not fully involved in the design and decision making processes, teachers can be excluded as well. Pupil participation, which offers opportunities for the design of more pupil-oriented schools and curricular, as well as real opportunities for first hand experiences in design, is not being supported well enough centrally, with schools and LEAs being left to find out which methods are most appropriate, with little dissemination of best practice.

We conclude that policy-making regarding participatory design/ergonomics should be better grounded in the complex and diverse realities of the (re)design of school environments in practice. The experiences of schools already engaged on the BSF process which have developed approaches to engage their students should be collated to provide a set of methods that could be used by the next wave of schools involved in the programme. Additionally greater attention should be given to the participation of teachers and the types of educational practices the new schools will support.

Outputs

Therefore, the outcome of the project was a set of guidelines to support the first stages of this activity sent to over 3000 schools, LEAs and architects. These remain available electronically at: http://www.coventry.ac.uk/researchnet/d/699. These were written with target end users in mind (including children), providing an overview of the benefits of participation, plus examples of methods which could be used to participation and examples of pitfalls to avoid. A one-day multistakeholder conference was held bringing together teachers, LEAs, architects and others interested in the process. Results were disseminated to participating schools through a one day workshop focusing on design literacy

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Cultural Appropriation in Design and 'The Cipher'

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Abstract

Dynamics of globalization redefine objects as agents of cultural exchange in various everyday contexts. Design activity constitutes a significant channel of cultural exchange because it presents objects to a system of social interactions that does not require geographical proximity of cultures. Design's conceiving a cultural element in a product, thus starting the process of commoditization involves practices of cultural appropriation. Appropriation of cultural elements from their local contexts to be designed or re-designed translates the element's cultural value into an exchange value that presents '*negotiated* decodings' (Rogers, 2006) of the 'different other'. Through design channels, '*the cipher'* (Ono and Buescher, 2001), '*a figure through which various commodities with multiple exchange values are marketed*', is produced as '*a social concept that circulates like a commodity'* (Ono and Buescher, 2001, p. 26). *'The cipher'* sets cultural stereotypes by encoding selected characteristics of a culture in a series of products and limits the (articulation) capabilities of design agency down to commodities floating in the market without any original cultural content.

Design's interpretation of culture needs a critical reflection on the processes of commoditization and practices of cultural appropriation. Through this critical reflection, design's capabilities to propose new grounds for cultural exchange as an ongoing process of growth can be explored. This paper discusses cultural appropriation as a key strategy in design's interpretation of culture in products and recognizes cultural appropriation as a practice for creating *'the cipher'* through cultural encoding and decoding. The research project named 'A Kaffiyal Project' presented in this paper focuses on the transformation of the *kaffiyeh* (the Middle Eastern headdress) from a traditional element of cultural identity to a fashion statement in different parts of the world. By using strategies of creating '*the cipher'*, the research explores and documents ways of decoding cultural stereotypes through design processes.

Keywords

cultural appropriation; 'the cipher'; focus group; kaffiyeh; stereotype; participatory design.

'Cultural appropriation, defined broadly as the use of a culture's symbols, artifacts, genres, rituals, or technologies by members of another culture, is inescapable when cultures come into contact, including virtual or representational contact' (Rogers, 2006). Any type of cultural produce (whether tangible or intangible) is subject to cultural appropriation. As a social practice cultural appropriation operates in different spheres of exchange and power structures in the social realm, and therefore is a complex phenomenon. Even though the concept of cultural appropriation has been discussed in law, media and cultural studies, it is an undermined yet significant issue in design studies. Design naturally offers a site of mediation for practices of cultural appropriation by constructing exchange. Design's role in such mediation is critical because the form of exchange determines how cultures interact and have an understanding of each other. Design offers strategies to encipher and distribute ''selected'' aspects of a particular culture in the form of commodities that have some sort of exchange value in global market. Therefore, design's involvement in the appropriation and commoditization of cultures has the ability to create *'the cipher a figure through which various commodities with multiple exchange values are marketed'* (Ono and Buescher, 2001, p. 26).

Recognizing the complex nature of cultural appropriation, Ziff and Rao (1997) express several concerns about appropriation's potential impacts in various domains. The first concern focuses on appropriation's role in causing cultural degradation by harming the integrity of the value system of a culture. Misrepresentation of a culture through appropriation can have *'corrosive effects on the integrity of the exploited culture'* as '*the appropriative conduct can erroneously depict the heritage from which is drawn'* (Riff and Zao, 1997, p. 9). Adolf Hitler's appropriation of the Swastika, symbol of good fortune and luck, demonstrates an extreme case of cultural transformation that determined the destiny of this prehistoric symbol. By claiming authority on this cultural element, Hitler's appropriation positioned the symbol at the heart of the Nazi imagery and changed the way the symbol is perceived forever. '*Before its appropriation by Nazidom, the swastika was used innocently as a design motif on everything from architecture to consumables, signifying good fortune and well being'* (Heller, 2000, p. 81) The appropriator's intention and way of displaying it publicly through propaganda and reproduction drained the cultural values attached to the symbol. Ultimately, Hitler and the swastika became interchangeable in the public eye. (Heller, 2000, p. 12)

Figure 1. Swastika as an appropriated cultural element

Another concern raised by Ziff and Rao is *'the impact of appropriation on the cultural object itself'* (Ziff and Rao, 1997, p. 8). When material elements of a certain culture such as cultural goods, symbols, and traditional and sacred objects are either physically or conceptually removed from their local contexts, their original meanings are altered. Through this alteration, the cultural values attached to the elements are distorted. Commoditization constitutes a major way of de-contextualizing a cultural symbol and distorting its meaning. Basing his example on this concern, Rogers (1996) points at the distortion of Native spiritual traditions by New Age producers and consumers. A third critique identifies the crucial role that the appropriating party's intentions play in the transformation of the cultural element. Related also to commoditization, the concern is that *'those engaged in misappropriation might be occupying the commercial field'* (Ziff and Rao, 1997, p. 14) and exploiting intellectual property of a culture for financial gain. When financial gain is prioritized either by an outsider appropriator or by a member of the particular culture, the element becomes a commodity to be reproduced and consumed until it is replaced by other elements. Commoditization in this sense can 'fail to recognize sovereign claims' (Ziff and Rao, 1997, p. 17) of the particular culture over its cultural property. Generally, the appropriating party ignores the particular culture's claims of authority because power structures and available resources enable them to set the rules. Cultural appropriation's capacity to exploit and misrepresent constitutes the subtext that is common to all the concerns raised. When an appropriating party is not willing to understand the social and cultural function of a cultural element in its native context, the relationship between the original value of the cultural element and its value created by the appropriator lacks meaningful links.

Elaborating on the concerns expressed above, it can be said that processes of commoditization appear to be instrumental for cultural appropriation because commoditization necessitates the removal of a cultural element from its local context. As a consequence of this removal, cultural value of the element is abstracted into an exchange value that inescapably takes on different meanings and functions within the global exchange system (Rogers, 1996, p. 488). While the gap between the element's cultural value and its exchange value defined by the appropriator grows larger, *'the commodity becomes a fetish, representation of values with no intrinsic relation to the object's use value, production or circulation*' (Rogers, 1996, p. 488).

When design practice approaches local cultures for the search for originality and presents a cultural element to the systems of exchange through products, it takes over a critical role in the conceptual distortion of the cultural element and the values attached to it. *'When culture is treated as a resource to be mined and shipped home for consumption'* (Rogers, 1996, p. 486) cultural appropriation appears to be a tool for commoditization of cultural elements. By deciding what to appropriate and interpret in a product, the designer claims authority to define which cultural elements deserve to be exchanged and even to stereotype a specific culture in a product. Such an approach *'presents a simplified view of cultural agency, which tends to be reduced to a set of a priori characteristics'* (Kluyukanov, 2008, p. 212*)* that are encoded and negotiated in products to create exchange value in the global market.

Even though cultural appropriation by design poses threats to the well-being of cultural elements and the cultures they represent, its potential to be used to create meaningful cultural exchange cannot be overlooked. The contribution of cultural appropriation to the evolution of world cultures is strongly related to the way in which the cultural, conceptual and material links are constructed. These links open channels for cultural interaction. Therefore, any cultural interaction that is devoid of any over arching cultural contexts might result in the loss of a set of values and also historical references that would contribute to the collective cultural memory. Even though cultural appropriation can sometimes be a harming activity, it can also be used as a counter-strategy to plot meaningful cultural exchange. Despite its commercial agenda, design practice has the potential to re-direct the commoditization processes of cultural elements and to ''encipher'' values that can integrate to the everyday practices of different cultures. *'Moving beyond an oversimplified view of culture in terms of consumer agency and revealing the significance of it phenomenal nature'* (Kluyukanov, 2008, p. 211*)* can eventually equip design with a social agenda that does not exclude financial agenda yet re-configure healthy overlaps between different agendas.

The Need for Research

The research presented in this paper aims to understand how cultural appropriation can be used as a critical strategy to explore ways of formulating meaningful channels of cultural exchange through design. The research can allow alternative paths of operation for design while approaching cultural and social realms. On the other hand, through this research design's capacities of intervening, translating, mediating relationships and negotiating (Dilnot, 2007) can be discussed in relation to global dynamics that configure patterns of production and consumption. Research-based design process offers an exploratory ground where *'the cipher',* not as a form of commodity but a form of cultural negotiation, can be created and debated. In this process, due to its selective and interpretive nature, cultural appropriation can be used as a key strategy to create *'the cipher'* that does not prioritize financial gain.

The research seeks answers to the questions such as:

- What is the role of design practice in cultural exchange and transformation?
- How can design processes be used as a tool for deciphering cultural stereotypes?
- Is it possible to counter-direct the exploitative dynamics of commoditization to form cultural negotiations?
- Though new design processes, is it possible to recreate the lost links between a cultural element's original context and the new context of use?

In order to develop cultural appropriation as a strategy for the design process, the researcher addressed the need to understand the dynamics of cultural appropriation as a social activity. Documenting specific cases of cultural appropriation in design (including graphic design, industrial design and fashion) and identifying patterns of the appropriated elements global activity were crucial to understand the relationship between the working dynamics of design and cultural appropriation. During the preliminary research, the researcher identified that some cultural elements had already been reduced down to commercial clichés devoid of any original cultural content such as the Indian bindi, Che Guevara image or the Swastika. On the other hand, some of the examples were still going through the process of active cultural appropriation and commoditization.

Figure 2. Gwen Stefani's appropriation of the Indian bindi / Bindi fashioned in stickers

The researcher found it relevant to identify a cultural element that is still going through the process of cultural appropriation by design and follow its path of evolution. By identifying the element's historical evolution, the researcher aimed to identify a pattern of evolution and to draw parallels to similar elements of transformation in progress. The researcher then aimed to create an alternative path of evolution by culturally appropriating the element and creating 'the cipher' to restore the element's original value in proposed designs. This process would also open up to discussion the role of the design practice and the designer in commoditizing cultural elements. The proposed designs would promote ''a cipher as a system of references to the element's original cultural value'', deconstructing Ono and Buescher's (2001) concept of *'the cipher'* that is instrumental in stereotyping a particular culture.

Research Framework

Drawing from the preliminary research on specific cases of cultural appropriation by design, the researcher identified a cultural element that demonstrates both historical and contemporary record of being culturally appropriated multiple times by various practices.

Kaffiyeh (traditional Middle Eastern headdress with a distinctive checkered pattern) has been an object of cultural appropriation throughout its centuries long history. The kaffiyeh, which is associated with violence and terrorism in mass-media, is widely used in film industry to animate characters of Eastern origin. Despite its negative connotations, kaffiyeh's recent transformation from being a symbol of Arab identity to being a fashion statement demonstrates the capabilities of design industry to lead the transformation of a cultural element.

In the beginning kaffiyeh was the symbol of male Bedouin identity. The Bedouin tribe had been dwelling in the desert of Arabia and was famous for its fierce resistance to outside influence. The Bedouin nomads were distinguished from the villagers and townspeople by their kaffiyehs. (Stillman, 1979, p. 66) Kaffiyeh was the tribal symbol that represented not only the resistant nature and the free spirit of the Bedouin, but also the social identity of the Bedouin. A significant change took place in village men's headdresses when the Palestinian Arabs started to unify against the British Mandate of Palestine. (Stillman, 1979, p. 68) 'The Great Uprising' lasted from 1936 to 1939 and changed the status of kaffiyeh for the rest of its life. The first appropriation of kaffiyeh happened around 1930s when the villagers and the townsmen adopted kaffiyeh and agal (the circle that is used to keep the fabric on the head) as the tools for expressing Palestinian nationalism.

Figure 3. Kaffiyeh's historical timeline of appropriation

In 1960s the black and white colored kaffiyeh was appropriated for the second time by Yaser Arafat (Chairman of The Palestine Liberation Organisation) and was introduced to the rest of the world. By making Kaffiyeh globally visible, Arafat started the process of kaffiyeh's transformation from a traditional cloth to an icon of resistance. The distinctive black and white pattern started appearing on the world press and gained public recognition. During 1970s, political dynamics in the Middle East and the uprising resistance to Israeli pressure caused the rise of an armed resistance. Kaffiyeh was appropriated for the third time by the armed rebels and was associated guerilla and violence.

Appropriation 2: Late 1960s Since 1967 to date Appropriation 3: 1970s

Figure 4. Kaffiyeh’s appropriation by Yaser Arafat and its association with violence

In late 1980s, kaffiyeh took its place on the chaotic runways of anti-globalization and antiwar street protests. Arab nationalism transformed into rebellious self-expressions under the symbol of generic resistance.

Appropriation 4: Since late 1980s

Figure 5. Kaffiyeh as symbol of generic resistance

With the rise of the military chic fashion in 1990s, kaffiyeh got popular among subversive youngsters and fashionable rebels who expressed their resistance through clothing. As the popularity of kaffiyeh in public continued to grow, the scarf started to be the subject of design interventions in early 2000s. Fashion and design industries started to use kaffiyeh in design projects and new possibilities for application were explored.

1990s

Appropriation 5: Early 2000

Figure 6. Kaffiyeh as a fashion statement

Despite kaffiyeh's current status as a fashion statement, traditional kaffiyeh has been resisting to outer influence. Even when the Middle Eastern men exchanged their traditional clothes for the western clothes, they kept this article of headgear unchanged and therefore alive. (Scott, 2003, p.105) That's why kaffiyeh is a resistant cultural symbol that makes the male clothing and the hairstyles virtually identical throughout the Arabian Peninsula.

Figure 7. Kaffiyeh in Middle Eastern every day

The decorative kaffiyeh pattern with slightly different variations has been keeping the tradition and the cultural identity unified throughout the Middel East. Therefore the pattern is not only decorative but also functional since it allows the tradition to be distinguished.

Drawing from kaffiyeh's dual status as a traditional everyday element that represents Arab identity and also as a culturally appropriated and commodified cultural element, the researcher decided to intervene on kaffiyeh's evolution process. Kaffiyeh's history of evolution is characterized by multiple appropriations in various social, cultural and political contexts. Through this analysis, the researcher found it relevant to build on kaffiyeh's history and follow its path of evolution to the next level. The research-based design process constitutes the next stage of the transformation of kaffiyeh where kaffiyeh is appropriated one more time by the researcher. By critically reflecting on processes of cultural appropriation, the researcher re-creates 'the cipher as a reference to kaffiyeh's original cultural value' according to the feedback of participants in focus groups that are staged during the design process.

Methods

Research-based design process is threefold. At the first stage of the process, three different focus group sessions were conducted with groups of participants from different cultural backgrounds. These focus group sessions aimed to bring together participants with low level of knowledge about kaffiyeh and Middle Eastern traditions. Initial data collection centered on formulating open-ended questions, recording the participants' answers and opening the sessions for discussion. Each participant's individual responses were documented and group discussions were structured with a round-table approach. Feedbacks received from the focus group participants were decisive in determining the structure and further steps of the design process. By comparing issues across different focus groups the researcher started creating product concepts that demonstrated different forms of appropriation and application of the kaffiyeh pattern. One of the focus groups was exposed to the product concepts and asked for commenting on the relevance of the new context of use. The researcher updated design criteria and production methods according to the participants' responses.

At the second stage of the process, the researcher aimed to present concepts for new contexts of use to a wider audience that is familiar with Kaffiyeh and the Middle Eastern traditions. 'A Kaffiyal Project' website was set up and an online survey was conducted with the members of Arab and non-Arab communities. Through this website, design concepts that were developed according to the outcomes of focus group sessions were demonstrated to the participants.

At the third stage, according to the results of the online survey, the researcher narrowed down the design concepts to form a cipher that reconstructs the original cultural meaning of the Kaffiyeh through a series of products. *'The cipher'* was made public through presentations and discussion groups.

Focus Groups

Throughout the research, focus group sessions played a crucial role in structuring the design process. The researcher planned to set up three different focus groups with the aim of addressing different set of questions. Each focus group session was conducted with 12 participants each. The researcher aimed to:

- Find out the group's level of familiarity kaffiyeh as a tradition that originated from Middle East
- Find out the general impression of traditional kaffiyeh according to the latest political and cultural incidents
- Find out how the impression of the scarf changes depending on the way it's fashioned or depending on the wearer

The questions that the researcher had prepared for the sessions were accompanied with two separate small-scaled experiments that helped the researcher to open up discussion through visual material.

In Focus Group I, which consisted of 12 participants (six male and six female junior college students of different majors), the researcher demonstrated three sets of photographs in which three models of different ethnic origins fashioned kaffiyeh differently. Participants were asked to look at the photographs and comment on the uses of kaffiyeh and its wearer. When the kaffiyeh is fashioned unlike its original way of use, for example fashioned as a belt around the waist, majority of the participants found it hard to associate the headdress with any tradition or specific culture. The way the headdress is fashioned around the waist implied the model as a fashion enthusiast who is not interested in the original cultural value of the headdress. The African-American model that wraps kaffiyeh around her neck gave the participants the impression that the wearer was aware of the origin of the headdress yet still was fashioning it in a sophisticated way. On the other hand the male model projected danger and was identified as a Middle Eastern extremist by the participants. The male model brought up discussions about the role of mass-media and films in constructing stereotypes. All of the participants agreed that the use of scarf in a disguising manner was threatening.

Interpreting the responses of the participants, the researcher concluded that the participants' knowledge on kaffiyeh was based on the stereotypical depictions of Middle Eastern cultures on mass media. Only two of the participants knew about the origin and the tradition of kaffiyeh based on their experiences in Europe. On the other hand, the way the scarf was appropriated by the wearer and positioned on the body was decisive in the participant's perception of the pattern and the scarf.

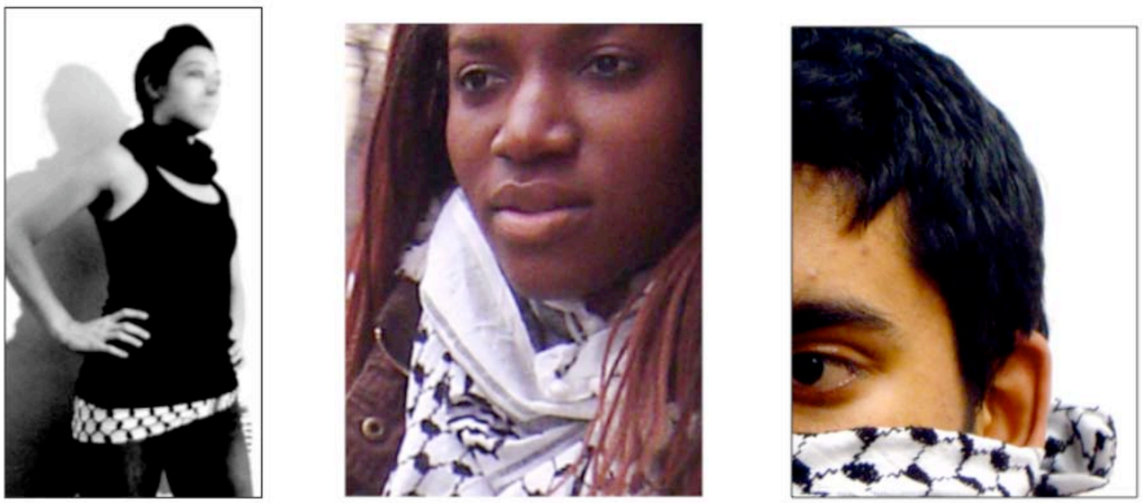

Figure 8. Models wearing kaffiyeh in different fashions

In Focus Group II, the researcher collaborated with 12 junior college students (8 female, 4 male) who were taking the Cultural Anthropology Course taught by Mary Martin at the University of the Arts in Philadelphia. In this session, the researcher experimented with different portions of the kaffiyeh's checkered pattern. Such and experiment was planned to observe the role of the pattern in participant's recognition of the scarf as a traditional element. The researcher also aimed to find out the smallest portion of the pattern that identifies the shown fabric as a Middle Eastern authentic cultural element. The optimal portion of the pattern that is recognized as of Middle Eastern origin would be appropriated and used in new contexts by the researcher.

In this session, the participants were exposed to different sections of the cloth and were asked whether they were familiar with the sections that gradually got larger. This way participant's perception of the pattern as an ethnic/authentic or a Middle Eastern design was observed. Moreover, the earliest level which participants identified as a part of Middle Eastern, ethnic element was addressed. (Number 004 below indicates the smallest recognizable portion of the kaffiyeh pattern that the researcher planned to appropriate.)

Figure 9. Experiments with portions of the pattern

Before stepping into the third focus group session, the researcher appropriated the smallest portion of the pattern (the portion consists of all three elements of the pattern at once) and applied the pattern on various everyday objects. Instead of re-purposing the scarf, the researcher/designer abstracted the scarf into its pattern and reproduced pattern as the essence of the kaffiyeh and its tradition.

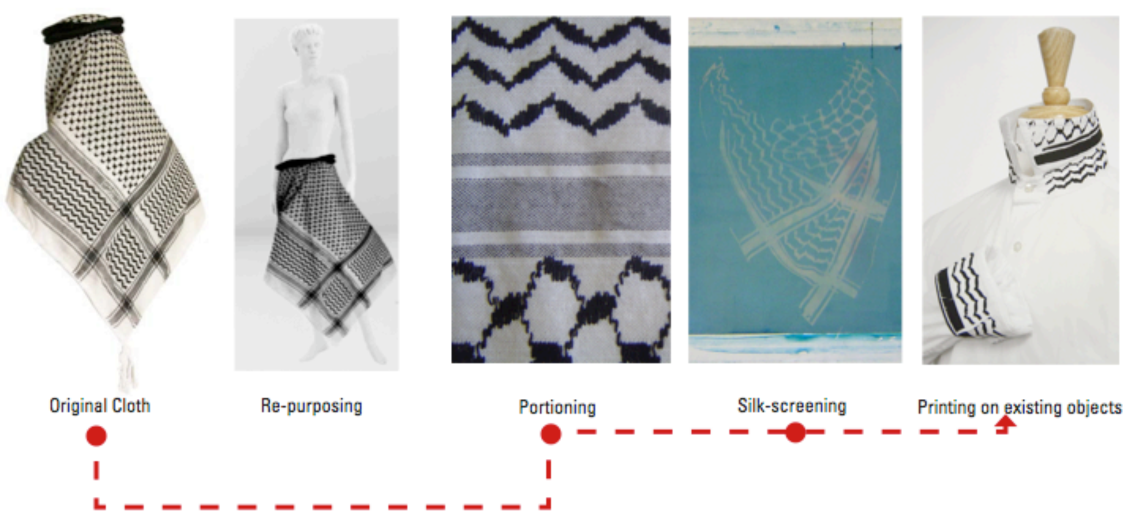

Figure 10. Reproduction process

Having reproduced the pattern on different everyday objects, the researcher moved on to the third focus group session. The participants of this focus group were twelve junior students (8 female, 4 male) who were taking the Middle Eastern Art and Culture Course taught by Professor Mary Martin at the University of the Arts Philadelphia. All of the participants were familiar with Middle Eastern cultures and traditions. After giving detailed brief on the kaffiyeh' original context of use and cultural value, the researcher exhibited the products as the new context of use for kaffiyeh. By placing the pattern on different parts of the body and relating the visibility of the pattern to the structure of the products, the researcher asked for participants' opinion on the relevance of the pattern application.

Figure 11. Researcher's experimentation with the pattern

According to eight of the participants, application of the pattern around the neck could have some vague associations with the original use of kaffiyeh. The participants mentioned that gestural aspects of the shirt and somehow subversive application of the pattern recalled kaffiyeh's association with protest. However, the other applications were considered disrespectful and meaningless.

Drawing from the participants' feedbacks, the researcher revised the design criteria and focused on applications that would:

- Refer to kaffiyeh's original place on the body through the placement of the pattern and the use of the product
- Engage the new contexts of use with everyday life
- Draw meaningful links between the gesture proposed by the new context and the original use of the cloth.

The participants' input in this session was crucial for identifying the next step of the process. Even though the idea of 'the cipher' wasn't mentioned in the sessions, the researcher aimed to formulate a set of products that would relate to different uses of kaffiyeh and values attached to it. Debating this issue over products or material examples helped the designer to charge different aspects of the products' physicality such as material, size, and function. The researcher also found it relevant not to create a new product from scratch but to build on the existing products. This way these everyday objects would host the essence of kaffiyeh and the participants would relate to the objects more easily.

For the next step of the design process, the researcher had enlarged the scope of pattern application to various everyday contexts. The new set of products proposed new associations between the materials or functions of the products and the cultural values represented by traditional kaffiyeh. For example could the lost uniqueness of kaffiyeh within the process of commoditization be restored in a diamond necklace produced in the shape of the kaffiyeh pattern? Or could the significance of this Middle Eastern element be restored by applying the pattern on loaded objects such as a veil? The researcher produced alternatives for different contexts of use and grouped these products under concept that can be presented clearly to a wider audience.

Online Survey

In the next phase of the design process, the researcher conducted online surveys with participants from members of Arab and non-Arab communities that are familiar with kaffiyeh and Middle Eastern culture in some ways. The researcher contacted Arab associations such as Penn Arab Student Society, Arab-American Association of New York, Al-Awda Palestinian Right to Return Group and Arab Women Active in the Arts and Media. The researcher designed a website (www.thekaffiyehproject.com) and displayed her the product proposals under main concepts.

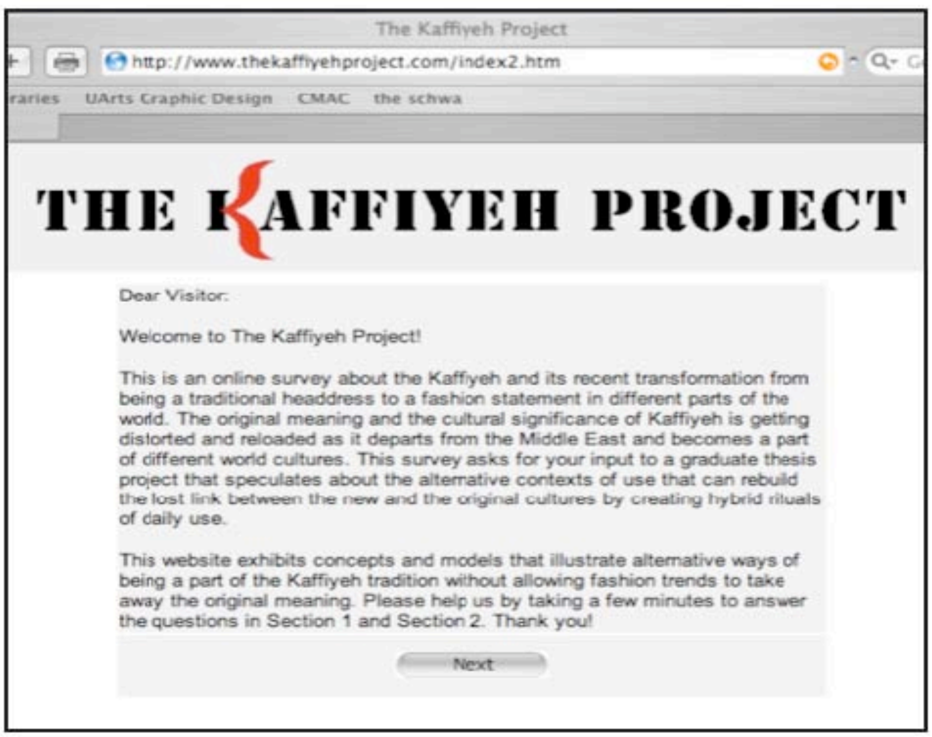

Figure 12. The opening page of the online survey

The survey was composed of an introductory slide show that introduces kaffiyeh to the participants, a short questionnaire that aimed to collect information about the participants and their level of familiarity with kaffiyeh, and the questionnaire about the concepts that were presented through drawings, prototypes and illustrations on each page with 3 questions.

The participants were asked to rate concepts according to:

- The success of the new concepts in relation to the original use of kaffiyeh
- The success pattern application on the level of identification of the pattern as “a kaffiyeh”
- The relevance of the concept to the tradition on the level of connection between the new context of use and the traditional context
- The significance of the concept in terms of the relevance between the choice of materials and the application of the pattern
- The success for the preservation of the essence of kaffiyeh in terms of the relevance of the place that the pattern is applied to kaffiyeh’s original position on the body

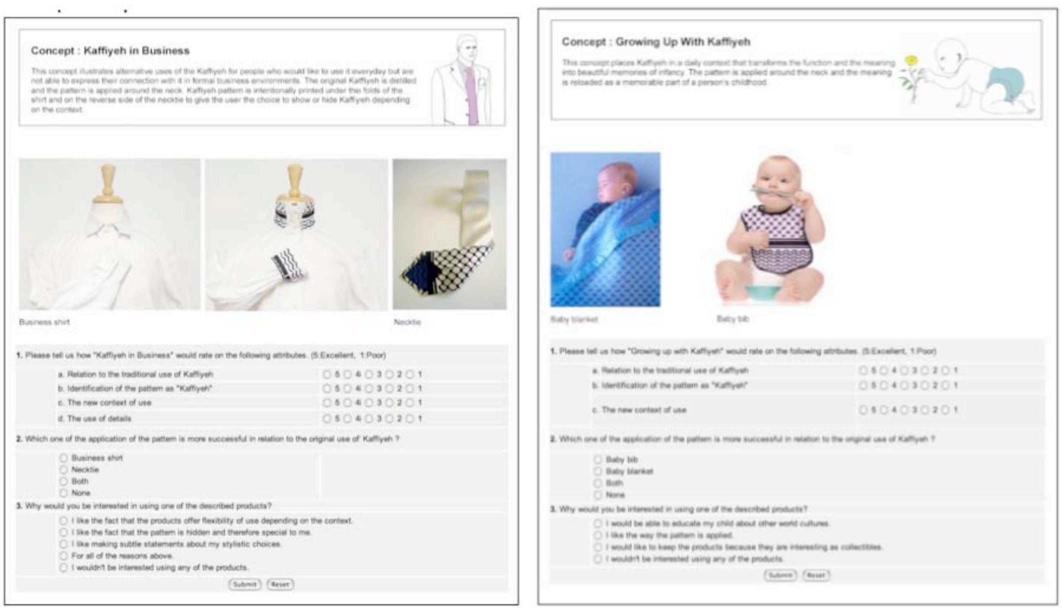

Figure 13. Survey pages from the website

The product proposals were grouped under concepts that could be related to personal stories from everyday life. By grouping the meaning and function of objects under main concepts, the researcher aimed to associate feelings such as comfort, need for expression of identity, security and need for protection with functions of kaffiyeh in its original context. These concepts encipher the essence of kaffiyeh in the material qualities of products.

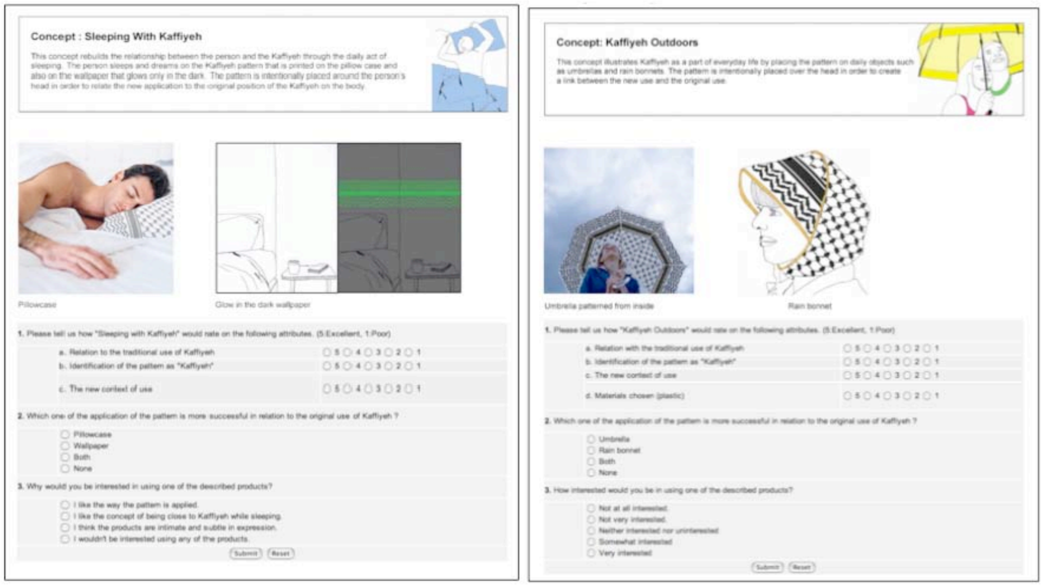

Figure 14. Survey pages from the website

40 participants (23 male-17 female), who took the online survey, rated the concepts and narrowed down the proposals. 32 of the participants were familiar with the scarf and its cultural value. The participants also provided a set of new criteria that the researcher had to consider for the final stage in creating ‘the cipher as a system of references to kaffiyeh’s original cultural value.’

Figure 14. Proposals that received the highest scores

Formulating ‘The Cipher’ and Displaying the Research-based Proposals

Even though various feedbacks from the participants structured the design process, ‘the cipher’ that would create meaningful links between the new contexts of use and the original context of kaffiyeh needed to be solidified according to one last set of criteria. The researcher used kaffiyeh’s original definition as her last set of to produce ‘the cipher.’ By enciphering the original definition of the scarf, a set of references to the original scarf would be created. According to its original definition kaffiyeh is:

- A big square cloth that can be multi-purposed depending on the context of need
- A head-dress that protects the face and the neck from sun, wind and dust

- A sign of modesty and respect
- A resistant traditional cloth with the distinctive pattern
- The signifier of the Bedouin tribe
- The symbol of Arab identity
- Symbol of resistance

When the researcher filtered the results of the online survey through these criteria, the proposals that create meaningful links between original kaffiyeh and the contexts of appropriation formed ‘the cipher’. Each part of ‘the cipher’ refers to an aspect of the original cultural element and creates links between the new context of use and the original context. Along with the product proposals that created ‘the cipher’, the researcher conceived the design of supplementary references that would communicate the cultural exchange the proposals are offering. The researcher designed product tags that refer both to the original and new contexts of use with the help of graphics and text. These tags juxtapose the traditional and new context of kaffiyeh on the front and the back. The text accompanying the new product explains how original function of the scarf transformed into a similar function in a totally new everyday context.

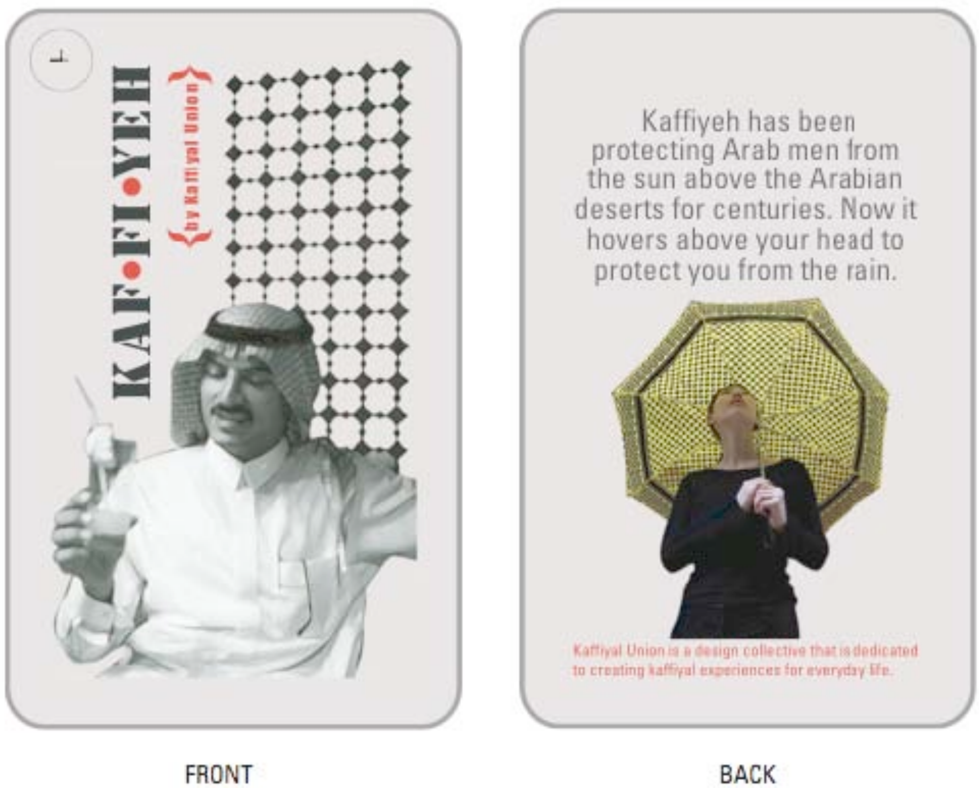

Figure 15. Kaffiyal Umbrella Product Tag / Back and front

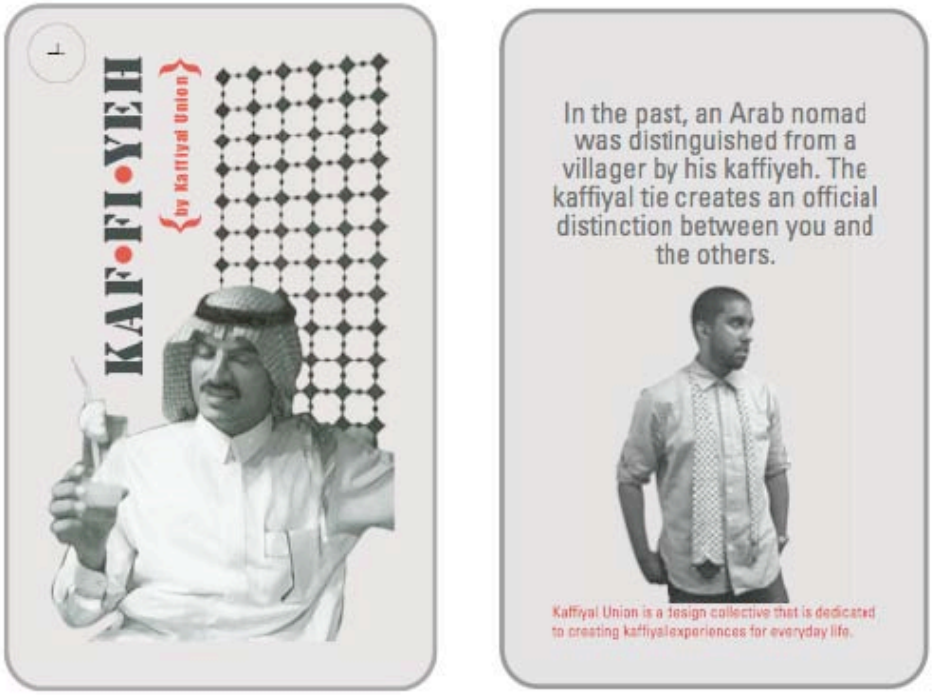

Figure 16. Kaffiyal Tie Product Tag / Back and front

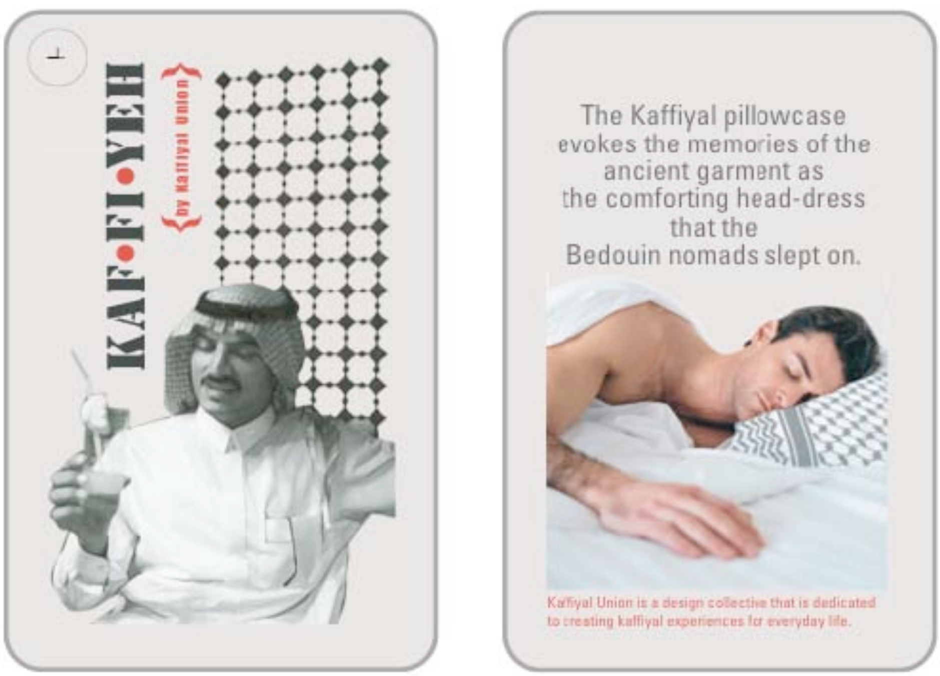

Figure 17. Kaffiyal Pillow Case Product Tag / Back and front

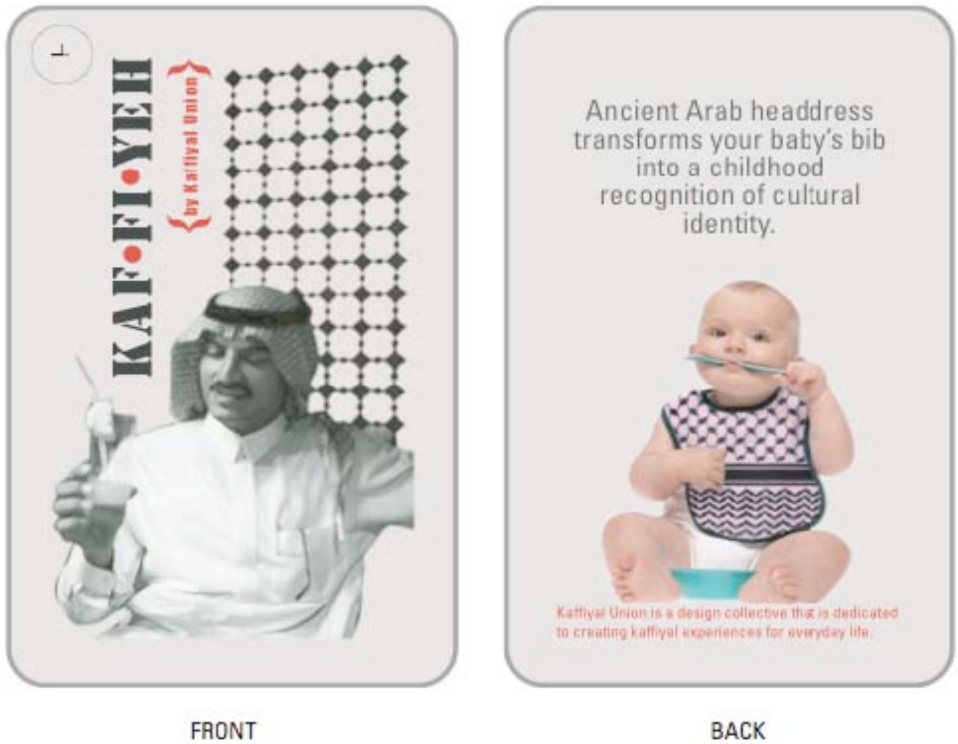

Figure 18. Kaffiyal Bib Product Tag / Back and front

The researcher promoted concept of 'the cipher' along with the product and the tags. 'The cipher' as a system of meaningful cultural references took on an educational yet entertaining role for both the members of the appropriating culture and the appropriated culture. 'The cipher' presents the design practice's potentials to create meaningful distortion that intends to carry the essence of a cultural element within the products. Practice of cultural appropriation is strategized as a tool for creating 'the cipher.'

Conclusion

This paper presented a research based design process that used cultural appropriation as a strategy to commodify a traditional cultural element (Kaffiyeh) yet to protect its cultural content with the help of 'the cipher'. Ono and Buescher's (2001) concept of the 'cipher' as a commodity was transformed into 'the cipher' as a set of meaningful references that travel across two different cultural contexts. The project has been a multi-dimensional and speculative intervention into kaffiyeh's ongoing process of transformation. Concepts of appropriation, cultural identity, cultural stereotypes, cultural exchange and globalization were debated over products.

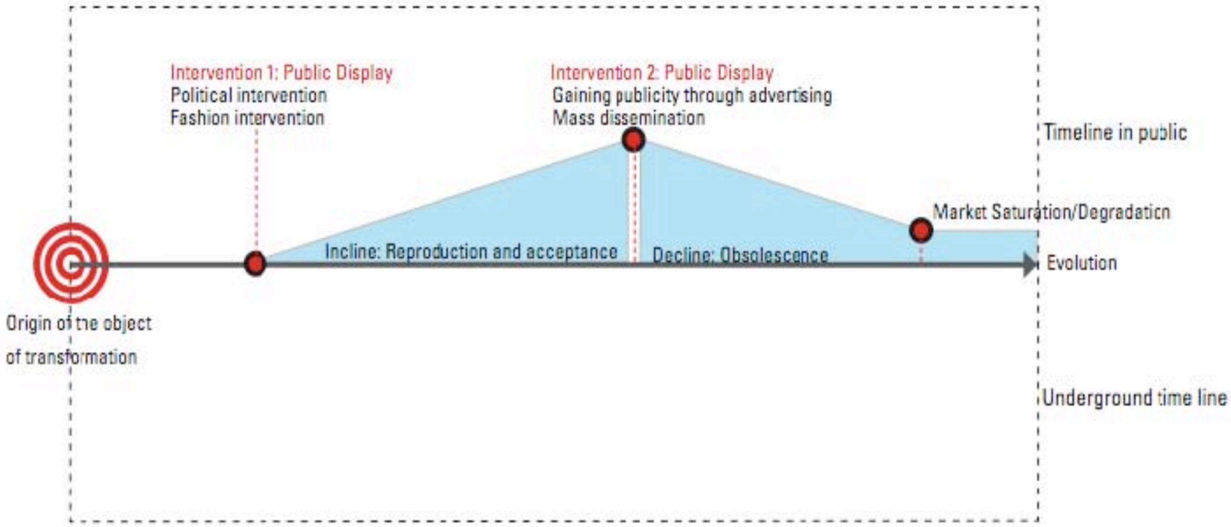

Figure 19. Chart of evolution through cultural appropriation

When a cultural element is removed from its native context through cultural appropriation, its cultural value is abstracted into an exchange value that floats in the market devoid of any cultural content. In a typical process of commoditization, the object of cultural appropriation starts to get away from its origin conceptually with the help of an intervention (design practice, public and political figures, fashion) that presents the cultural element to the public. With this first intervention, the cultural element also interacts with commercial and business cycles. Evolution of the object in public inclines as the public becomes familiar with it and accepts it. At this stage, the commodity is mass-disseminated and reproduced. Before the evolution in public starts to decline, the second intervention happens as a second gesture to re-establish or strengthen status of the commodity in everyday. As the market gets saturates, popularity of the image starts to decline and the public loses its interest in the image of the object. In the end the commoditized cultural element is reduced down to a commercial cliche that continues its life with little public interest.

In ‘A Kaffiyal Project’, the researcher observed the process of evolution and intervened on the process of commoditization at the point where the commodified cultural element was mass-dissseminated. By creating a conceptual underground path (or ‘the cipher’ as a system of reference) that links the cultural element back to its origin of use, the researcher aimed to restore the lost link between two exchanging cultures. This conceptual underground path, ‘the cipher’, redirects the evolution path of the cultural element and elevates it to another level.

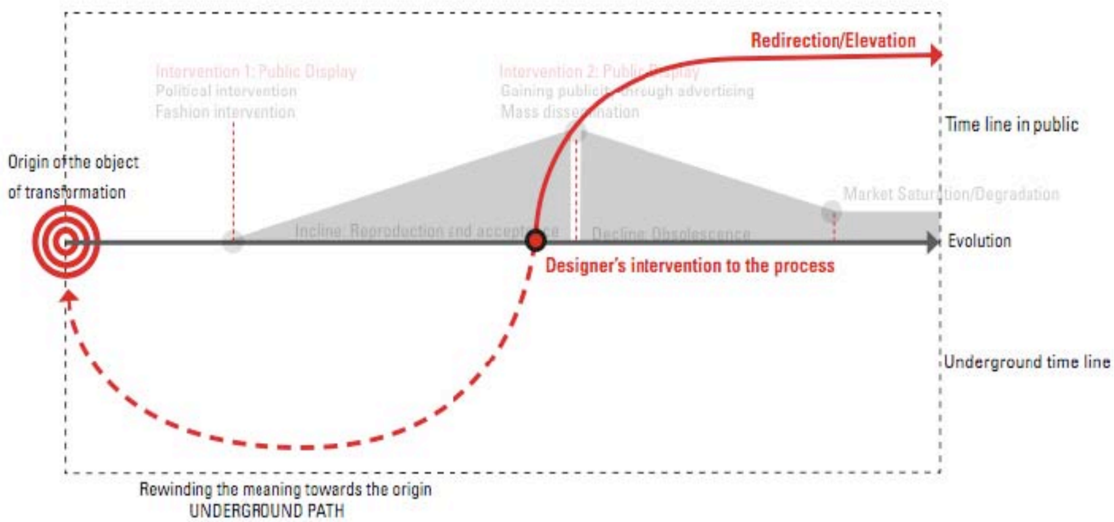

Figure 20. Chart of evolution after design intervention

It is important to recognize that products create channels of exchange in various dimensions. Their material, physical, structural, cultural and social qualities have the potential to host references and change perceptions. Products, through design, have the potential to plot interactions between different set of social and cultural actors. In an increasingly saturated global world where products circulate in closed loops of consumption and taste, it is critical for the design activity to create room for critical reflection. Developing a critical agenda for design requires debate, participation and open-processes of creation.

On the other hand, practice of cultural appropriation needs to be discussed and explored more in the realm of product design as a part of design's social agenda. Design processes have the potential to challenge the destiny of commoditized cultural symbols in ways that share the authority of deciding on the value of a cultural element with the society. Despite its negative implications on culture, cultural appropriation can indeed contribute to the evolution of cultures and redefinition of the boundaries, if the concerns that were stated in the introduction are taken into consideration. Through critical and participatory processes, design practice can generate sensitivities towards processes of cultural exchange and also create awareness on its crucial role in determining the evolutionary path of cultures.

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Figure 7.
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Figure 8 – Figure 20.
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Yo Soy Yo Y Mi Circunstancia: My Life as a Cleaner

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Abstract

Initial research by the authors using an online survey of over six hundred participants analysing what (if any) activities lead to discomfort, particularly in the hand, showed that cleaning tasks and in particular, mopping, sweeping and hoovering led to higher levels of hand discomfort than other ADL's (Carre, 2009). Activities of Daily Living (ADL's) such as cleaning, hoovering, mopping, and so on have had little or no previous research undertaken on them. In 2005, Tresea et al., examined the prevalence of work related injury and explored barriers to, and experienced of, reporting them amongst workers. The results showed that over one year, three quarters of the workers studied experienced work-related pain. With reference to the above study, the authors defined two categories of cleaning activity, termed heavy work and light work. 'Heavy' work was characterized by neutral postures, walking, repetitive movements involving the articulations of the upper limb pushing a 1-6 kg (wet or dry) mop, with occasional more intense effort. 'Light' work was characterized by flexed postures, walking, rapid repetitive movements involving the articulations of the upper limb and the movement of light weights (dusting) or 1-3 kg weights (emptying wastebaskets), with more occasional intense effort (Teresa et al., 2005).

It was proposed to study the process of using cleaning equipment such as a mop, brush and hoover and ascertain what factors may lead to discomfort particularly in the hand. However to inform the design of the questionnaire's, tasks to be analysed and experimental set-up, one of the authors took a job as part of this cleaning team and has worked for over two years as a cleaner, logging their own experiences and activities in a diary and recording the experiences of their colleagues.

This paper details those experiences with comments and reflections from the diary work and demonstrates how the experiential approach led to improved design of experiments and data gathering.

Keywords

Comfort, Grip, Daily Living, Cleaning

Introduction

Whilst cleaning activities were seen to produce the highest pain levels and frequency the authors also wanted to understand the forces in the hand when undertaking these activities. Previous studies carried out on grip force applied to handles but were usually measured on a single axis (Peebles, 2003, Massey-Westropp et al., 2004., Mathiowetz et al, 1985 and Welcome et al., 2004). This approach has been widely used to monitor and control the grip force during glove tests, biodynamic response measurements and many other experiments involving handgrip simulation (Dong et al., 2004, Aliden et al., 2005, Marcotte, et al., 2005). The hand forces in these studies are either grip force or push force.

A few studies have attempted to study the distribution hand force at the hand-handle interface and their dependence on the handle size, grip and push force that could serve as a vital basic for the design handle.

In their 2005 study, Aliden et al., identified the magnitudes and locations of localized pressure peaks occurring at the hand surface as functions of the handle size and static hand grip and push force. In his study, the hand-handle pressure are acquired for three different diameters of circular cross-section handle by using a 16 x 11 pressure sensing grip under different combination of static grip and push force. The result showed that the contact force developed in the vicinity of knuckles and the palm is generally attributed to the push force, while forces at the finger surface are caused by the gripping actions. According to Reidel et al (1995), Rempel et al., (1992), and Radwin et al (1987), the primary factor increasing the risk of cumulative trauma disorders is the operation of some of the tools that demand high grip, push or hand handle contact force.
Fransson and Winkel (1991), Pyykko et al., (1976), found that the contact force between the hand and the tool handle can effect the severity of exposure to the hand transmitted vibration and hand wrist cumulative trauma disorder. They also found that the hand arm responses measured in terms of the hand transmitted vibration, and electrical activity of the muscle flexor carpi-ulnaris and finger-flexor muscle, increase simultaneously with the increase of hand-handle coupling intensity, whilst the peripheral circulation of the finger decreases.
Even though, studies have established the magnitude and hand-handle coupling force and various measures of the hand arm responses, the mechanisms leading to the risk of hand-wrist cumulative trauma disorders have not been identified. High contact forces impose high stresses on the anatomical structure of the hand, which may be strongly affected by many factors such as working posture, weight of the tool, grip and push forces, handle size, individual work habits and hand to handle interface pressure (Marcotte P., et al., 2005).

In 2007 it was decided to undertake a PhD project to understand these mechanisms leading to hand-wrist cumulative trauma in more detail. The successful applicant was Mrs S.R. Kamat (Rahayu), and she has over the last two years been studying a full-time PhD at Sheffield Hallam University, undertaking studies into hand discomfort during performing activities of daily living (ADL's). From initial survey work undertaken by the authors on these ADL's cleaning activities such as hoovering, wiping and so on were seen to rate highly on by pain discomfort and pain frequency when compared to other activities. Hence it was decided to understanding the nature of these cleaning activities in more detail. As part of her studies she decided to take a part-time job as a cleaner with a major employer within Sheffield. The initial aim of taking this job was to understand some of the issues faced by professional cleaners whilst undertaking their normal tasks. Further, the study was undertaken to see how immersive design techniques and the usefulness of those techniques can be used to inform a set of experiments to understand the nature of discomfort and pain during cleaning activities. The diary entries outlined here are purposely in the first person and anecdotal in nature. Typographical errors and language are kept in for authenticity (Rahayu is from Malaysia, and whilst her English is good, it is not her first language and her journal entries were always intended to be informal). The informality of the entries is further emphasized by the use of the term 'Hoovering', which is a British colloquial term for the action of using a vacuum cleaner. Parts of her full diary entries are shown here to how this immersive technique enabled us to design our experiments.

Diary Entries

Rahayu started work as part of an evening cleaning team working 20 hours a week. The team had 20 members with a mean age of 34, (ages 25 to 40) and was evenly split between genders.

> *My experience as cleaner on the first week makes me know how difficult the cleaning activities it is. Most people think the activity is easy, but when I perform the activity frequently every day, I feel more tired and suffer serious pain at my back. The pain increase slightly and continuously up to the present moment. As a part time cleaner in office building, I clean the table, windows and door glass, cleaning bin, washing the cup bin, cleaning the kitchen areas and toilet, mopping floors and hovering around an area (under a table, under chair, edge and lobby) for 4 hour per days and 5 days per week.*

The typical jobs that Rahayu undertakes are shown in the following Figures.

Figure 1: Mopping

Figure 2: Cleaning sinks and toilets

Figure 3: Hoovering

Figure 4: Carry Plastic Bag

Figure 5: Wiping Mirrors, tables and doors

She continues:

> *At first, I thought it is the easiest job. I do not experience any discomfort or pain. However, after a couple of month, think change. I begin to suffer a back pain. As time goes by, it becomes annoying. I begin to feel discomfort after one hour hovering and mopping in 30 minutes.*
>
> *Back pain is one of the bigger problems. Every time when I hoover under the table, the chair, mopping, carrying or washing the cup bin, I have to bend my body. These actions contribute discomfort at my back.*
>
> *After hoovering for about 20 minutes, I felt discomfort at my hand and finger. The vacuum and vacuum handle are so heavy, the air pressure is high and the office areas itself is difficult to hoover especially hoovering under the table, chair and corner. I have to bend my body and give more grip on the vacuum handle to perform it.*
>
> *The second pain is on the shoulder. When I hoover or carry bin and cup bin or even washing cup bin, I feel stress at the tender on my shoulder? Sometimes, I take a rest for 10 minutes before continuing hoover.*
>
> *After 6 months, the back pain becomes more serious. If felt discomfort while doing the hoovering, mopping, carrying and washing cup bin. I take an off for 2 weeks after consulting a doctor. She suggests me to take a rest. All my pains heel after resting in 2 weeks.*

Hence after 6 months of cleaning 20 hours per week Rahayu has had to take time off from her job due to discomfort. After two weeks she returns to work but pains in her back quickly become worse:

> *From the back pain, I begin to experience discomfort and pain in shoulder, arm, hand and finger especially after hoovering, mopping the floor, cleaning water bin and cleaning toilet. My hand and finger become stiffness. Some time I feel tender and cramp at the shoulder and arm.*

The McGill pain indicator questionnaire test is used by occupational therapists (amongst others) to describe and rate levels of pain. First developed in 1971, it attempts to gauge the quality of pain experiences. Rahayu refers to it in this next diary entry.

The discomfort at the hand and finger are increasing from level 2 (mild pain) to level 4 (pain) after frequent cleaning activities. From using one hand, I have to use both hands while hoovering just to reduce the hand grip force, easy to control the vacuum handle and reduce pain at shoulder, arm hand and finger.

We can see here that her experiences are starting to inform her work. It is also worth noting here that these painful experiences have started to affect the nature in the way she undertakes the task. From using one hand originally she now uses two, completely changing the posture of performing the task.

As part of her studies Rahayu produced a diagram to aid her in understanding the location of the pain in the hand when asking participants about their pain experiences. She refers to these locations in the next excerpt from her diary entry.

This diagram is shown in Figure 6 below:

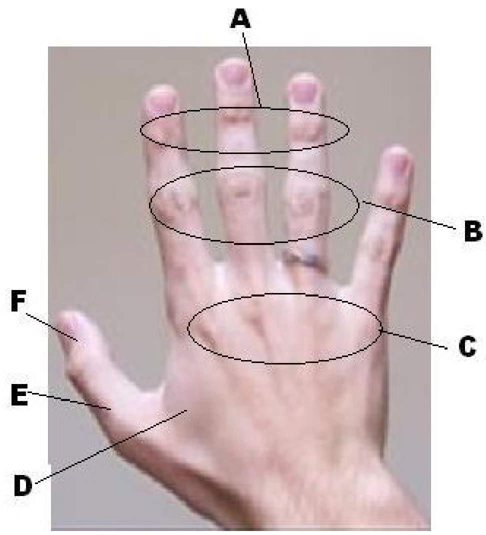

Figure 6: Pain location hand diagram

After 7 months, I feel the similar pain experience when mopping and hovering. My finger and hand felt discomfort at the area F and E after performing the task. The pains heel after 10 minutes. The similar pain at location A, B and C under the muscle occurs when I carry the water bin and dust bin. The level of pain for both activities is still under level 2.

After 8 months, the pain becomes more serious. From back pain, I begin to experience discomfort and pain in shoulder, hand and finger. A lot of hand and finger movement is required during cleaning activity. Therefore, from self experience, I believe that there always discomfort experience by cleaner, especially for those whom work more than 10 years.

During this period the level of discomfort for Rahayu is seen to continue:

In month 8th, I begin to feel discomfort in my back pain from the first week till now. My hand and finger feel discomfort after 4 months working till now. The level of pain increase when I clean for a longer period. Sometimes my hand tingle and wrist pain, especially when the task is repetitive strain such as hoovering,

> *mopping a floor and clean table. I felt intermittent pain along the side of the right hand from litter finger to wrist when I carry the water bin and waste plastic bag. It is similar the pain location is at A, B and C under the muscle pain, but the level of pain increase to level 3.*

> *After 11 months working, the level of pain becomes irritating. My hand and finger become sharp and throbbing at the location C and B. The pain become serious while performing the cleaning activity and the pain cannot heel. Thus I took 2 days medical leave. I put a lotion to reduce the throb. After 2 days rest, I become better. However, I can only work for 2 days.*

Again, Rahayu has had to take time off work to due injuries related to work. However, this time her supervisor decides to change her activities to reduce the impact on her hand.

> *A week after, I come back to work as normal. My supervisor gives me a simple task such as clean tables and hoovering without carrying any heavy thing. Although it is simple, I still feel the pain but not serious compared to last week, I still have to put lotion at my hand on location B, C and D to heel the pain.*

> *A year past, the level of the pain increased to level 3. The pain felt at location A, B, C, D, E and F but more serious about location A, B and C, the thumb not to be serious pain whenever I carry out my daily cleaning activities.*

> *Due to my illnesses, my cleaner supervisor gives me a new task, hoovering the floor. Eventually, it takes about 2 hours to hoover because the floor is too wide. After 2 days hovering, I begin to feel more pain on my hand and finger. Sometimes I have a symptom like numbness in my hand, decrease in griping strength, pain in the finger, pain in the neck and shoulders, tremor in the hand/arms and pain at my back. The level of pain in this task can be categories under level 3 and 4 depend on the certain location. Location A, B and C level 4 and F, E and D under level 3.*

> *Base on my experience doing hoovering, I found that some activities look simple but difficult when doing hoovering at certain place for instance under the table, the chair, at the corner and the stairs. My hand and finger move very frequently during hoovering under the chair and table. From my observation when doing hoovering under the table, chair and corner, I found that it has a connection between hand and finger movement with higher grip force, especially when I am bending my body. While doing hoovering under the table and chair I felt more tired and pain at back, hand and finger.*

Figure 7: Hoovering under a table

Figure 8: Hoovering under a chair

Figure 9: Hoovering in the lobby

I took some photographs of myself hoovering. The photographs show the position of our body while hovering under the table. We need to bend our body to reach the surface that we want to clean. This movement will be irritating if we have to hoover in a longer period. A lot of hand manipulative movement is required doing the hoovering task especially when hand and finger try to control *handle vacuum. As a Cleaner, hovering at the corner and under the table is the most difficult task. The degree in bending our body and hand and finger movement become greater and it needs more force to clean the surface. When I hoover the carpet I do not have to bend so it is easy.*

Hoovering is generally seen as a difficult task, unless hoovering a bare carpet. Rahayu also talks of other easy tasks:

Figure 10: Wiping a door

Cleaning the mirror is one of the simple tasks on cleaning activities. I don't feel any pain, when doing this task. We don't need to bend the body on this task but a lot of hand and finger movement is required during doing this task.

And other 'simple' tasks:

Figure 11: Wiping a computer

Figure 12: Wiping a desk

Cleaning the table is one of the activities give painful at the back. These activities look easier and simple, but I need to bend my body to reach the surface that I want to clean. A lot of hand and finger movement is required during cleaning the table. This movement will be irritating if I have cleaning many tables in a longer period. The degree in bending our body become greater and it needs more force to clean the surface.

A lot of hand and finger movement is required during cleaning kitchen. These tasks are simple but I felt tired when carry the bin and mopping the floor every day.

From the above diary entries we can see various themes emerging. Posture is seen to massively influence comfort and posture is heavily influenced by the task undertaken, i.e. hoovering under table or wiping a low table surface as to hoovering a carpet or wiping a mirror. Changes in posture during the task also led to changes in grip as the user attempted to control the activity. The repetitive nature of the tasks particularly requiring changes in posture and grip led to fatigue and in some cases significant discomfort leading to illness. The illness itself then in turn started to effect the way in which the task was then undertaken.

Obviously a better understanding of the cleaner activities especially on body posture, hand and finger movement and discomfort and painful feeling when undertaken these activities can aid in the design of products that may reduce instances of discomfort or enable the allocation of work activities so that there is less impact on the body.

Within Lab4living at SHU we have access to motion capture systems and thin-film force sensors to study posture and grip. From the experiences outlined above a series of tests were designed to utilize this equipment with regards producing this improved understanding of posture and grip. Further by embedding herself as part of a cleaning team made access to willing participants for the test work relatively easy.

Methods Used (In Situ and Laboratory Studies)

From the above diary entries several themes emerged that informed the experiments that we wished to undertake. Hoovering was seen as a common task that leads to fatigue and discomfort. Further hoovering posture due to the nature of what the cleaner was actually hoovering (i.e. under a desk, table or chair as opposed to a lobby) was also seen to effect comfort both in the back, shoulder, arm and hand. Changes in posture as well as manipulation of the vacuum cleaner handle were seen to be contributory factors leading to this discomfort.

As stated previously, whilst there have been several previous studies undertaken to analyze the activities of shoulder and arm muscle during force generation in different shoulder and positions when performing and force using the epidemiological and electromyography (EMG). However little previous studies have been undertaken on the force and hand and finger movement related with discomfort or pain while doing the ADLs activities.

From the diary entries outlined earlier several studies were proposed. Firstly, the authors decided to concentrate on understanding the hoovering task as this was the primary task that lead to most discomfort for Rahayu and tied in with opinions provided by the online survey. Secondly, it was decided to undertake studies both *in situ* and in the laboratory. The *in situ* studies would help us understand which hoovering task created the greatest force in the hand since from Rahayu's dairies some tasks were seen as more difficult than others. The *in situ* studies consisted of using the Tekscan thin-film force sensors on the handle of the vacuum cleaner and measuring the grip forces as the cleaners worked. Over 20 professional cleaners were studied. Figure 13 shows one of the cleaners using the equipment and Figure 14 a close-up of the sensor.

Figure 13: Thin Film Force sensor on vacuum handle *in situ*

Figure 14: Thin Film Force sensor on vacuum handle

Results from the sensor are displayed as pressure 'patterns'. To aid in helping us understand the relationship between these pressure patterns and discomfort the patterns were mapped onto a simple schematic of the hand as shown below.

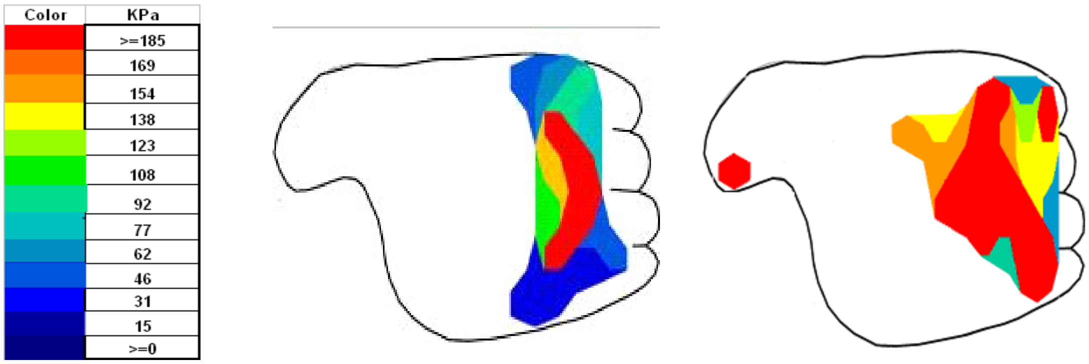

Figure 15: Pressure Distribution on the hand whilst hoovering

The hand on the left is a female cleaner gripping the vacuum handle gently before undertaking the task with the pressure distribution on the right the same cleaners hand during hoovering under a chair. The pressure patterns were seen to be affected by hand size and the task undertaken. Further results are not presented here since this paper is about how the experiential learning informed the experiments. The results from this work are currently under review elsewhere. Following on from this *in situ* work that identified which tasks created the highest 'pressure patterns' the same tasks were repeated in the laboratory combined with motion capture. Motion capture allows for the real-time measurement of movement through tracking of highly fluorescent markers using specialized infra-red cameras. Figure 16 shows the marker set-up including the markers and Tekscan thin-film sensor. Twenty cleaner professional were tested hoovering a carpet, in the corner, under a chair and under table. The cleaners were marked-up with the fluorescent markers to track motion of the vacuum cleaner relative to the task, their hand, arm, shoulders and back position.

Figure 16: Close-up of had set-up for laboratory experiments, laboratory set-up for hoovering under a chair, motion capture analysis

From this technique were able to understand the different actions of the cleaners undertaking these series of tasks and look at the forces in their hands whilst undertaking this task.

Conclusions

The results from the experiments have only been briefly presented here since the emphasis of this paper is how the experiences of Rahayu working as a cleaner helped in production of a series of experiments. The key insights were:

- hoovering whilst thought of as an easy task, rapidly creates discomfort in the back, shoulder and hand. Hence it was decided to concentrate initially on this task for our experiments.
- differing hoovering tasks create varying levels of discomfort. Interestingly, hoovering in a corner ranks highly for this which we did not expect or originally consider. Also fatigue plays its part, cleaning a bare carpet is relatively easy but becomes uncomfortable if a large area is to be cleaned. Hence a series of tasks were used to replicate the *in situ* environment.
- posture in relation to the task, repetitiveness and hand size all play a part in the increase in force in the hand leading to discomfort. Hence we measured participant height, hand size and repeated each experiment several times before taking a capture.

A major benefit of this experiential approach is the personalization of the issue it becomes a 'real' problem as opposed to someone else's that we are trying to understand. This is important in both enabling us to understand the issues around our research but enables us to discuss these issues with a greater deal of depth, we actually understand the problem. It is not interpreted and filtered in some way. As a researcher one of the most shocking elements to come out of the diary was how quickly Rahayu became ill and had to have to take time off work due to pains in her hand.
A further interesting advantage was the ease of getting volunteers to come to our laboratory and undertake the tasks asked of them. Nobody from Rahayu's cleaning team refused to take part in the survey and further, all the studies were conducted with a great deal of warmth and humour making the studies enjoyable and setting the volunteers at ease. Similarly all participants were happy to come back for further studies on mopping and wiping that are currently being undertaken.
It is worth noting in the preparation of this paper that Rahayu took a photograph of her hands as she was determined to show how her hands had become swollen and scarred from undertaking these cleaning tasks (the scarring comes from a reaction to the latex gloves she used), to that end it is shown below:

Figure 17: Rahayu's Right Hand

Finally, the authors believe that most importantly in 'embedding' herself as a cleaner we discovered how serious this issue actually is. There are as stated previously studies on vibration white finger and heavy (predominantly male) work such as construction, but little in the field of cleaning activities. The authors feel that this paper shows that it is time to change.

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Retail Design and the Visually Impaired: A Needs Assessment

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Abstract

This study represents a first attempt to investigate the need for universal retail design in Canada. Specifically, the research objectives were to expand understanding of the unique challenge of visual impairment and the shopping experience of visually impaired consumers, and to identify gaps in retail design in order to better serve the visually impaired community.

The researchers conducted three focus group interviews with a total of 17 informants recruited by an independent consultant who was affiliated with a visually impaired advocacy organization in the Greater Toronto Area in Ontario, Canada. Data were transcribed and then analyzed using QSR NVivo 8.

Findings suggest that mobility is the biggest daily challenge facing visually impaired consumers. Retail shopping involves significant effort at every step of the process for visually impaired shoppers, including getting into the store; judging product quality; distinguishing colour; reading labels, store signage, and receipts; negotiating store layout and fitting rooms; dealing with store lighting; and interacting with sales associates. This paper identifies visually impaired shoppers' needs for universal retail design, discusses implications, and makes recommendations to policy makers and industry practitioners in the defined fields.

Keywords

needs assessment; shopping experience; universal retail design; visually impaired

Introduction

Vision loss is a detrimental effect of aging that impacts physical, social, and psychological aspects of people's lives (Moore & Miller, 2003; Pelletier, Thomas, & Shaw 2009). Approximately 3.6 million Canadians are diagnosed with disabilities, including 648,000 people with visual impairment or blindness, many of whom are elderly (Government of Canada, 2004). In the U.S., more than 3 million Americans over age 40 live with blindness and low vision (National Eye Institute [NEI], 2004, 2008). Without a doubt, the prevalence of eye disease increases with age; the American cohort with blindness or low vision may reach 5.5 million by 2020 (NEI, 2004).

Using North American criteria, blindness is defined as the maximal visual acuity in the better eye being equal or less than 20/200, while low vision is classified as maximal visual acuity in one eye equal or less than 20/40 (Maberley et al., 2006). It is important to note that only a small fraction of the Canadian population is blind; the majority of visually impaired persons live with low vision (Maberley et al., 2006). As a rule, most people adjust reluctantly to predictable changes in vision as they enter middle age: they purchase reading glasses to compensate for the inability to focus on small print, need increased light levels for improved contrast perception, and find it more difficult to drive at night due to hindered glare recovery from oncoming headlights (Carter, 1994). However, with advancing age, other serious forms of eye disease and vision loss may occur, including macular degeneration, which typically impacts central vision; cataracts, which manifest as reduced glare recovery and decreased visual acuity; glaucoma, which initially presents as a loss in peripheral vision; and diabetic retinopathy, whose symptoms include overall decreases in visual acuity, colour perception, and the ability to adapt from dark to light (Castor & Carter, 1995; The Eye Diseases Prevalence Research Group, 2004; Rosenberg & Sperazza, 2008). Some of these symptoms may be improved with surgery or medication (Pelletier et al., 2009) and resulting vision loss may be offset by using handheld magnifiers, specialized glasses with tinted filters to reduce glare, large print computer software, voice synthesizers, and audio books or other talking devices (Castor & Carter, 1995).

Loss of vision correlates to reduced quality of life (Allen, 1989; Jackson, 2006; Misajon et al., 2005; Moore et al., 2003; Pelletier et al., 2009). Persons with visual impairment have an increased risk of falls and associated injuries (e.g., hip fractures), medication mistakes, social isolation, and depression (Carter, 1994; Jackson, 2006; Pelletier et al., 2009). These issues have critical significance now that our society includes more than 4.6 million Canadians over the age of 65 (Statistics Canada, 2009).

Traditional design processes for products and the retail environment focus primarily on the mainstream market, with little attention to the needs of aging baby boomers and the disabled community (Coleman, 2001; Kaufman-Scarborough, 1999). As people are living longer (Statistics Canada, 2007) and more people are living with some type of disability (Government of Canada, 1981), incorporating universal design principles into design practice has become increasingly necessary. Universal Design (sometimes referred to as Inclusive or Accessible Design) is defined as “the design of all products and environments to be usable by people of all ages and abilities to the greatest extent possible” (Story, 2001, p. 10.3). Ron Mace is accredited as the originator of the term “universal design” (Ostroff, Limont, & Hunter, 2002). As a polio survivor, he was confined to a wheelchair from the age of 9 onward, the challenges he faced inspired him to become an architect and an advocate for accessible design which he believed was critical to independent living (Ostroff et al., 2002). Market accessibility is one of the key principles of Universal Design (The Center for Universal Design, 2010) and forms the core justification of this study.

Over the last 25 years, society has become more aware of the barriers facing people with special needs. For example, since the federal government published its *Obstacles: Report of the Special Committee on the Disabled and the Handicapped*, municipal building codes now require ramps and elevators for improved accessibility to public buildings (Government of Canada, 1981). More recently, the provincial government introduced the *Accessibility for Ontarians with Disabilities Act*, *2005*, which promotes barrier-free living (Government of Ontario, 2005). Nevertheless, persons with visual impairment are significantly limited in their abilities to travel alone and unaided (Golledge, 1993). Moreover, as Kaufman-Scarborough (1999) pointed out, truly inclusive shopping access requires more than merely widening the doors; it is only “achievable through a balancing of legally required architectural attributes, moderated by adjustments in terms of actual merchandise, displays, and specific store environment created by each retailer” (p. 505). In this sense, retail design should be looked at from a “servicescape” perspective (Bitner, 1992) which considers the store’s physical surroundings as a holistic element underpinning both the customer’s and the store employee’s experience. Inclusive design sends positive messages to disabled people, messages which tell them “you are important,” “we want you here,” and “welcome” (Napolitano, 1995, p. 33).

Literature Review

Environmental psychology theories recognize the impact of the retail environment on shoppers. Two paradigms may be applied to explain and organize shoppers' emotional, cognitive, and behavioural responses to the retail surroundings they encounter. Mehrabian and Russell's (1974) emotion-cognition-behaviour paradigm is considered classic but has faced challenges in recent years. This theory posits that emotions are antecedents of cognition, which in turn lead to two contrasting forms of behaviour: approach and avoidance (Donovan & Rossiter, 1982). Approach involves a desire to stay, explore, and affiliate, while avoidance comprises the opposite behaviours. An alternate theory states that cognition elicits emotion (Lazarus, 1991). In other words, upon entering a given environment, a person first evaluates the external and internal cues in terms of his or her own experience and goals; once such an appraisal is made, an emotion will result (Lazarus, 1991). The cognition-emotion theory has received empirical support in retail atmospherics (Baker, Grewal, & Parasuraman, 1994; Chebat & Michon, 2003) and serves as an overarching conceptual framework for the current study.

The retail environment is an important factor in consumers' evaluation of the products and services offered, because shoppers may assign aesthetic and instrumental values to the formal, expressive, and symbolic qualities of store environments (Fiore & Ogle, 2000). Therefore, a retail environment may influence consumers' inferences about merchandise, service quality, and store image (Baker et al., 1994). A number of studies suggest that ambient and social cues are significant atmospheric elements that influence consumers' affective states in store environments and impact their shopping and purchasing behaviour (Baker, Levy, & Grewal, 1992; Bellizzi, Crowley, & Hasty, 1983). Ambient cues refer to physical and auditory aspects of store environments, such as lighting, music, colour, and display, whereas social cues correspond to factors such as the number and friendliness of employees.

Beyond the impact of a retail store's physical environment on shopper behaviours and perceptions of merchandise and services, perception may also be internalized and influence shoppers' self-perception. This is true for sighted and visually impaired shoppers alike, but is more significant for visually impaired people due to the unique challenges they face in their daily lives. Symbolic interaction theory addresses how individuals come to understand their world and the process of developing this understanding (Solomon, 1983), and is used as another point of departure for this study's data analysis. The theory assumes that people interpret the actions of others and respond accordingly (Solomon, 1983). The process of interpretation involves the use of symbols which can be traced to shoppers' perceptions of how they interact with the retail environment they encounter. According to Blumer (1969), symbolic interactionism is based on three fundamental premises. First, human beings respond to things (e.g. encounters with others) according to the meanings that the things have for them. Second, the meanings of such things are derived from the social interaction that one has with one's fellows. Third, these meanings are handled in, and modified through, an interpretive process that a person uses when dealing with the things he or she encounters. Therefore, meaning is central to people's actions; it is socially constructed and derived by people as they interact (Blumer, 1969).

Symbolic interaction theory can be used to analyze visually impaired shoppers' interaction with store design as well as store employees. The symbolic messages visually impaired shoppers receive from their shopping experience may form their perception of how retailers view them (or do not view them) as valuable customers, and this perception may in turn positively or negatively impact such shoppers' self-perception. In addition, visually impaired shoppers may respond to the retail environment based on the interpretation of their experience. This psychological impact is an important aspect of quality of life among the visually impaired; therefore, it deserves serious attention among the public, and in particular policy makers and industry practitioners in the defined field.

The selection and purchase of clothing by visually impaired people has been the subject of research studies in Hong Kong, the United Kingdom, and the United States (Bradley, Hopkins, & Bailey, 2000; Frency, 2000; Kaufman, 2000). Difficulties reported include inadequate sales service, poorly communicated clothing details and pricing information, as well as awkward store navigation when compared to sighted cohorts. There clearly was a dearth of information related to the visually impaired experience within the Canadian apparel market.

Consequently, this study represents a first attempt to investigate the need for universal retail design in Canada. Specifically, the research objectives were to expand understanding of the unique challenge of visual impairment and the shopping experience of visually impaired consumers, and to identify gaps in retail design in order to better serve the visually impaired community by making recommendations to policy makers and the industry practitioners in the defined fields.

Research Method

Data Collection

Three focus group interviews were conducted with a total of 17 informants recruited by an independent consultant who was affiliated with a visually impaired advocacy organization in the Greater Toronto Area in Ontario, Canada. Each focus group consisted of 5-7 informants and interviews were held at office boardrooms close to the participants' residences. The focus group sessions were facilitated by one of the researchers and audio recorded.

Focus Group Questions and Informants

The open-ended questions focused on how visual impairment impacted daily life as well as problems encountered with clothing and shopping. Demographic information was collected via a questionnaire. Each focus group session lasted approximately 90 minutes. The audio-recorded data were later transcribed and analyzed using QSR NVivo 8.

The focus group participants were about equal in gender representation (8 women, 9 men), the majority (58.8%) were between 41-60 years of age, and 64.7% lived with a partner, relatives, or friends. Most of the informants (88.2%) had obtained a high school diploma and 52.9% had earned postsecondary degrees, including 11.8% with a graduate degree. About 82.4% were unemployed, and the majority (58.8%) had an annual income of less than $20,000 (see Table 1 for more detailed demographic information).

Findings and Discussions

The Unique Challenge of Visual Impairment

All informants reported that mobility was the biggest daily challenge they faced. Because they were not able to drive and depended primarily on public transportation for moving around, the range of places they could go and stores they could shop in was limited. One informant's comments described this typical situation of being visually impaired:

> Well, it's mobility. I think that about all of us at some point have lost our [driver's] license. You live a lot happier life with that concept of being able to go to the front door and hop in the car and drive down the street. It takes a long time, I think, to put that urge away, I guess, and then you have to figure out all sorts of alternatives to achieve that same goal…and to try not to get the feeling of being marginalized out of the main stream….So…you sort of feel that you could do pretty much what you did before if you could get there.

Shopping Experience of the Visually Impaired

In addition to mobility challenges, going shopping involved much more significant effort at every step of the process for the visually impaired; as one informant told us, simply finding the entrance is an arduous task:

> The experience is…you know, like, losing part of my sight. Now it's really hard for me to take the city bus; walking a distance, I can walk, but the thing is, it's getting from the bus stop to the store, especially if there's some construction there, you know [XX mall] where they change everything around, so it's like, where do we go? You don't know where you're supposed to stop the bus…and it's more extra walk too, because you know I have to get off at the light, and so now you don't know if you should walk left or right…for an opening to where you want to go [in the mall].

Due to visual impairment, the informants reported that they lost confidence in their ability to evaluate apparel quality and distinguish colour effectively, and to read labels, store signage, and receipts. However, these are all important factors of a satisfactory shopping experience and outcome. One male informant illustrated this scenario about judging quality:

> I went to [X store] last year for my winter boots. I found these great Velcro strap boots. They were great, but they were not leather. I've worn them right out. But when I was in Winnipeg in December I saw the very same boot in leather in [XX store]. Twenty bucks for one pair, eighty bucks for the other. Now, I probably would have seen that the twenty-dollar pair really wasn't that good, like, you can't really see inside and see what kind of stitching, and you know, the quality, like, well let's feel it, you know? And all that stuff looks good when it's brand new right? But give it a couple weeks and snow and rain and da da da.

Regarding colour, most informants described an inability to distinguish like shades of colour. They often felt embarrassed for wearing clothes, socks, and shoes that didn't coordinate. With this in mind, they depended on other sighted shopping companions or store associates for assistance. Challenges with reading labels and tags are prevalent among the informants due to small fonts, limited colour contrast between the text and background, and location of the label–tag information.

> Those tags are so small…you have to go and ask for the price after [asking for the sizes], but just to find the size you want, that's tough, because the numbers are so small.
>
> Yeah and they're always in amongst the other print too, you can't make them out.
>
> You know, to buy a shirt, you can't see [the tags]. Some days I might be able to hold it in the right spot and see that it says medium or large; other days, you know it gets so frustrating, I can't see it.
>
> The care labels, not only are they small, but being colour coded you can't always tell exactly what each thing is meant for. 'Cause sometimes they have them in yellow, red, or green. 'Cause sometimes I have trouble with the reds and greens. And sometimes just the printing isn't always very clear. You can usually make out where it's made, but the rest of it is very small.

Regarding store signage, informants indicated that letter size, font type, and sign colour, content, and location all presented them with barriers for a smooth shopping experience:

> I hate italicized. You know, like they'll do the script where it's all fancy and stuff. It might look pretty, but to us, just simple plain blacks, like Arial or something like that is clearer for us than the other types of print.

> It's even the location of the signage; if it's too high up you can't see it. But each one of us are probably different heights, so if you walk into a store and it's at my eye level then I'll see it but if it's higher or lower I won't.
>
> [In some stores, the signs will] be 8½ by 11 and the letters will be an inch, inch and a half, so those are pretty good, they'll say what it is, like men's sportswear or something like that. But if you go in …[other stores], there are no signs that say what it is, you pretty much have to look at it and say those are trousers on the shelf, I suppose, or shirts, whatever. You pretty much have to see the item to know what it is, as opposed to the sign.

Paying for purchases also created stress for the visually impaired. The issues ranged from an inability to read the receipt, to handling cash and using debit or credit cards. The informants discussed various experiences with checkout procedures:

> I favour going with cash now. Because…you just give the money and they give you the change. As opposed to if you go credit card…that process of signing is, could be a challenge….Often they'll put that thing down on the table and you'll have to find the line, to [sign]…so my signature has become very brief now, just an "R" and some squiggles. Probably not on the line. Like, if I work hard or bring the bifocals down and get within range I can see the line, but that's a stressful situation, you know; it's stressful when you have seven people behind you or whatever….We complained about receipts that are really faint, but that's the one thing that I think should be really dark and bold, there should be a huge X that's about half inch, for everybody, and then you can see at three feet without bifocals, you can see the X, and sign next to it.

A number of informants described their concerns about not being able to see the information on sales receipts. They worried that incorrect charges (e.g., due to cashier error or a discrepancy between the price tag and actual pricing in the checkout system) may have been posted on their purchase. Because they would be unaware of this at the time of purchase, travelling back to the store at a later date to get the problem corrected would require considerable additional effort.

Using cash may not be an ideal option, either, as one informant commented:

> If you use cash, the only drawback is, and you've probably all have this experience, it happens more in [XX] but it could happen anywhere, where they put the bills on your palm and they balance the coin on top of that? If you make a false move then the coin is all over the place.

With touch screen debit card machines, the informants found punching in their personal identification number (PIN) to be particularly problematic:

> The worst problem I just had the other day at a store, and I had to just leave…my order and leave the store, because they had a debit machine, a touch screen. I can't use that. On the Interac machine, okay, I can feel the buttons. And if worse comes to worst, once I punch my code in, I can ask the [cashier], "can you just press chequing for me?" 'Cause sometimes the machines…are all different…Then I push okay, then I cover it and I can feel the buttons. Then I punch in my code, then I push okay, and my order's fine. [With the touch screen machine], I didn't know there was anything on screen. I had to just say no, I had to walk out of the store.

Due to mobility challenges, visually impaired shoppers often need assistance from family members whom they shop with, as well as from store associates, especially when shopping alone. However, the informants' experiences of interacting with store employees have not been, to a large extent, satisfactory. The issues focused on the following aspects: store employees' lack of knowledge of the store and merchandise; insensitivity toward the unique needs of the visually impaired shoppers; and perceived reluctance to accommodate visually impaired customers. These issues were illustrated through the following scenarios:

> I was in [X store] a couple weeks ago…and they had pop on sale. So, I told [the store associate], "I need…two cases Diet Pepsi, and two cases Coke Zero." The guy comes up and is like, "is this what you want?" It's a bottle of pop! I said, "no. I want the twelve, two twelve-packs." So he comes back and goes, "do you want six bottles of this and six of this?" I'm like, "no!"….So he comes back and he's got the little…bottles. And he's like, "is it these ones?" I'm like, "no. It's in a box. It's square. There's twelve cans in there, and it says 'Diet Pepsi.'"

> I have a sister that's totally blind, went to the restaurant….We had a waiter there that she was, you know, trying to talk, and my sister, you know she wasn't paying attention to her. And so…I told the waitress that she's totally blind. So now that she knows that she's totally blind, she was almost eating the food for her. And she's talking louder too.

> Well, a lot of it is, what I think it is…a fear on the part of people working in the stores, and a lack of education. They don't know to come forward if they're afraid. I have enough sight, sometimes I almost feel like they duck behind a counter so they don't have to serve you….[The fear] is we're going to ask them for more help than they're prepared to give. Or they're going to expend far too much time for far too little return.

Experiences in the fitting room are also worth noting. The issues identified included seating, paint colour for walls, as well as lighting. Due to mobility and low vision challenges, visually impaired shoppers must engage in a complicated multistep process in the change room before even trying on any clothing: closing the door; feeling around to find hooks for a cane, purse, or coat; feeling around to find a seat because vision loss always results in reduced ability in maintaining balance; and looking for a mirror. If a change room is painted a dark colour and has poor lighting, these first steps become a daunting task.

Issues related to store lighting were most frequently mentioned among the study informants. As a large percentage of visually impaired people have problems with light adaptation, the issues identified included lighting contrast in different areas in a store, with lighting being too dark or too bright. Our informants gave us the following vivid illustrations of the light adaptation problem:

> For a lifetime I've had to make these trade-offs….If I know I'm going to go into a place, I wear sunglasses for a bit before, so I'm kind of half dark-adapted before I get in. And then…I'll take my sunglasses off and I'll have a chance of sort of seeing…into the shadows a bit more. So if you…go back to the retail example, if you're walking around the store and there's…a big bright light down on an arrow on the floor, and you're in the bright light, and then you walk out of the arrow and you're in the shadows. And your eyes are going as far as the function of adapting to the light, they're going up and down, they're working hard to try to get…[but they] can't come back…instantly.

> [I don't like the skylight in the malls because] when you have bright sunlight and you come in and then you have the glare in your eye and you can't see, or you get shadows from displays that are in the mall concourse.

> I find if you're under the pot light exactly, yes you might have good light, but the minute you are off of it then you have light and shadow. And that can really throw you. So as much as I really don't like fluorescent, it maybe gives you a better uniform type of light. But you don't want it too bright.

> A lot of the times if you walk into a place they've got the white walls, white floors, white ceilings, fluorescent lights; it just tends to make everything blend together too much, and it makes it way too bright, so then everything goes all wishy-washy and you're squinting trying to see what's around.

Conclusion and Recommendations

Environmental psychology literature suggests that retail atmospherics make a significant impact on shoppers' perception and shopping behaviour (Baker et al., 1992; Bellizzi et al., 1983; Chebat & Michon, 2003). This seems to be the case among visually impaired shoppers in our focus groups. Due to the unique challenges of this consumer group, their needs within the retail environment are well defined, but different than the needs of persons with other disabilities (Baker, Stephens, & Hill, 2002). Providing proper accommodation to this unique consumer group not only conforms to universal design principles, but also improves quality of life for the visually impaired. Symbolic interaction theory states that individuals interpret the symbolic meaning they receive from the people and environment they encounter, internalize it, and respond accordingly. Therefore, when the retail environment is designed with reasonable consideration of the disabled community's needs, it may send a signal to this market segment that conveys how retailers, commercial real estate developers, and society at large value them. Based on our focus group study, we identified the following needs and make the recommendations set forth below.

Store Environment

Store layout should be straightforward and logical. Because of mobility challenges, most of the visually impaired informants found it stressful to navigate through stores in which the division of departments is not intuitive and clearly labelled. For example, in some stores, boys' clothing is adjacent to the men's department, which may cause visually impaired shoppers to inadvertently cross into the different clothing section and purchase a wrong-sized item. Aisles should be wide and without obstruction. Though most of the visually impaired shoppers are not in wheelchairs, their vision loss is a significant impediment for moving around freely in a store. Narrow aisles or aisles containing display fixtures or protruding merchandise may pose potential tripping hazards for these shoppers and cause damage and bodily injury.

Signage is critical to help visually impaired shoppers better navigate through a store. It is recommended that signs use large fonts and regular-styled letters, and incorporate strong colour contrast between the letters and background (flashy digital signs and fluorescent colours should be avoided). In addition, clear signage to indicate what merchandise is on the shelf is helpful for this group of consumers. Alternatively, a hand-held scanner that can read (and announce with audio cues) the signs and tags would be especially beneficial.

Checkout procedures should be streamlined with the visually impaired consumers in mind. In particular, "checkout stress" for this group of consumers would be lessened through the use of receipts with a large font and a bold signature line; the proper handling of change by the cashier; the provision of user-friendly debit card machines for the visually impaired; and possibly an audio-enhanced checkout system that announces the price and quantity of merchandise being scanned.

For visually impaired shoppers, the preferred store lighting is uniform, fluorescent lighting that is not too bright. Lighting should be designed as an integral component of the overall store environment. Specifically, there should be colour contrast between general store lighting and walls, floors, and shelves. Using carpets in merchandising areas and tile in walkways helps define different functions within the store and provides some directional clues for the visually impaired.

Service Personnel

Store associates should be available and committed to assisting visually impaired customers. They need to be knowledgeable about merchandise within the store and receive training on the unique needs of this consumer segment and on how to provide appropriate assistance in a sensible way. They are the frontline people who interact with the shoppers directly and the symbolic message they send plays a critical role in shopping satisfaction among visually impaired customers.

Limitations and Future Research

The findings of this study are based on three focus group interviews conducted with selected members of a visually impaired advocacy organization in the Greater Toronto Area in Ontario, Canada. While these initial data provide valuable insights, inclusion of a diverse population would provide richer understanding. For future studies, systematic sampling is recommended for a more complete understanding of needs among the visually impaired community in Canada.

Additionally, how the retail shopping experience influences visually impaired shoppers' quality of life and self-perception might be another area that merits in-depth investigation. Providing appropriate accommodation for the visually impaired and other disabled communities requires collective efforts from the whole society, especially policy makers and industry practitioners in retail, commercial real estate development, design, and related fields. Future research should look into this dynamic system and explore retail universal design concept from diverse perspectives.

Table 1 Demographics of the Informants

Age	**No. Informants**
Younger than 18 years of age	0
19 - 40 years of age	2
41 - 50 years of age	5
51 - 60 years of age	5
61 - 70 years of age	4
Older than 70 years of age	1
Sex	
Female	8
Male	9
Household status	
Married/living with partner	5
Living alone	6
Living with relatives	4
Living with friends	1
Education	
Some elementary or high school education	2
High school diploma	5
Some post-secondary education	1
Post-secondary degree or certificate or diploma	7
Graduate Degree	2
Employment	
Yes	2
No	14
Income	
Less than $20,000	10
$21,000 - $ 50,000	6
$51,000 - $70,000	1
$71,000 - $100,000	0
Greater than $100,000	0

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Hong Yu is an Associate Professor in the Ted Rogers School of Retail Management at Ryerson University in Canada. Dr. Yu specializes in researching the interaction between retail environment and consumers in a cultural context. Her main domains are in shopping experience and behaviours of diverse consumer segments in various retail venues and effective marketing strategies for different retail channels. She's been interviewed and invited to speak at conferences on the topics and also provided training sessions for retail design practitioners.

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Sandra Tullio-Pow is an Associate Professor in the School of Fashion at Ryerson University. She has designed women's sportswear and bridal wear as well as the official maternity uniform for the Royal Canadian Mounted Police. She is a consultant to various policing agencies on uniform design and garment specifications. Recent research with Princess Margaret Hospital produced a Canadian and U.S. design patent for a modular bag with therapeutic arm rest. Her passion is improving the quality of life for those with special needs by engineering clothing that combines both function and fashion.

Approaching Product Subjective Sustainability: Comparative Study on Evolution of Users' *Kansei* during Lifetime of their Mobile Phones between Iran and Japan

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Abstract

Most of the scholar works about Sustainable Design treat of the objective side of product sustainability, whereas its subjective side has not been observed adequately. A sustainable product should be able to last in its expected lifetime not only objectively but subjectively. The main focus of design researches concerning the subjective issues of sustainability is on 'lifetime optimization of products'. Focusing on the subjective side of product sustainability, here the concept of 'Product Subjective Sustainability' is proposed to specifically indicate 'the emotional, affective and/or aesthetical capability of a product for satisfyingly and pleasantly lasting during its expected long/short lifetime'. However, such a concept may generally encompass all possible subjective effects of the product on sustainability values. This research basically aims to clarify 'Product Subjective Sustainability' experientially. As *Kansei* embraces much wider subjective issues of product than emotion, this study is based on *Kansei* Engineering approach. Here, a comparative and analytical study is done on the evolution of users' *Kansei* toward their personal product during its entire lifecycle in two different contexts, Iran and Japan. The product lifecycle from user perspective is divided into three stages including purchasing or choosing, keeping or using and replacing or throwing away the product. The assigned personal product for this comparative analysis is mobile phone which is an approximately short-lived product. Thus, two groups of Iranian and Japanese subjects are investigated about their senses, feelings and/or emotions (ie *Kansei*) regarding their mobile phone during each of its lifecycle stages. After extracting the patterns of evolution of their *Kansei* and thence drawing the trends of subjective sustainability of mobile phone in Iran and Japan, the resulted patterns and trends would be compared.

Keywords

Product Subjective Sustainability; Psychological Lifetime; *Kansei* Evolution; Attachment; Mobile Phone; Context.

The importance of subjective aspects of sustainability has been reinforced within some scientific debates almost from the first stages of emerge of the concept of sustainable development (Douven, Nijkamp, & Scholten, 1995; Ierland, Straaten, & Vollebergh, 2001). Some researchers argue that sustainable development is an inherently subjective concept (Kemp, & Martens, 2007). However, most studies about sustainability, especially in the last decade, have focused on its objective side, whereas its subjective aspects have not been observed adequately (Hart, 1994; Paddison, Money, Lever, & Lever, 1995). The key challenge of "subjective environmental aspects of products and processes" has been discussed in design research since the last decade (Hoffman, 1997). As design touches human multilaterally, the given importance to the subjective issues of sustainability within the design researches – for instance about sustainable lifestyle and socio-ethical values – is increasing theoretically and empirically (Childs, Agouridas, Barnes, & Henson, 2006). Practically, the main focus of design researches concerning the subjective issues of sustainability is on 'lifetime optimization of products' (Nes, & Cramer, 2003). Emphasizing "the main challenge in design for longevity lies in achieving an enduring satisfaction with the product, rather than only meeting the momentary desires of today", Nes and Cramer (2005), on the basis of the results of analysis of the factors influencing the users' decision for product replacement, propose five design strategies for product longevity including: design for reliability and robustness; design for repair and maintenance; design for upgradeability; design for product attachment and design for variability. Among these five strategies 'product attachment' seems to be the most directly-related one to product psychological or subjective lifetime. 'Product attachment' simply is defined as "the emotional bond experienced with a product" (Schifferstein, Mugge, & Hekkert , 2004). Many design researchers argue that extending the psychological life span of durables as well as increasing the degree of consumer-product attachment could be instrumental to reduce the demand for scarce resources and the rate of solid waste disposal and may contribute to a more sustainable society (Mugge, Schifferstein, & Schoormans, 2004; Hinte, 1997; Govers, & Mugge, 2004). The strategy to enhance product attachment is however the most uncertain in actually enhancing longevity. As this strategy is based on the fact that the disposal of products is made harder when one feels attached to the product, it brings so many questionable points and challenges implying that it should be well considered and applied delicately (Nes, & Cramer, 2005). A product, even a very personal one like mobile phone, could be emotionally pleasurable, aesthetically appealing and/or functionally comfortable during its expected short/long lifespan while there might not be any strong user-product-attachment. Moreover, durability of users' satisfaction and emotional pleasure regarding a product and its appeal may not necessarily eventuate to attachment. In fact, user-product-attachment is one of the product subjective issues including the user's total attitude, feeling, affection, emotion and/or appreciation, which could be called *Kansei*, about a product (Childs, Agouridas, Barnes, & Henson, 2006; Schütte, Eklund, Ishihara, & Nagamachi, 2007). Keeping the above mentions as the background and aiming to analytically expand 'product subjective sustainability', this paper presents the process and results of a comparative study done on the evolution of users' *Kansei* toward their mobile phone during its entire lifecycle between two different contexts, Iran and Japan.

Approach

Conceptualization

Considering the above mentioned points and challenges concerning product attachment and also according to the authors' findings within the last researches (Zafarmand, Tauchi, Terauchi, Kubo, & Aoki, 2009a,b), it seems that product attachment is just one of the effective means that can be used for extending or optimizing the psychological lifespan or subjective lifetime of products, while there are some other effective means in this regard. Thus, there is a room for an open concept or wide expression to comprehensively encompass product subjective issues contributing to the products pleasurable longevity when considering product sustainability.

The term 'subjective sustainability', as a versatile and wide concept, has been used in the literatures of various fields, such as Social Sciences (Becker, & Jahn, 1999), Public Policy (Tierney, 2003), Forest Management (Raison, Brown, & Flinn, 2001), Urban Planning (Hart, 1994; Paddison, Money, & Lever 1995; Castello, 2006) and Package Design (Salazar, 2008). 'Subjective sustainability' in terms of Social Sciences generally is the matter of the social and cultural issues of sustainable development (Becker, & Jahn, 1999) and in Urban Studies specifically is about "rising real incomes, adjusted market frameworks and changing consumer preferences interact to moderate resource inputs while raising GNP" (Hart, 1994; Paddison, Money, & Lever, 1995). According to Haie (2006), subjective sustainability criteria should be approached through subjective judgments, subjective classifications and subjective conclusions. Nevertheless, the definite territory of 'subjective sustainability' has not been identified clearly and expanded well within the literatures.

In this research "a product's capability of being pleasing, appealing and satisfyingly lasting during its expected long/short lifetime" is called 'Product Subjective Sustainability' (PSjS). The word 'sustainability' in this concept is to imply not only a fair durability but the imperative application of such durability in terms of product sustainability. However, such a concept could be expanded to generally embrace all subjective issues of product reflecting/effecting/affecting sustainability values.

Experimental Framework and Purpose

To experientially expand PSjS, we have carried out a comparative analysis on the evolution of Japanese and Iranian users' *Kansei* toward a product in its entire lifecycle. For covering all subjective issues, this analysis is on the basis of *Kansei* Engineering approach (Schütte, Eklund, Ishihara, & Nagamachi, 2007). Here, the entire lifecycle of product from user perspective is divided into three main stages including: Purchase (P); Keep/Use (KU); and end or Replace (R). The specified product type for this analytical study is Mobile Phone, since its subjective issues are more considerable than the other kinds of product due to the users' very close/personal relation with it despite being a short-lived product (Zafarmand, Sugiyama, Watanabe, & Ono, 2006a,b). User's emotional attachment to mobile phone – rather than the other kinds of product – is also reflected in numerous scholarly works (Vincent, 2006; Vincent, 2005; Wehmeyer, 2007; Wehmeyer, 2008).

Furthermore, there is the highly effects of context on the form-structural patterns of aesthetic boredom and consequently aesthetic durability of mobile phone (Zafarmand, Sugiyama, Watanabe, & Ono, 2007). In fact these two phenomena affect product psychological lifetime while being included in the subjective issues of product. Within the authors' last researches with the same theme and approach just a limited number of Japanese students were investigated. To find out the effects of contextual differences on PSjS, here a considerable number of mobile phone users living in two quite different contexts are investigated. The major processed output of investigation would the *Kansei* descriptive items regarding each lifecycle stage of the subjects' mobile phones, the items and subjects groupings and thereupon the various patterns of the evolution of the subjects' *Kansei* regarding their mobile phone during its lifecycle. Finally, as the main outcome of this study, the major trends of PSjS would be drawn on the basis of the results.

Outline and Method

This comparative study has been performed within three main steps. In the first step, two groups of Iranian and Japanese subjects are investigated through the definite and extensive-descriptive questionnaire. The second step is the process and analysis of the data derived from the questionnaire by using KJ Method, Descriptive Statistics, Quantification Theory Type III (QT3) and Cluster Analysis. Last, as the third step, the results of analysis are interpreted and put in discussion.

All of the subjects are selected randomly. The Japanese subjects ranging from 15 to 24 years, 31% female and 69% male in total, consist of 32 students of Chiba University and 17 high school students living in Chiba. The Iranian subjects ranging from 16 to 28 years, 77% female and 23% male in total, consist of 50 university students – of University of Tehran, Iran University of Science and Technology and Shiraz University – and 21 high school students living in Shiraz. They are investigated about: a brief history of their used/replaced mobile phones; their reasons for replacing mobile phone; the level of dis/satisfaction of their current mobile phones; and their feeling, emotion, image and/or attitude – namely *Kansei* – regarding their mobile phones in each of the three lifecycle stages of P, KU and R separately into three different questions.

The *Kansei* descriptive words responded by the subjects are summarized through KJ Method. Then the subjects' responded items in all three lifecycle stages are processed altogether by using QT3. To identify the *Kansei* items' grouping and also the subjects' grouping on the basis of their *Kansei* regarding their mobile phones in the three lifecycle stages, the method of Cluster analysis is used. On the basis of the axis dimensions as the output of QT3, all of the subjects' *Kansei* statuses in the three lifecycle stages of their mobile phones are put in the 3-dimensional spaces. As the following formulation shows, if the distance of a subject's *Kansei* status (S_i) in two different lifecycle stages, for example P and R, was higher than the addition of Average distance and Standard Deviation (Av.+SD), that is considered important case regarding the shift between those two stages.

$Dist\ S_{iPR}$ = *Distance of* S_i *in P and R lifecycle stages*

$$Dist\ S_{iPR} = \sqrt{(X\ S_{iP} - X\ S_{iR})^2 + (Y\ S_{iP} - Y\ S_{iR})^2 + (Z\ S_{iP} - Z\ S_{iR})^2}$$

If $Dist\ S_{iPR} > Av.+SD$, S_{iPR} *Importance = 1*

If $Dist\ S_{iPR} < Av.+SD$, S_{iPR} *Importance = 0*

The various patterns of the subjects' *Kansei* evolution are then extracted from the positions of the highlighted important cases in terms of the resulted groupings in each lifecycle stage. Then, according to the positions of extracted patterns in the areas of the resulted 3-dimensional spaces, the major trends of PSjS are drawn. Finally, the major trends and patterns of PSjS extracted from Iranian and Japanese subjects' responses are compared.

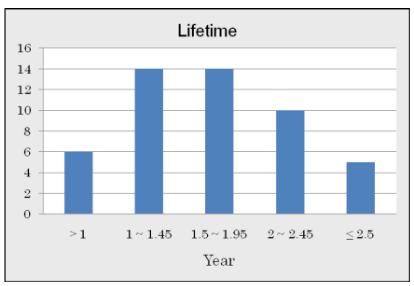
Results

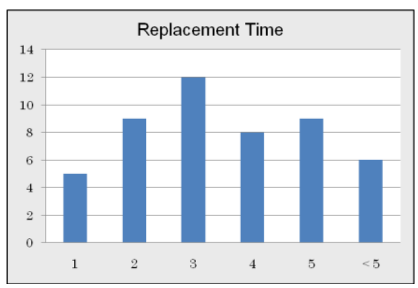
Replacement Circumstances

The general results of investigating the Japanese and Iranian subjects regarding mobile phone replacement are as follows. Indifferently, a Japanese subject and an Iranian one have already used respectively '3.6' and '2.4' mobile phones (Av.MP) from '5.37' and '3.75' years ago. The average lifetimes of mobile phone used by the Japanese and Iranian subjects are respectively '1.59' and '1.88' years. Besides, just 65% of the Japanese subjects are satisfied with their current mobile phone and 80% of them like it. But 85% of the Iranian subjects are satisfied with their current mobile phone while 80% of them like it. For more easily comparison, the above mentioned results are presented in Table 1. The histograms of Japanese and Iranian subjects' mobile phone lifetimes and replacement times are also shown respectively in Figures 1, 2, 3 and 4.

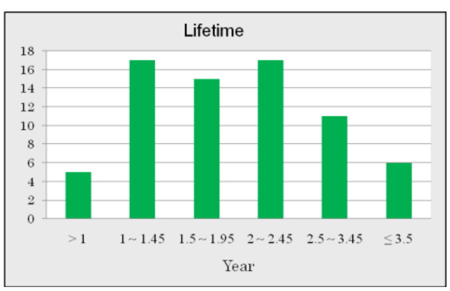
Subjects	Tot No.	Av.MP used	Start of use	Av. Lifetime	Satisfied with current MP	Like current MP
Japanese	49	3.6	5.37 *yrs ago*	1.59 *yrs*	65%	80%
Iranian	71	2.4	3.75 *yrs ago*	1.88 *yrs*	85%	80%

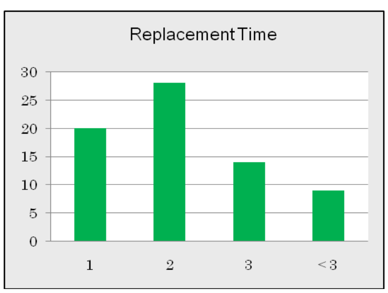
Table 1 Comparison of mobile phone replacement circumstances between Iran and Japan





Figures 1 & 2 Histograms of Japanese subjects' mobile phone lifetime and replacement time





Figures 3 & 4 Histograms of Iranian subjects' mobile phone lifetime and replacement time

The Japanese subjects' reasons for replacing mobile phone are summarized into 11 items including Boring, Broken, Defect, Form, Found Favorite, Lost, Novelty, Oldness, Price, Service and Tattered. The ones of Iranian subjects' are also summarized into 18 items including Boring, Broken, Defect, Facilities, Fashion, Form, Gift, Individuality, Interest, Lost, Novelty, Oldness, Performance, Physics, Price, Quality, Service and Variety. To distinguish the most ongoing and frequent reasons and compare them between the Japanese and Iranian subjects, the reasons are sorted followed by their frequency into the bar-graphs shown in Figures 5 and 6. As it can be seen, the most ongoing and frequent reasons are respectively Defect, Oldness, Novelty and Broken in the context of Japanese subjects and Facilities, Defect, Broken and Form in the context of Iranian subjects.

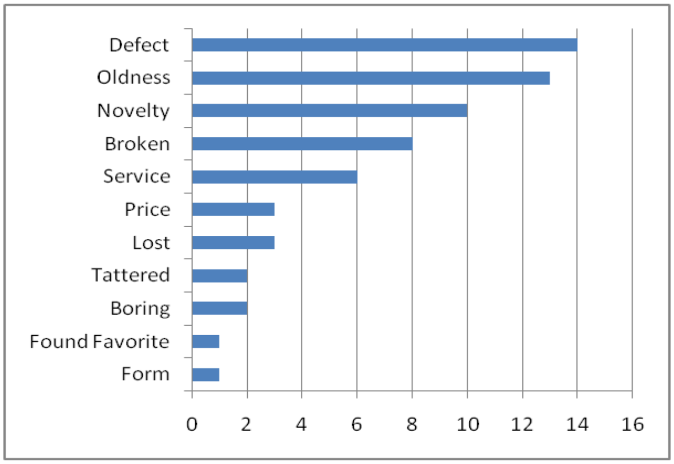


Figure 5 The Japanese subjects' main reasons for replacing mobile phone

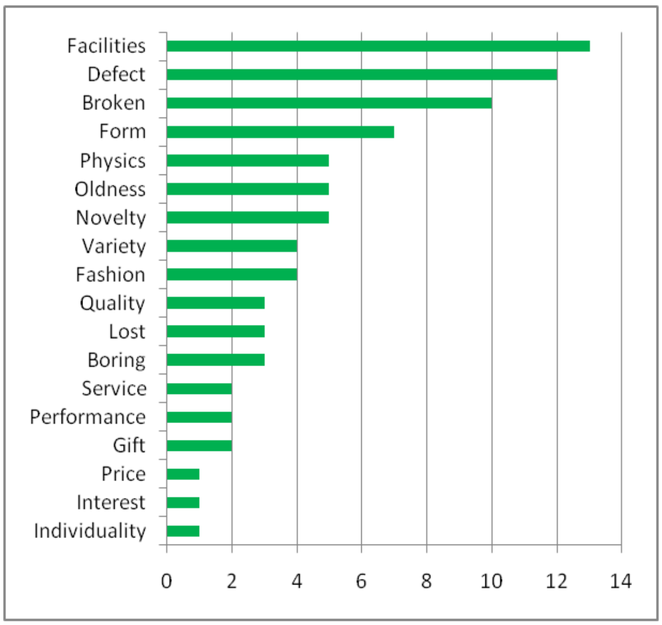


Figure 6 The Iranian subjects' main reasons for replacing mobile phone

Derived Kansei Items Groupings

In total, 626 Japanese *Kansei* keywords (including 136 ones for R stage, 278 ones for P stage and 212 ones for KU stage) and 635 Persian ones (including 190 ones for R stage, 224 ones for P stage and 219 ones for KU stage) are derived respectively from the Japanese and Iranian subjects' responses regarding their *Kansei*, emotion or feeling about their mobile phone in its different lifecycle stages. These two groups of keywords are separately summarized into 41 and 42 *Kansei* items or descriptive words through KJ Method. The Japanese and Iranian subjects' responded data about their *Kansei* regarding all of the three lifecycle stages of their mobile phones are separately adapted to these 41 and 42 *Kansei* items and processed by using QT3 and Cluster

Analysis. The overall output distributions of the *Kansei* items in the lifecycle stages of mobile phone regarding each country's subjects are shown into X-Y and X-Z graphs in Figures 7 and 8.

The chosen cut-off lines for the clustering algorithms have yielded five clusters marked from *C.1* to *C.5* in the X-Y graph and eight clusters marked from *G.1* to *G.8* in the X-Z one regarding the Japanese subjects (Fig. 7), and six clusters marked from *Ci.1* to *Ci.6* in the X-Y graph and six clusters marked from *Gi.1* to *Gi.6* in the X-Z one regarding the Iranian subjects (Fig. 8). This choice of cut-off is carefully made in order to arrive at the most meaningful groupings for understanding of the relationship between various *Kansei* items. The lists of *Kansei* items, their output dimensions in X, Y and Z axis, their belonging clusters in X-Y and X-Z graphs and their frequencies in each lifecycle stage according to the Japanese and Iranian subjects' responses are presented in Tables 2 and 3. To illustrate the lifecycle stage (P, KU or R) each item associates with rather than the other stages, the different point shapes and colors are used in the graphs. This suggested association is decided on the basis of the higher frequencies of each item in the lifecycle stages highlighted in Tables 2 and 3.

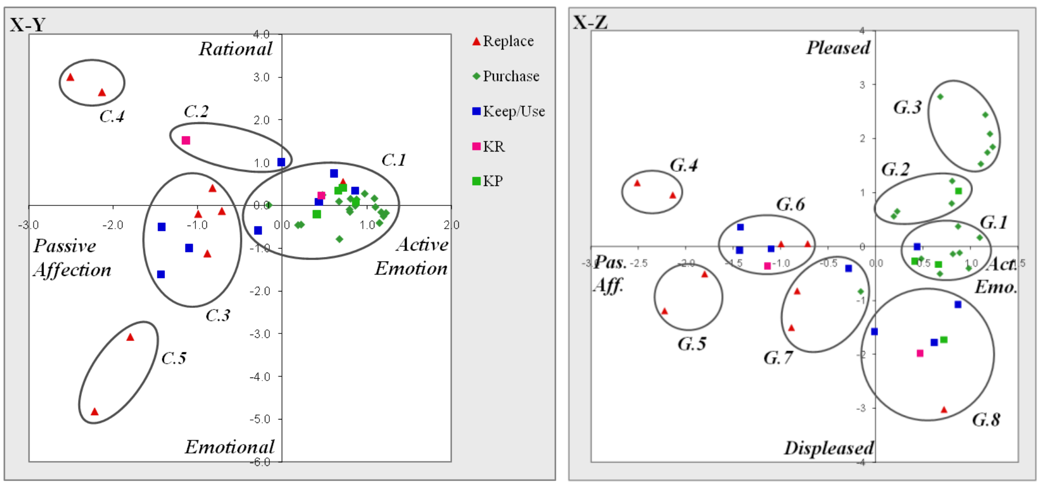


Figure 7 Distributions and groupings of 41 *Kansei* items in X-Y and X-Z graphs of Japanese subjects

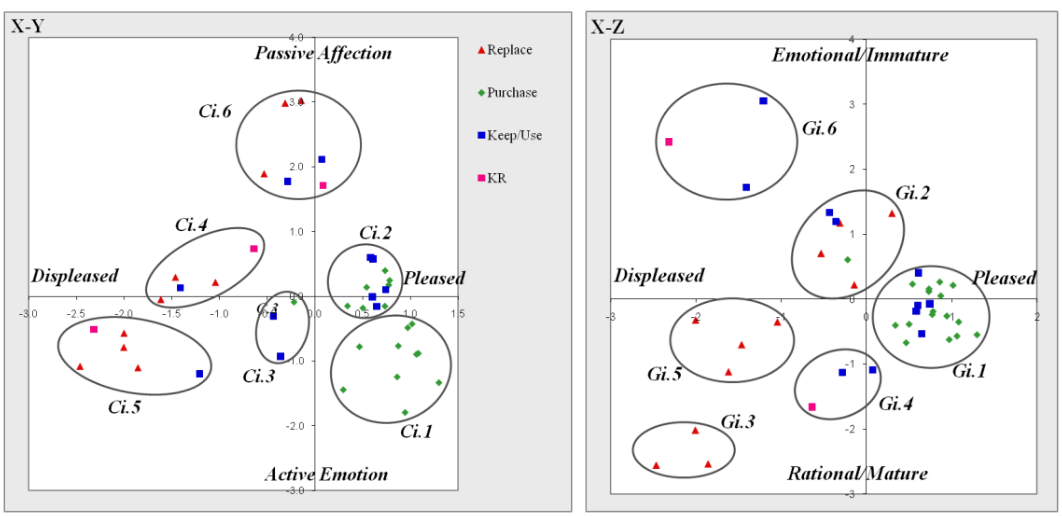


Figure 8 Distributions and groupings of 42 *Kansei* items in X-Y and X-Z graphs of Iranian subjects

In the graphs relevant to the Japanese subjects (Fig. 7), the directions of the three axis of X, Y and Z are respectively named as '*Passive Affection - Active Emotion*' (*Pas.Aff - Act.Emo*), '*Emotional - Rational*' (*Emo - Rat*) and '*Displeased - Pleased*' (*Disp - Ples*). The clusters *C.1* to *C.5* can be characterized respectively as Gratification/Concerns, Old, Enduring, Ally and Lonely. Similarly, clusters *G.1* to *G.8* can be characterized respectively as Practical Concerns, Pleasant, Joy/Fresh, Ally, Lonely, Attached, Undergone and Dissatisfied. As it can be seen, the items having more association with the lifecycle stage of P and R are located respectively in the right and left sides of the graphs.

In the graphs relevant to the Iranian subjects (Fig. 8), the directions of the three axis of X, Y and Z are respectively named: '*Displeased - Pleased*'; '*Active Emotion - Passive Affection*'; and '*Rational/Mature – Emotional/Immature*' (*Rat/Ma – Emo/Im*). The clusters *Ci.1* to *Ci.6* can be characterized respectively as Joy/Fresh, Satisfaction, Concerns, Dissatisfaction, Displeasure and Attachment. The clusters *Gi.1* to *Gi.6* can be also characterized as Joy/Fresh, Affected, Riddance, Ally, Displeasure and Boring. Similarly, the items having more association with the lifecycle stage of P and R are located respectively in the right and left sides of the graphs. All of the above given names are decided on the basis of the context and distribution of the *Kansei* items in the graphs.

	QT3 Output			Groupings		Freq. in Subj. Clus. X-Y					Freq. in Subj. Clus. X-Z					*Freq. in L.Stage*			*Total*
Kansei Items	X	Y	Z	X-Y	X-Z	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	P	KU	R	*Freq.*
Accustom	-0.29	-0.59	-0.40	*C.1*	*G.7*	3	6	0	0	0	4	0	0	5	0	1	8	0	9
Achievement	0.68	-0.80	2.78	*C.1*	*G.3*	1	8	0	0	0	1	0	4	0	4	7	2	0	9
Anger	0.72	0.55	-3.02	*C.1*	*G.8*	0	2	0	0	0	0	0	0	2	0	0	0	2	2
Anxiety	0.81	0.15	-0.14	*C.1*	*G.1*	0	12	0	0	0	0	0	4	8	0	10	1	1	12
Appreciation	-2.51	3.00	1.18	*C.4*	*G.4*	1	0	4	10	0	9	6	0	0	0	0	5	10	15
Attachment	-1.44	-1.61	-0.07	*C.3*	*G.6*	17	1	0	0	1	18	0	0	1	0	0	12	7	19
Boasting	1.11	-0.04	1.53	*C.1*	*G.3*	0	3	0	0	0	0	0	3	0	0	3	0	0	3
Boring	-0.16	0.00	-0.84	*C.1*	*G.7*	0	6	0	0	0	3	0	0	3	0	3	2	1	6
Cherished	-1.43	-0.50	0.36	*C.3*	*G.6*	12	3	0	3	1	15	2	1	1	0	2	10	7	19
Complain	0.72	0.41	-1.73	*C.1*	*G.8*	0	16	0	0	0	0	0	0	16	0	7	7	2	16
Complication	0.67	0.09	-0.51	*C.1*	*G.1*	1	27	0	0	0	1	0	8	19	0	18	6	4	28
Curiosity	0.19	-0.47	0.56	*C.1*	*G.2*	1	3	0	0	0	1	0	2	1	0	3	0	1	4
Desire	0.87	-0.01	0.37	*C.1*	*G.1*	1	11	0	0	0	1	0	7	4	0	7	5	0	12
Discovery	1.20	-0.26	2.09	*C.1*	*G.3*	0	4	0	0	0	0	0	3	0	1	4	0	0	4
Easy	0.23	-0.46	0.65	*C.1*	*G.2*	6	21	0	0	0	8	0	11	7	1	14	13	0	27
Excite	1.17	-0.16	1.74	*C.1*	*G.3*	0	6	0	0	0	0	0	5	0	1	6	0	0	6
Familiarity	-1.10	-1.00	-0.04	*C.3*	*G.6*	6	2	0	1	0	8	0	0	1	0	0	6	3	9
Flaw	0.46	0.23	-1.98	*C.1*	*G.8*	1	8	0	0	0	1	0	0	8	0	1	4	4	9
Fragile	0.41	-0.21	-0.27	*C.1*	*G.1*	1	3	0	0	0	1	0	1	2	0	2	2	0	4
Functional	0.48	0.24	-0.23	*C.1*	*G.1*	2	55	0	3	0	6	0	21	33	0	31	16	13	60
Good-look	0.80	-0.10	0.80	*C.1*	*G.2*	1	12	0	0	0	1	0	9	3	0	10	2	1	13
GUI-like	0.88	0.13	-0.12	*C.1*	*G.1*	0	10	0	0	0	0	0	3	7	0	6	4	0	10
Important	-1.00	-0.20	0.05	*C.3*	*G.6*	10	7	0	4	0	16	0	0	5	0	5	5	11	21
Longevity	-0.72	-0.13	0.05	*C.3*	*G.6*	14	16	0	5	0	21	0	4	10	0	6	14	15	35
Lost	-0.89	-1.12	-1.50	*C.3*	*G.7*	2	2	0	0	0	2	0	0	2	0	0	1	3	4
Nostalgic	-1.80	-3.07	-0.51	*C.5*	*G.5*	7	0	0	0	4	11	0	0	0	0	0	2	9	11
Novelty	0.86	0.35	-1.07	*C.1*	*G.8*	0	18	0	0	0	0	0	4	14	0	7	10	1	18
Old Style	-0.01	1.01	-1.58	*C.2*	*G.8*	0	9	0	2	0	2	0	0	9	0	2	5	4	11
Partner	-2.14	2.65	0.96	*C.4*	*G.4*	1	0	2	8	0	7	4	0	0	0	0	4	7	11
Pity	-2.22	-4.81	-1.19	*C.5*	*G.5*	1	0	0	0	2	3	0	0	0	0	0	1	2	3
Pleasure	0.80	-0.16	1.22	*C.1*	*G.2*	1	30	0	1	0	3	0	22	4	3	28	2	2	32
Puzzled	0.98	0.27	-0.41	*C.1*	*G.1*	0	10	0	0	0	0	0	3	7	0	8	2	0	10
Reasonable	0.66	0.35	-0.33	*C.1*	*G.1*	0	8	0	0	0	0	0	2	6	0	4	4	0	8
Refresh	1.23	-0.18	1.85	*C.1*	*G.3*	0	10	0	0	0	0	0	8	0	2	10	0	0	10
Regret-Wasteful	-0.83	0.41	-0.82	*C.3*	*G.7*	3	7	0	5	0	9	0	0	6	0	0	3	12	15
Superfluous	1.09	0.16	0.16	*C.1*	*G.1*	0	3	0	0	0	0	0	2	1	0	2	1	0	3
Surprise	1.15	-0.42	2.44	*C.1*	*G.3*	0	4	0	0	0	0	0	2	0	2	3	1	0	4
Tattered	-1.14	1.52	-0.36	*C.2*	*G.6*	1	1	0	2	0	3	0	0	1	0	0	2	2	4
Temporary	0.61	0.75	-1.78	*C.1*	*G.8*	0	13	0	1	0	1	0	0	13	0	2	9	3	14
Toy	0.87	0.08	1.03	*C.1*	*G.2*	0	2	0	0	0	0	0	1	1	0	1	1	0	2
Uniqueness	0.43	0.08	0.00	*C.1*	*G.1*	0	4	0	0	0	0	0	1	3	0	1	2	1	4

Table 2 *Kansei* items and their dimensions, belonging clusters and frequencies relevant to Japanese subjects

	QT3 Output			Groupings		Freq. in Subj. Clus. X-Y					Freq. in Subj. Clus. X-Z					*Freq. in L.Stage*			*Total*
Kansei Items	X	Y	Z	X-Y	X-Z	*Ai*	*Bi*	*Ci*	*Di*	*Ei*	*Fi*	*Gi*	*Hi*	*Ii*	*Ji*	P	KU	R	*Freq.*
Accustomed	-0.29	1.77	-1.13	*Ci.6*	*Gi.4*	0	1	0	5	2	0	0	0	6	2	0	6	2	8
Anxiety	-0.22	-0.09	0.61	*Ci.3*	*Gi.2*	2	6	14	6	0	0	0	6	17	5	12	8	8	28
Appeal	0.97	-0.48	-0.63	*Ci.1*	*Gi.1*	0	0	12	1	0	0	0	0	13	0	10	3	0	13
Big	-1.47	0.29	-0.70	*Ci.4*	*Gi.5*	1	4	0	1	0	0	0	1	0	5	0	0	6	6
Bored	-2.32	-0.51	2.42	*Ci.5*	*Gi.6*	10	2	0	0	0	0	4	5	0	3	0	6	6	12
Broken/Lost	-0.31	2.98	1.17	*Ci.6*	*Gi.2*	0	1	0	5	4	0	0	4	6	0	0	1	9	10
Companion	0.07	2.11	-1.09	*Ci.6*	*Gi.4*	0	1	0	9	4	0	0	0	13	1	1	7	6	14
Confident	0.74	0.10	-0.07	*Ci.2*	*Gi.1*	0	0	6	2	0	0	0	0	8	0	3	5	0	8
Decreasing Value	-0.36	-0.93	1.20	*Ci.3*	*Gi.2*	3	3	8	0	0	0	0	3	8	3	2	11	1	14
Dislike/Bad-Feel	-2.00	-0.57	-0.32	*Ci.5*	*Gi.5*	10	4	0	0	0	0	0	3	1	10	0	6	8	14
Ease/Utility	0.34	-0.15	-0.40	*Ci.2*	*Gi.1*	1	2	11	4	0	0	0	0	16	2	8	6	4	18
Embarrassment	-2.01	-0.79	-2.02	*Ci.5*	*Gi.3*	2	2	0	0	0	1	0	0	0	3	0	1	3	4
Excited	1.30	-1.33	-0.55	*Ci.1*	*Gi.1*	0	0	4	0	0	0	0	0	4	0	4	0	0	4
Expiring	-0.53	1.89	0.70	*Ci.6*	*Gi.2*	0	1	1	1	2	0	0	2	2	1	0	2	3	5
Flaw	-1.05	0.21	-0.35	*Ci.4*	*Gi.5*	7	10	6	4	0	0	0	2	13	12	0	12	15	27
Good-feeling	0.87	-0.76	0.05	*Ci.1*	*Gi.1*	0	1	41	0	0	0	0	0	42	0	27	13	2	42
Good-look	0.77	0.18	-0.24	*Ci.2*	*Gi.1*	0	0	18	3	0	0	0	0	21	0	10	8	3	21
Happy-R-End	-2.47	-1.09	-2.56	*Ci.5*	*Gi.3*	12	3	0	0	0	7	0	1	1	6	0	0	15	15
Individual	0.61	0.58	0.40	*Ci.2*	*Gi.1*	0	0	9	3	0	0	0	0	12	0	4	5	3	12
Light	0.50	-0.18	-0.39	*Ci.2*	*Gi.1*	0	1	6	0	0	0	0	0	6	1	4	2	1	7
Like	0.78	0.25	-0.19	*Ci.2*	*Gi.1*	0	0	28	6	2	0	0	0	36	0	17	12	7	36
Longevity	0.58	0.60	-0.19	*Ci.2*	*Gi.1*	0	0	13	4	2	0	0	0	19	0	2	13	4	19
Love	0.08	1.71	-0.57	*Ci.6*	*Gi.1*	0	1	4	8	3	0	0	1	14	1	2	7	7	16
Mod-Replace-Think	-1.41	0.13	1.72	*Ci.4*	*Gi.6*	9	6	2	5	0	0	2	12	4	4	2	13	7	22
Nostalgic	-0.14	3.02	0.22	*Ci.6*	*Gi.2*	0	1	0	9	9	0	0	2	16	1	0	1	18	19
Novelty	0.86	-1.24	0.27	*Ci.1*	*Gi.1*	0	0	19	0	0	0	0	0	19	0	16	3	0	19
Old	-1.62	-0.05	-1.12	*Ci.4*	*Gi.5*	4	10	0	1	0	1	0	1	1	12	0	3	12	15
Ordinary	-1.21	-1.20	3.05	*Ci.5*	*Gi.6*	4	4	3	0	0	0	1	7	2	1	1	8	2	11
Perfection	0.74	0.40	0.16	*Ci.2*	*Gi.1*	0	0	9	2	1	0	0	1	11	0	7	3	2	12
Pleasure	1.08	-0.88	-0.35	*Ci.1*	*Gi.1*	0	0	25	0	0	0	0	0	25	0	23	2	0	25
Prestige	0.47	-0.78	-0.67	*Ci.1*	*Gi.1*	1	1	10	1	0	0	0	0	11	2	7	4	2	13
Proud	1.02	-0.42	0.21	*Ci.1*	*Gi.1*	0	0	10	0	0	0	0	0	10	0	7	3	0	10
Reasonability	0.54	0.14	0.23	*Ci.2*	*Gi.1*	0	1	9	2	0	0	0	0	12	0	8	0	4	12
Riddance	-1.86	-1.11	-2.54	*Ci.5*	*Gi.3*	9	0	2	1	0	4	0	0	3	5	2	1	9	12
Satisfied	0.60	-0.01	-0.09	*Ci.2*	*Gi.1*	0	2	26	5	0	0	0	2	31	0	7	23	3	33
Simplicity	0.65	-0.16	-0.53	*Ci.2*	*Gi.1*	0	1	7	1	0	0	0	0	9	0	4	5	0	9
Tattered	-0.64	0.74	-1.66	*Ci.4*	*Gi.4*	0	2	1	1	0	0	0	0	2	2	0	2	2	4
Techno-Advantage	0.73	-0.15	0.12	*Ci.2*	*Gi.1*	0	1	21	2	0	0	0	0	24	0	13	8	3	24
Thirst/Discovery	1.06	-0.89	-0.57	*Ci.1*	*Gi.1*	0	0	4	0	0	0	0	0	4	0	3	1	0	4
Tolerable	-0.44	-0.31	1.33	*Ci.3*	*Gi.2*	1	14	12	1	0	0	0	12	14	2	9	16	3	28
Unaccustomed	0.30	-1.44	1.32	*Ci.1*	*Gi.2*	0	0	4	0	0	0	0	1	3	0	3	1	0	4
Variety	0.94	-1.79	-0.26	*Ci.1*	*Gi.1*	0	0	7	0	0	0	0	0	7	0	7	0	0	7

Table 3 *Kansei* items and their dimensions, belonging clusters and frequencies relevant to Iranian subjects

Subjects' Groupings and Kansei Statuses in Lifecycle Stages

In order to delineate the subjects' *Kansei* statuses concerning their mobile phone during its P, KU and R lifecycle stages, the resulted graphs of distribution of the Japanese and Iranian subjects in X-Y and X-Z axis are shown in Figures 9 and 10. These distribution graphs and the ones of *Kansei* items grouping (Figures 7 and 8) are built on the basis of the 'sample score' and 'category score' of the same output of QT3 analysis on the same input data derived from each country's subjects, and hence can be overlapped. The same names are therefore given to the directions of X, Y and Z axis in both sets of distribution graphs. The purposely chosen cut-off lines for clustering within the resulted X-Y and X-Z dimensions have yielded respectively five clusters marked from *A* to *E* and five clusters marked from *F* to *J* in the graphs relevant to Japanese subjects, and five clusters marked from *Ai* to *Ei* and five clusters marked from *Fi* to *Ji* in the graphs relevant to Iranian subjects.

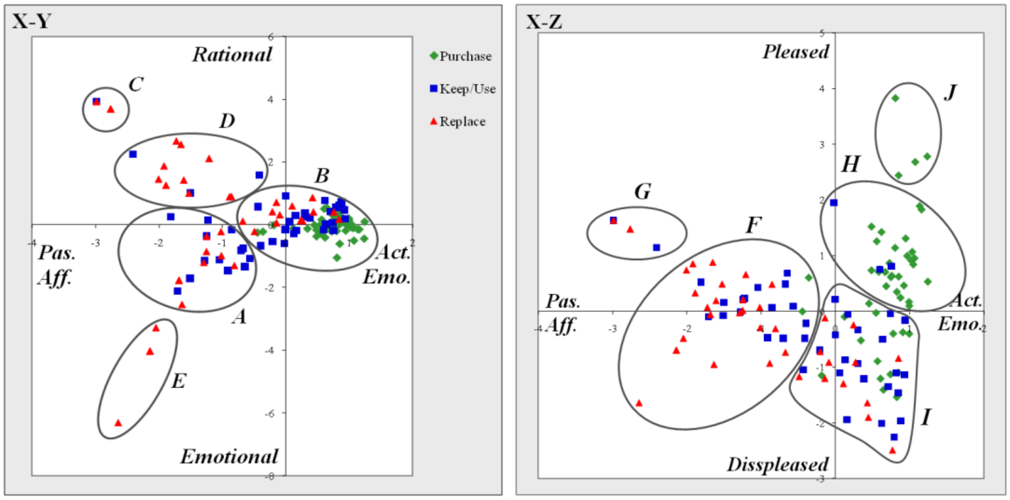


Figure 9 Distribution and groupings of Japanese subjects' *Kansei* status in the lifecycle stages of their mobile phones

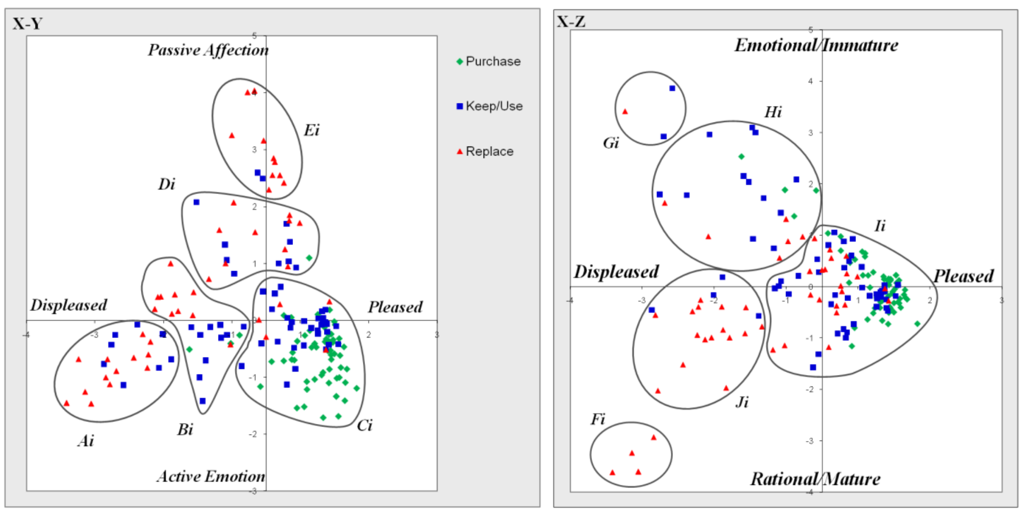


Figure 10 Distribution and groupings of Iranian subjects' *Kansei* status in the lifecycle stages of their mobile phones

According to the *Kansei* items responded by majority of the subjects belonging to each cluster highlighted in Tables 2 and 3, the following appropriate names can be given to the clusters to express each cluster's exceptional characteristic. Regarding the graphs relevant to Japanese subjects (Fig 9), the given names to clusters *A* to *E* are: Attached; Gratification/Concerns; Gratitude; Ally; and Lonely. Clusters *F* to *J* are also named as Attached/Lonely, Gratitude, Pleasant, Dissatisfied/Concerned, and Joy/Fresh. Regarding the graphs relevant to Iranian subjects (Fig 10), clusters *Ai* to *Ei* are named as Bored/Displeased, Concerned, Joy/Pleased, Attached and Affected, while clusters *Fi* to *Ji* are named as Ridded, Bored, Detached, Joy/Pleased and Dislike/Bothered.

In these graphs (Figs 9 and 10) each point represents a subject's *Kansei* status in each of the three lifecycle stages, which are discernible by three different colors and shapes in the graphs. The subjects' *Kansei* statuses in P stage are almost located in the left side of the graphs. The resulted clusters indicate each subject's *Kansei* statuses in the three lifecycle stages of his/her mobile phone.

Patterns of Subjects' Kansei Evolutions

In order to distinguish the various patterns of the subjects' *Kansei* evolution during the three lifecycle stages of their mobile phones, the clusters to which each subject belongs in each lifecycle stage (presented in Tables 4 and 5) are used as indicators for sorting the subjects into various types.

	QT3 output X, Y and Z in lifecycle stages									Dist. of 2 stages			Importance			Belonging clusters		
	P			KU			R			P-KU	KU-R	P-R	P-KU	KU-R	P-R	P	KU	R
S_1	0.92	0.07	0.46	−0.65	−1.34	0.69	−2.05	−3.27	−0.49	2.12	2.66	4.57	0	0	1	*BH*	*AF*	*EF*
S_2	0.95	−0.18	1.31	0.06	0.10	−1.10	−0.21	0.42	−0.72	2.59	0.56	2.41	0	0	0	*BH*	*BI*	*BI*
S_3	0.91	0.21	−0.38	0.64	0.01	−0.50	−0.49	−0.21	−1.17	0.36	1.33	1.66	0	0	0	*BI*	*BI*	*BI*
S_4	1.24	−0.43	2.78	−0.70	−0.81	−0.48	−2.01	1.46	0.74	3.81	2.89	4.28	1	0	1	*BJ*	*AF*	*DF*
S_5	1.16	−0.14	1.83	0.79	0.57	−2.26	−1.89	1.27	0.33	4.16	3.79	3.68	1	1	0	*BH*	*BI*	*DF*
S_6	1.08	−0.50	2.68	−1.51	−1.71	−0.08	−1.68	−1.76	−0.06	3.97	0.18	4.09	1	0	1	*BJ*	*AF*	*AF*
S_7	0.45	0.00	0.14	0.13	−0.29	−0.87	−0.14	0.07	−0.12	1.10	0.88	0.65	0	0	0	*BI*	*BI*	*BI*
S_8	0.83	−0.01	0.35	0.85	0.63	−1.46	0.27	0.14	−0.92	1.92	0.93	1.39	0	0	0	*BH*	*BI*	*BI*
S_9	0.61	0.52	−1.21	0.30	0.27	−0.33	−1.64	−2.53	−0.95	0.96	3.46	3.80	0	0	1	*BI*	*BI*	*AF*
S_{10}	1.04	−0.07	1.07	−0.41	1.59	−0.48	−1.65	2.57	0.88	2.69	2.09	3.77	0	0	1	*BH*	*DF*	*DF*
S_{11}	0.99	0.17	0.17	0.82	0.55	−1.11	0.76	0.42	−2.49	1.34	1.39	2.68	0	0	0	*BH*	*BI*	*BI*
S_{12}	1.00	0.14	0.10	−2.41	2.25	1.15	−2.76	3.70	1.47	4.14	1.53	5.36	1	0	1	*BH*	*DG*	*CG*
S_{13}	1.05	0.00	0.84	0.00	0.92	−0.42	0.10	0.61	−1.30	1.88	0.94	2.42	0	0	0	*BH*	*BI*	*BI*
S_{14}	0.12	−0.11	−0.10	0.60	−0.16	0.75	−1.29	−1.19	−0.03	0.98	2.29	1.78	0	0	0	*BI*	*BH*	*AF*
S_{15}	0.55	0.01	−0.03	0.94	0.19	−0.16	0.44	0.42	−1.90	0.45	1.83	1.92	0	0	0	*BI*	*BI*	*BI*
S_{16}	0.84	0.48	−1.10	0.16	0.29	−1.94	−1.73	2.68	0.07	1.11	3.65	3.58	0	0	0	*BI*	*BI*	*DF*
S_{17}	0.65	0.55	−1.41	0.17	−0.19	−0.05	0.24	0.15	−0.24	1.62	0.40	1.29	0	0	0	*BI*	*BI*	*BI*
S_{18}	0.57	0.17	−0.90	−1.22	0.15	0.23	−1.02	−0.98	−0.30	2.12	1.26	2.04	0	0	0	*BI*	*AF*	*AF*
S_{19}	0.76	−0.09	0.64	0.88	0.72	−1.96	−0.86	0.91	0.48	2.73	3.00	1.90	0	0	0	*BH*	*BI*	*DF*
S_{20}	1.00	0.21	−0.40	0.38	0.22	−1.21	−1.25	−0.85	0.02	1.01	2.30	2.52	0	0	0	*BI*	*BI*	*AF*
S_{21}	−0.45	−0.24	0.00	−0.68	−0.75	0.49	−0.09	0.32	−0.92	0.75	1.87	1.13	0	0	0	*BF*	*AF*	*BI*
S_{22}	0.83	0.32	−1.54	−0.57	−1.07	0.09	−1.02	−0.21	0.07	2.56	0.97	2.51	0	0	0	*BI*	*AF*	*AF*
S_{23}	0.75	0.02	0.61	0.00	0.00	0.00	0.00	0.00	0.00	0.97	0.00	0.97	0	0	0	*BH*	*0*	*0*
S_{24}	0.80	−0.19	1.14	0.71	0.42	−1.35	−0.68	0.12	−0.74	2.56	1.54	2.41	0	0	0	*BH*	*BI*	*BF*
S_{25}	0.49	−0.36	1.52	−1.28	−1.14	−0.01	−1.25	−0.36	0.21	2.47	0.81	2.17	0	0	0	*BH*	*AF*	*AF*
S_{26}	0.34	−0.12	−0.52	−2.41	2.25	1.15	0.00	0.00	0.00	3.99	3.49	0.64	1	0	0	*BI*	*DG*	*0*
S_{27}	1.07	−0.10	0.95	0.62	0.77	−2.01	−0.89	0.90	−0.93	3.12	1.86	2.89	0	0	0	*BH*	*BI*	*DF*
S_{28}	0.74	0.32	−1.13	−0.91	−1.46	−0.47	−2.65	−6.30	−1.64	2.52	5.27	7.45	0	1	1	*BI*	*AF*	*EF*
S_{29}	0.73	−0.20	0.87	0.30	0.36	−0.94	0.43	0.87	−1.64	1.94	0.88	2.75	0	0	0	*BH*	*BI*	*BI*
S_{30}	0.60	−0.16	0.75	−1.28	−1.14	−0.01	−2.14	−4.02	−0.70	2.25	3.08	4.95	0	0	1	*BH*	*AF*	*EF*
S_{31}	0.48	−0.15	0.74	−0.39	−0.67	−0.22	−1.92	1.88	0.85	1.39	3.16	3.15	0	0	0	*BH*	*BF*	*DF*
S_{32}	0.85	−0.60	2.44	−1.81	0.25	0.53	−1.53	1.01	0.49	3.39	0.82	3.47	0	0	0	*BJ*	*AF*	*DF*
S_{33}	0.88	0.11	0.25	−1.50	1.01	0.16	−1.61	1.43	0.19	2.55	0.44	2.82	0	0	0	*BH*	*DF*	*DF*
S_{34}	0.62	−0.39	1.42	−1.71	−2.11	−0.09	0.00	0.00	0.00	3.27	2.72	1.60	0	0	0	*BH*	*AF*	*0*
S_{35}	0.67	−0.12	0.71	0.75	−0.18	0.81	0.00	0.00	0.00	0.15	1.12	0.98	0	0	0	*BH*	*BH*	*0*
S_{36}	−0.19	0.00	−1.15	0.93	0.47	−1.14	−1.68	−1.76	−0.06	1.21	3.60	2.56	0	0	0	*BI*	*BI*	*AF*
S_{37}	0.85	0.03	0.62	−1.05	−1.12	0.43	−2.76	3.70	1.47	2.23	5.22	5.22	0	1	1	*BH*	*AF*	*CG*
S_{38}	0.97	0.01	1.00	−0.01	−0.15	0.22	0.00	0.00	0.00	1.26	0.27	1.39	0	0	0	*BH*	*BI*	*0*
S_{39}	0.60	−0.16	0.75	0.93	0.47	−1.14	−1.21	2.12	0.66	2.02	3.24	2.92	0	0	0	*BH*	*BI*	*DF*
S_{40}	0.68	0.02	0.45	−0.02	−0.60	1.95	−0.14	0.72	−1.21	1.77	3.43	1.98	0	0	0	*BH*	*BH*	*BI*
S_{41}	1.14	−0.13	1.89	0.00	0.00	0.00	0.00	0.00	0.00	2.21	0.00	2.21	0	0	0	*BH*	*0*	*0*
S_{42}	−0.36	−0.21	0.61	−2.99	3.93	1.63	−2.99	3.93	1.63	5.01	0.00	5.01	1	0	1	*BF*	*CG*	*CG*
S_{43}	0.81	−1.04	3.83	−0.85	−0.17	0.07	−2.14	−4.02	−0.70	4.20	4.13	6.17	1	1	1	*BJ*	*AF*	*EF*
S_{44}	0.56	−0.27	1.26	0.00	0.00	0.00	−0.81	−1.29	−0.31	1.40	1.56	2.32	0	0	0	*BH*	*0*	*AF*
S_{45}	1.25	0.11	0.53	−0.21	−0.54	−0.70	0.00	0.00	0.00	2.01	0.91	1.36	0	0	0	*BH*	*BI*	*0*
S_{46}	1.02	0.02	0.91	0.74	0.07	−0.04	−2.14	−4.02	−0.70	1.00	5.04	5.38	0	1	1	*BH*	*BI*	*AF*
S_{47}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	*0*	*0*	*0*
S_{48}	0.78	0.21	−0.40	−1.25	−0.36	0.21	−1.25	−0.36	0.21	2.19	0.00	2.19	0	0	0	*BI*	*AF*	*AF*
S_{49}	0.58	−0.17	0.71	−0.44	0.58	−1.05	0.85	0.18	−0.84	2.17	1.36	1.61	0	0	0	*BH*	*BI*	*BI*

Table 4 Dimension, distance, importance and clusters of Japanese subjects' *Kansei* in the lifecycle stages

	QT3 output X, Y and Z in lifecycle stages									Dist. of 2 stages			Importance			Belonging clusters		
	P			KU			R			P-KU	KU-R	P-R	P-KU	KU-R	P-R	P	KU	R
S_1	0.85	−0.12	0.20	0.37	−0.03	0.49	−0.47	2.07	0.89	0.57	2.30	2.66	0	0	0	*CIi*	*CIi*	*DHi*
S_2	0.73	−0.48	−0.42	−0.66	−0.30	−0.03	0.00	−0.29	0.33	1.45	0.75	1.06	0	0	0	*CIi*	*BIi*	*CIi*
S_3	0.93	0.18	0.03	−0.88	−0.70	−0.57	0.49	1.71	0.20	2.10	2.88	1.60	0	0	0	*CIi*	*BJi*	*DIi*
S_4	0.94	−0.53	−0.40	0.91	−0.43	−0.47	−0.17	4.04	0.31	0.13	4.66	4.75	0	1	1	*CIi*	*CIi*	*EIi*
S_5	0.56	−1.52	0.68	−0.81	−0.12	1.72	0.00	0.00	0.00	2.22	1.91	1.76	0	0	0	*CIi*	*BHi*	*0*
S_6	0.38	−0.69	0.08	−2.20	−0.25	2.92	−2.55	−1.46	−3.60	3.86	6.64	4.76	1	1	1	*CIi*	*AGi*	*AFi*
S_7	0.92	−0.25	−0.18	0.89	−0.06	−0.25	−0.52	−0.42	−1.14	0.20	1.71	1.73	0	0	0	*CIi*	*CIi*	*BIi*
S_8	1.14	−0.47	−0.16	0.87	−0.52	−0.03	−1.39	1.00	−0.39	0.30	2.75	2.94	0	0	0	*CIi*	*CIi*	*BJi*
S_9	0.90	−0.54	0.13	0.75	−0.18	−0.14	0.34	1.85	0.26	0.47	2.11	2.46	0	0	0	*CIi*	*CIi*	*DIi*
S_{10}	1.07	−0.32	0.12	0.36	−0.13	−0.22	−2.55	−1.46	−3.60	0.82	4.65	5.32	0	1	1	*CIi*	*CIi*	*AFi*
S_{11}	1.03	−1.02	0.07	0.83	0.01	−0.10	0.20	0.28	−0.37	1.06	0.74	1.61	0	0	0	*CIi*	*CIi*	*CIi*
S_{12}	0.63	1.10	−0.64	0.30	1.70	−0.83	0.09	2.55	−1.17	0.71	0.94	1.64	0	0	0	*DIi*	*DIi*	*EIi*
S_{13}	0.86	−0.38	0.14	−0.96	−0.25	0.93	−0.16	1.55	−0.15	1.99	2.25	2.20	0	0	0	*CIi*	*BHi*	*DIi*
S_{14}	0.92	−0.38	−0.41	0.13	0.47	−0.34	0.26	2.42	0.02	1.17	1.98	2.90	0	0	0	*CIi*	*CIi*	*EIi*
S_{15}	0.00	0.00	0.00	0.66	−0.14	−0.18	0.00	0.00	0.00	0.70	0.70	0.00	0	0	0	*0*	*CIi*	*0*
S_{16}	1.02	−1.34	0.22	0.55	−0.44	0.38	−2.74	−0.68	3.42	1.03	4.48	4.98	0	1	1	*CIi*	*CIi*	*AGi*
S_{17}	−0.52	−0.41	1.88	−0.13	2.60	−1.57	−2.28	−1.12	−2.02	4.59	4.32	4.34	1	1	1	*BHi*	*EIi*	*AJi*
S_{18}	1.18	−0.86	−0.25	−0.97	−1.00	3.10	−2.55	−1.46	−3.60	3.98	6.89	5.05	1	1	1	*CIi*	*BHi*	*AFi*
S_{19}	1.01	−0.08	−0.05	0.33	1.04	−1.00	−2.32	−0.68	−0.55	1.62	3.19	3.41	0	0	0	*CIi*	*DIi*	*AJi*
S_{20}	1.05	−1.69	0.03	0.76	0.03	−0.23	−1.33	0.46	−1.97	1.77	2.76	3.78	0	0	0	*CIi*	*CIi*	*BJi*
S_{21}	0.57	−0.27	0.22	1.02	−0.10	−0.18	−0.04	3.16	−0.25	0.63	3.43	3.51	0	0	0	*CIi*	*CIi*	*EIi*
S_{22}	0.81	−0.96	−0.14	0.31	0.04	0.37	−1.54	0.42	−0.98	1.24	2.32	2.86	0	0	0	*CIi*	*CIi*	*BJi*
S_{23}	0.71	−1.04	0.28	−0.57	−0.26	0.11	−2.34	−1.00	−2.93	1.51	3.59	4.43	0	0	1	*CIi*	*BIi*	*AFi*
S_{24}	0.59	−1.08	0.59	−1.51	−0.24	−0.16	−1.69	−0.38	−0.26	2.38	0.24	2.53	0	0	0	*CIi*	*AJi*	*AJi*
S_{25}	0.26	0.09	0.70	0.09	0.20	0.81	−1.06	0.49	−0.40	0.23	1.69	1.77	0	0	0	*CIi*	*CIi*	*BJi*
S_{26}	1.02	−1.34	0.22	−1.02	2.08	2.04	−0.50	3.25	1.32	4.38	1.47	4.96	1	0	1	*CIi*	*BHi*	*EHi*
S_{27}	0.76	0.10	−0.22	0.76	−0.23	−0.39	−1.38	0.12	−0.84	0.38	2.21	2.22	0	0	0	*CIi*	*CIi*	*BJi*
S_{28}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	*0*	*0*	*0*
S_{29}	0.08	−0.73	1.04	−0.93	−1.42	3.00	0.87	−0.52	−0.03	2.31	3.64	1.35	0	0	0	*CIi*	*BHi*	*CIi*
S_{30}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	*0*	*0*	*0*
S_{31}	0.83	−1.71	−0.66	−0.07	−0.41	0.53	0.34	1.76	0.60	1.99	2.20	3.73	0	0	0	*CIi*	*CIi*	*DIi*
S_{32}	1.00	−0.02	−0.50	0.17	−0.37	1.06	−1.80	−0.24	−0.48	1.79	2.50	2.81	0	0	0	*CIi*	*CIi*	*AJi*
S_{33}	0.45	−1.54	−0.80	0.00	0.00	0.00	−0.68	1.59	−1.22	1.80	2.12	3.36	0	0	0	*CIi*	*0*	*DIi*
S_{34}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	*0*	*0*	*0*
S_{35}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	*0*	*0*	*0*
S_{36}	0.45	−0.37	0.53	−1.38	−0.69	0.19	−2.19	−0.89	1.64	1.90	1.67	2.91	0	0	0	*CIi*	*0*	*AHi*
S_{37}	1.05	−0.41	−0.30	−0.93	−1.42	3.00	0.20	2.55	−0.50	3.97	5.41	3.09	1	1	0	*CIi*	*BHi*	*EIi*
S_{38}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	*0*	*0*	*0*
S_{39}	−0.08	−1.17	1.87	0.22	0.59	−0.91	0.00	0.00	0.00	3.31	1.11	2.21	0	0	0	*CHi*	*CIi*	*0*
S_{40}	0.80	0.03	−0.41	0.44	0.93	−0.73	−0.17	4.04	0.31	1.02	3.33	4.18	0	0	1	*CIi*	*DIi*	*EIi*
S_{41}	0.39	−0.57	0.47	0.82	0.16	−0.20	0.92	0.33	−0.27	1.08	0.21	1.28	0	0	0	*CIi*	*CIi*	*CIi*
S_{42}	0.71	−0.41	−0.51	−0.67	−0.08	0.75	0.00	0.00	0.00	1.90	1.01	0.97	0	0	0	*CIi*	*BHi*	*0*
S_{43}	0.64	−0.18	0.22	−1.56	−0.84	2.96	0.00	0.00	0.00	3.58	3.45	0.70	0	0	0	*CIi*	*AHi*	*0*
S_{44}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	*0*	*0*	*0*
S_{45}	0.66	−0.48	−0.01	0.87	−0.03	−0.10	−0.59	1.00	0.57	0.50	1.90	2.03	0	0	0	*CIi*	*CIi*	*DHi*
S_{46}	−0.52	−0.41	1.88	0.00	0.00	0.00	0.04	2.30	0.34	1.99	2.32	3.16	0	0	0	*BHi*	*0*	*EIi*
S_{47}	0.97	−0.39	−0.13	0.35	1.38	−0.89	0.00	0.00	0.00	2.02	1.67	1.06	0	0	0	*CIi*	*DIi*	*0*
S_{48}	0.95	−0.69	−0.43	−0.05	2.49	−1.31	0.00	0.00	0.00	3.45	2.82	1.25	0	0	0	*CIi*	*EIi*	*0*
S_{49}	0.26	−0.71	0.98	0.41	−0.48	0.61	0.00	0.00	0.00	0.46	0.88	1.24	0	0	0	*CIi*	*CIi*	*0*
S_{50}	−1.12	−0.51	2.53	−0.33	−0.11	0.21	0.27	1.25	−0.08	2.49	1.52	3.45	0	0	0	*BHi*	*BIi*	*DIi*
S_{51}	0.95	−0.61	0.12	0.83	0.04	−0.08	−1.93	−0.65	−1.51	0.69	3.19	3.31	0	0	0	*CIi*	*CIi*	*AJi*
S_{52}	1.09	−0.83	−0.41	−0.57	1.06	1.44	0.00	0.00	0.00	3.12	1.87	1.43	0	0	0	*CIi*	*DHi*	*0*
S_{53}	0.60	−1.22	0.65	−0.36	−0.80	2.09	−0.84	0.73	−0.77	1.78	3.28	2.80	0	0	0	*CIi*	*CHi*	*DJi*
S_{54}	0.92	−1.10	−0.73	−2.26	−0.43	1.80	0.00	0.00	0.00	4.11	2.92	1.61	1	0	0	*CIi*	*AHi*	*0*
S_{55}	0.81	0.00	−0.30	−1.09	−0.12	2.16	−1.07	0.09	−0.91	3.10	3.07	1.98	0	0	0	*CIi*	*BHi*	*BJi*
S_{56}	1.08	−0.62	−0.23	1.05	−0.42	0.04	0.00	0.00	0.00	0.34	1.13	1.27	0	0	0	*CIi*	*CIi*	*0*
S_{57}	0.92	−0.23	0.15	0.81	−0.08	−0.11	−2.64	−1.25	−3.23	0.32	4.80	5.02	0	1	1	*CIi*	*CIi*	*AFi*
S_{58}	0.95	−0.24	0.15	−2.20	−0.25	2.92	−2.91	−1.45	−3.61	4.20	6.68	5.52	1	1	1	*CIi*	*AGi*	*AFi*
S_{59}	1.32	−1.20	−0.72	−0.47	0.82	−0.15	0.00	0.00	0.00	2.75	0.95	1.92	0	0	0	*CIi*	*DIi*	*0*
S_{60}	1.00	−0.59	−0.32	−1.09	−0.12	2.16	0.13	2.78	0.56	3.27	3.53	3.59	0	0	0	*CIi*	*BHi*	*EIi*
S_{61}	1.16	−1.10	−0.21	0.30	−1.13	0.88	−2.91	−1.45	−3.61	1.39	5.53	5.31	0	1	1	*CIi*	*CIi*	*AFi*
S_{62}	0.88	−0.33	−0.10	0.87	0.19	0.03	−1.58	0.41	0.98	0.54	2.64	2.79	0	0	0	*CIi*	*CIi*	*BHi*
S_{63}	0.37	0.05	0.58	−0.05	0.51	0.28	−0.11	0.01	0.95	0.69	0.83	0.60	0	0	0	*CIi*	*CIi*	*CIi*
S_{64}	0.83	−0.92	−0.28	0.18	1.00	−0.17	0.32	0.95	−0.35	2.03	0.23	1.94	0	0	0	*CIi*	*DIi*	*DIi*
S_{65}	1.07	−1.01	−0.32	0.43	−0.85	0.93	−1.72	−0.60	−0.39	1.41	2.53	2.82	0	0	0	*CIi*	*CIi*	*AJi*
S_{66}	0.41	−0.70	−1.16	0.56	−0.01	−0.02	−1.73	−0.83	−0.94	1.34	2.60	2.16	0	0	0	*CIi*	*CIi*	*AJi*
S_{67}	0.85	−0.05	−0.25	−1.88	−0.08	1.78	−1.63	0.20	−1.02	3.40	2.83	2.61	0	0	0	*CIi*	*AHi*	*BJi*
S_{68}	−0.39	−0.26	1.37	−0.60	1.33	0.01	−1.29	0.16	−0.99	2.11	1.68	2.56	0	0	0	*BHi*	*DIi*	*BJi*
S_{69}	0.92	−0.86	−0.50	0.89	−0.20	−0.41	0.00	0.00	0.00	0.67	1.00	1.36	0	0	0	*CIi*	*CIi*	*0*
S_{70}	0.98	−0.34	−0.10	−2.37	−0.77	−0.46	0.11	2.85	0.73	3.39	4.54	3.41	0	1	0	*CIi*	*AJi*	*EIi*
S_{71}	1.15	−1.42	−0.06	−2.08	−1.14	3.87	−0.27	4.01	0.98	5.09	6.17	5.70	1	1	1	*CIi*	*AGi*	*EIi*

Table 5 Dimension, distance, importance and clusters of Iranian subjects' *Kansei* in the lifecycle stages

As each subject's *Kansei* status in the three lifecycle stages is quantifiably represented by three points specified by X, Y and Z dimensions, the distance between these points indicates the level of the subject's *Kansei* changes during the stages. Accordingly, the higher distance than 'Av.+SD' is considered important while indicating a drastic change of a subject's *Kansei* status during two lifecycle stages. The resulted Average distances, SD and the addition of these two parameters relevant to the Japanese subjects are respectively 2.27, 1.45 and 3.72 (Av.+ SD=2.27+1.45=3.72). The ones relevant to the Iranian subjects are also 2.23, 1.58 and 3.81 (Av.+ SD=2.23+1.58=3.81). As the result, the important cases of the Japanese and Iranian subjects' *Kansei* evolution during the lifecycle stages of their mobile phones being identified through their belonging X-Y and X-Z clusters in each stage are also highlighted respectively in Tables 4 and 5.

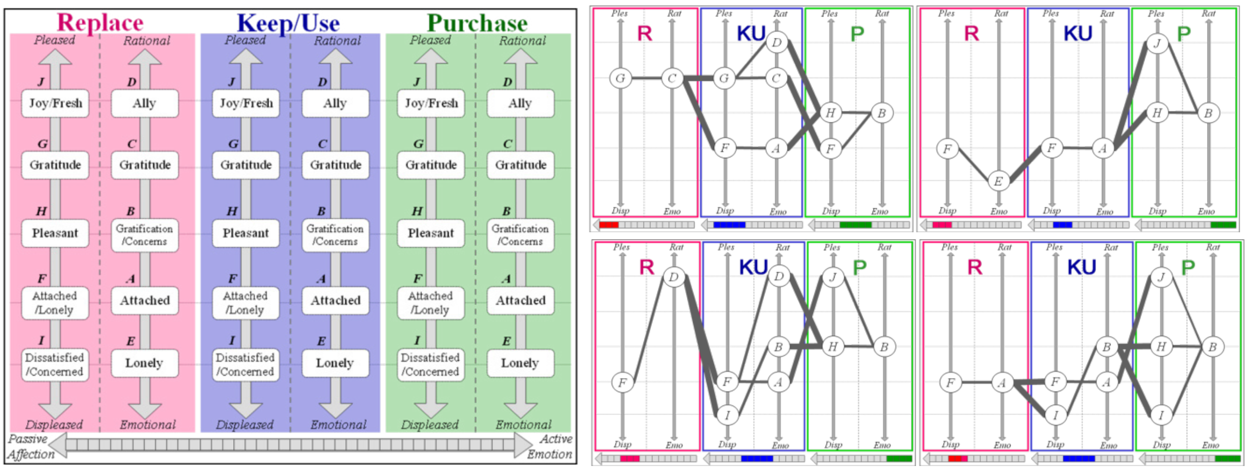


Figure 11 Important patterns of *Kansei* evolution extracted from Japanese subjects' responses

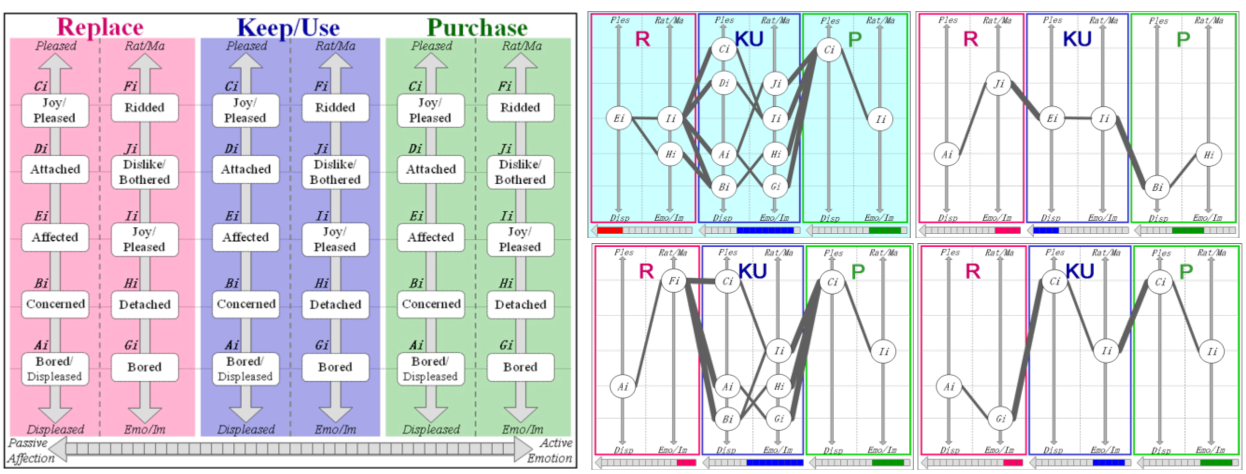


Figure 12 Important patterns of *Kansei* evolution extracted from Iranian subjects' responses

On the basis of the similarity of the clusters belonging to the important cases in R stage, namely the eventuation of their *Kansei* evolutions, these cases could be set into four main classes regarding each country's subjects. The resulted classes of the extracted patterns of the Japanese and Iranian subjects' *Kansei* evolutions during the lifecycle stages of their mobile phones are visualized into two diagrams respectively shown in Figures 11 and 12. The colored part in the scaled arrow located below each stage in the diagramed classes is to indicate the position of the ongoing clusters in that stage beside '*Passive Affection - Active Emotion*' directions. As there is a reversely similarity between the axis directions in the distribution graphs derived from the Japanese and Iranian subjects' responses, the axis (X-Y-Z) directions order relevant to the Japanese subjects is considered as the base in the format of diagrams. Accordingly, in the diagram relevant to Iranian subjects (Fig. 12), the axis directions are adapted to the same order as Japanese subjects' one to be more easily comparable. As the result, the eventual *Kansei* statuses in all four classes of the patterns extracted from the Japanese subjects' responses are good or positive, whereas such statuses in the classes extracted from the Iranian ones are almost negative. However, just in one class relevant to the Iranian subjects, which is highlighted in Figure 12, there is a low degree of positivity namely eventual affective relation.

Interpretation and Discussion

Iran and Japan have two quite different contexts of mobile phone market. In Japan, the presented mobile phone devices are almost the regionally localized product designed specifically for Japanese users while the carriers are offering the very advanced and wide services. But the presented mobile phone devices in Iran almost belong to the global market. The Iranian mobile phone users are bereft of so many services such as internet, online search and navigation. Comparing with last 5 years, the number of mobile phone users is drastically increased in Iran. Nowadays the Iranian students almost have their own mobile phone, whereas 5 years ago only less than half of them had it (Zafarmand, Sugiyama, Watanabe, & Ono, 2006b).

As the general results of investigation show, mobile phone is approximately a short-lived product in both countries. However, its lifetime is actually a little longer in Iran than Japan. Considering the contextual differences between Iran and Japan from socio-cultural, economic and industrialization points of view, the Japanese subjects' backgrounds and experiences in mobile phone use and replacement are naturally higher than the Iranian subjects. But mobile phone replacement reasons in Iran are more various than in Japan; seemingly the more standardized individuals belonging to a more industrialized country. In both countries, the similar top/main reasons for replacing mobile phone including 'defect', 'broken' and 'oldness' are almost actual, rational or somehow objective. Nevertheless, for the Japanese users 'novelty' and 'service' and for the Iranian users 'facilities', and 'form' are also among the top main reasons of replacement. Majority of both countries' subjects are satisfied with and interested in their current mobile phones. However, in Japan the percentage of those being satisfied is lower than of those liking their current mobile phones, but in Iran vice versa.

The *Kansei* items derived from the investigations of the Japanese and Iranian subjects despite of having some similarity are not the same. This point emphasizes the highly effect of context socio-culturally and linguistically on a user's *Kansei* about a product and his/her responded words in this regard. As the distribution graphs of the items (Figures 7 and 8) show, the main axis (X) directions relevant to the Japanese and Iranian subjects, which generally identify the most ongoing reciprocal trend of the items derived from each context, are not the same. The one relevant to the Japanese subjects is 'Active Emotion - Passive Affection', whereas the one relevant to the Iranian subjects being 'Displeased - Pleased'. Furthermore, numerous clusters of the items are located near the directions of 'Passive Affection' in the graphs relevant to Japanese subjects and of 'Displeased' in the ones relevant to Iranian subjects.

A pattern of *Kansei* evolution eventuating in a cluster of *Kansei* items with a positive *Kansei* status indicates a state of PSjS. As all of the classes of the patterns of *Kansei* evolution extracted from the Japanese subjects' responses have eventuated in the positive statuses, there is seemingly a tangible state of PSjS in mobile phone market of Japan. Unlikely, most of the classes of the patterns of *Kansei* evolution extracted from the Iranian subjects' responses have eventuated in the negative statuses. Therefore, it seems that product subjective un-sustainability is an ongoing issue in mobile phone market of Iran. Nevertheless, there is a low or potential degree of PSjS in one of the classes relevant to Iranian subjects.

Combining the X-Y and X-Z clusters of the subjects' *Kansei* status in R stage regarding the resulted classes of the important patterns of the subjects' *Kansei* evolution, on the one hand, there are four main trends of PSjS being ongoing in mobile phone market of Japan. The first one identified by clusters *A* and *F* characterized as Attached and Attached/Lonely can be called <u>Affectional Attachment</u>. The second one identified by clusters *C* and *G* both characterized as Gratitude can be called <u>Gratification</u>. The third one identified by clusters *D* and *F* characterized as Ally and Attached/Lonely can be called <u>Rational/Associational Attachment</u>. And the last one identified by clusters *E* and *F* characterized as Lonely and Attached/Lonely can be called

Emotional Attachment. The above-mentioned three kinds of attachment imply that there is a clear demarcation between various kinds of relationship, which could be in affective, collaborative and/or emotive way between a user and his/her object as well as human, and the consequent attachments in Japan.

On the other hand, there are three main trends of product subjective un-sustainability occurring in mobile phone market of Iran. The first one identified by clusters *Ai* and *Fi* characterized as Bored/Displeased and Ridded can be called Affectional Detachment. The second one identified by clusters *Ai* and *Gi* characterized as Bored/Displeased and Bored can be called Boredom or Emotional Detachment. The third one identified by clusters *Ai* and *Ji* characterized as Bored/Displeased and Dislike/Bothered can be called Emotional Objection/Dissatisfaction. However, there is also a potential trend of PSjS in Iran. This potential trend can be identified by cluster *Ei* characterized as Affected in R stage followed by clusters *Ci* or *Di* and *Ii* characterized as Joy/Pleased or Attached and Joy/Pleased in KU stage. As this trend involves a degree of affective, emotive and/or associative relation with mobile phone at the same time, it can be called generally Psychological Attachment. Therefore, unlike the Japanese subjects, the Iranian subjects' responses have not indicated a clear demarcation of the various kinds of affective, collaborative and/or emotive relationship with their mobile phones and the consequent psychological attachment. Such a point reemphasizes the highly effect of context on PSjS.

Conclusion

The actual lifetime of Mobile phone, as an approximately short-lived product, is not the same in different contexts. The majority of Iranian users cannot afford to quickly replace their mobile phone, even though they don't like it. Despite of the longer actual lifetime of mobile phone in Iran than Japan, product subjective un-sustainability is seemingly an ongoing and egregious problem in mobile phone market of Iran. This point led us to conclude that PSjS is not necessarily analogous to a longer lifetime of product. Product subjective un-sustainability at least has three main trends including: Affectional Detachment; Boredom or Emotional Detachment; and Emotional Objection or Dissatisfaction. On the other hand, PSjS has at least four major trends including three different kinds of attachment and a state of gratification. Attachment, as the most important trend of PSjS, may appear into the following levels: deep, permanent, passive or affective; partnership, association or collaborative; and shallow, temporary, active or emotive. Besides, the trend of gratification indicates a good utility of mobile phone and at the same time cherishing it as an important and valuable object. In order to extend the subjective lifetime of mobile phone various design solutions or means being fit to the above-mentioned trends of PSjS should be applied. According to the findings of this research, PSjS in fact is not necessarily the issue of a constant *Knasei* toward a product. Rather, it would be the result of various emotions, feelings or moods, etc regarding a product and their evolution while being mostly good or pleasant or dynamically positive and becoming mature alongside the product's expected lifespan being over.

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Dealing with the human-centered approach within HCI projects

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Abstract

Our interactions with objects or/and systems through digital screens are constantly increasing. Industry and information technology have more and more ambition toward offering new functions and interactions through these computerized systems. At the same time as the complexity of these systems is escalating, the complexity in designing them also grows. While user-centered approaches and usability in the area of human-computer interfaces (HCI) have been thoroughly researched for more than a decade now, we still encounter regularly unsatisfying interfaces. It is generally recognized that the design of HCI within multidisciplinary teams brings better answers to users. However as design practitioners, we see the inadequacy when it comes to working with other disciplines, at the conceptual level, and in creating shared understanding and new knowledge regarding user-centeredness. The paper explains what factors contribute to user-centered design and how we can see the inadequacy within multidisciplinary teams. Aiming to create the conditions for knowledge sharing and emergence of innovative and sustainable solutions, we propose a model called environment for reflective collaboration that encourages interdisciplinary attitude and allows for achieving joint reflective practice. Both seem necessary for dealing with the complexity of HCI. In this model, design is used as a method to understand people. Applying this design process in the early stages of a project provides the needed structure for collaboration. We explain the model as used in a real project, and we explain how a project-grounded approach helped the team bridge theory and practice.

Keywords

User-centered design; HCI; Interdisciplinary; Project-grounded approach.

As users of a variety of digital devices, we are witnessing an ongoing development of human-computer interfaces (HCI). While digital technologies are transforming lives, each one of us can recall occasional dissatisfaction. User-centered approaches and usability have been thoroughly researched in the area of HCI. Also it is known that it is crucial to develop HCI within a multidisciplinary team (Dourish, 2004; Löwgren & Stolterman, 2004; Preece, Rogers, & Sharp, 2002). However as design practitioners, we encounter conflicting situations: within multidisciplinary teams, members have difficulty in agreeing on the needs and motivations of the user, on usability issues, and on creating shared understanding.

It is generally accepted that unsuccessful design is a direct result of an inadequate approach at the conceptual level, and in many cases, the inadequate approach is caused by problems of communication and understanding among team members (Carrara, Fioravanti, & Nanni, 2009; Kleinsmann, Valkenburg, & Buijs, 2007). In our practice, we have witnessed that HCI specialists (who, in many cases, are computer scientists) and designers have a different understanding about users' interests and needs as well as usability. We have also noticed that HCI specialists and other participants of these multidisciplinary teams are mainly concerned with their own expertise, making it very difficult to consider the end user.

In this context, how can we create the conditions for a variety of contributing experts to go beyond their individual knowledge, thereby enriching their reflections in order to efficiently collaborate within a human-centered design? The idea is that their enriched knowledge will then contribute to a more successful design, and to the development of the project in a timely and more economically efficient manner.

What contributes to user-centered design?

Early interfaces were technology-centered, made by engineers in order to be used by experts like themselves (Carroll, 2000; Linard, 2001). In the beginning, as the computer's time was more expensive than people's time, efforts were focused on making more efficient computers rather than making them more usable for users (Dourish, 2004). With early software interfaces, in the 1950s and 1960s, the communication with computers was by code, based on the mathematical model of computers (Boyarski & Buchanan, 1994). During the 1970s, communications were cognitively based, which means they were based on task requirements (Linard, 1998). It was only later, around 1983, when the Internet appeared that we started seeing interfaces based on users' needs, related to the context of use, and activity of the user as Mark Weiser mentioned in1988 (Weiser & Brown, 1996): "The important waves of technological change are those that fundamentally alter the place of technology in our lives. What matters is not technology itself, but its relationship to us". Yet human-computer interfaces are still mostly developed with a technology-centered approach (Carroll, 2000; Dourish, 2004; Linard, 2001).

With the development of information technology, an interest in the active user and in activity theory also grew. The designers of human computer interfaces (HCI) found themselves confronted with new demands of users, which were created by the evolution in Information Technology (IT), and by the lack of performance of the classic engineering-type interfaces (Linard, 1998; Norman, 1988; Winograd & Flores, 1986).

The fast development of information technology, along with users asking for an easier and more efficient interface, contributed to the creation of a new design domain called 'interactivity design', which is defined as "The shaping of use-oriented qualities of a digital artifact for one or more clients" (Löwgren & Stolterman, 2004). This new domain combined interests form many disciplines including business, technology and engineering, psychology, interaction, design, media and culture. It became clearer that interactivity design was about humans and the way humans understand information technology.

With the technological advancement of HCI, the disciplines of ergonomics and cognitive psychology became highly involved in studying users' needs and performance with the use of interface and interactive devices, which contributed to the move away from technology-centered design and to the shift to a focus on the human being. The following definition by Boyarski & Buchanon (2000) shows the focus on users: interactivity design is: "the synthesis of many traditional and new elements of design thinking, leading to products that provide intelligent and emotionally satisfying experiences serving a wide variety of human needs."

Inadequacies

With the growing number of non-specialist users of computers and interactive devices, around 1995, companies started to see the need to better understand users. They brought together project teams composed of a variety of people with different expertise. However, as Preece et al. (2002) mention, the communication and collaboration between the team is not easy. "The more people there are with different backgrounds in a design team, the more difficult it can be to communicate and progress forward the designs being generated." The reason seems to be that people from different backgrounds have different perspectives and different ways of talking about things; what is valued by one person maybe of no interest to another; the lack of a common language creates confusion and becomes the source of disinterest and dissatisfaction regarding the exchange of ideas. Communication and collaboration become almost impossible. This communication difficulty is similar to what we have experienced on many occasions throughout our practice.

To better serve users, a number of researchers have suggested new ways and techniques for a user-centered design. However, in our practice we have remarked that it is difficult to use those techniques thoroughly within a multidisciplinary team. The encountered difficulties are, in most cases, that team members fail to see the advantages of using such new ways and that they are not committed to user-centered approaches. In this situation, it seems essential that we need to create a situation where sharing knowledge among team members becomes natural and easy.

Aims

In HCI projects, to increase the efficiency of the user's experience, project members should consider the user in all phases of the design process, from the early stages of a project (Carroll, 2000). In addition, it is well accepted that the design of any interactive system is a multidisciplinary activity (Löwgren & Stolterman, 2004). We find essential to consider the following four factors: the uniqueness of each project, the continuous change of user needs, the rapid development of information technology, and that we are dealing with complex and messy situations. We believe that to design with usability and sustainability in mind, the multidisciplinary project team needs to, not only consider these four critical factors, but also understand the relationship between them.

An efficient communication seems to let us deal with these factors. However, searching for effective ways of communication between disciplines has been a concern for researchers, trying to find a new language that could go beyond the subjects of individual specialists: a language that could be understood by all would allow for the exchange of knowledge and design outside the boundaries of individual disciplines.

As a team, we need fluid communication between disciplines and exchange of knowledge, which means to move toward interdisciplinarity. According to Morin (1994), the interdisciplinary approach supports dialogue and the exchange of knowledge, analysis, and methods between two or more disciplines. It also implies interaction and a mutual enrichment between specialists. By agreeing on the needs and motivations of the user, by sharing knowledge and by constructing new knowledge, the team can become committed to each other and to interdisciplinarity.

Design activity in HCI

With a particular focus on the design of interactive devices, researchers in this field generally accept that 'design' is not something that can be narrowly defined. In that respect, of main concern to the HCI community is user-centeredness and the various approaches and techniques offered. Carroll (2000) recommends the scenario-based design method, which he defines as follows: "scenarios are concrete stories about use". Referring to Schön, he says, "scenarios evoke reflection-in-action".

From a cognitive point of view, Visser (2006) mentions that design, in the context of HCI, has specific characteristics that distinguish it from other cognitive activities. She explains that design takes different forms depending on its main purpose. For her, from the perspective of computer science and cognitive design research, design can be characterized as a problem solving activity with the following aspects: that design problems are ill-defined problems (or in Simon's terms, ill-structured); design problems are complex and cannot be decomposed into independent sub-problems; design problems have several acceptable solutions, which are more or less satisfying; analysis of the problem and elaboration of the solution are not two consecutive stages, rather they progress in parallel; for their activities, designers cannot rely on a pre-existing plan: they need to use opportunities related to different design situations; and, designers reuse knowledge from previous design projects.

Although the above list does not mention the multidisciplinary aspect of design activity and all issues related to collaboration leading to design solutions, the author also explains that design always requires the integration of information, knowledge and competencies from several domains.

The activity of design, as Boyarski (1998) brought up, is also practiced by other disciplines that include engineering, computer science, and information technology. In that respect, today partnering with these disciplines is common practice. However, communication between various disciplines is still problematic. The question remains how design activity can lead to a better exchange of information and construction of new knowledge for the project?

In project situations, although the team shares the overall objective, each team member has a particular goal towards which her/his effort and focus is directed. Team members' interests may even be in conflict in some situations. Nevertheless, when the issue is designing HCI, it is fundamental that all disciplines exercise and integrate a user-centered approach in every aspects of the project. This idea has been gaining acceptance by many researchers. User-centeredness cannot simply be a tag phrase used in a general sense in discussions; rather it must be applied to achieve specific concrete goals. Consequently, adherence and engagement of all team members to the approach is needed. This means bringing team members together to work constructively and efficiently, with common understanding of goals. For Boyarski (1998), there is need for an ‘interdisciplinary attitude’, by which he means “integrating approaches from other disciplines, allowing ‘multiple sighting’ on a problem”. This suggests that all team members should participate in the design and should think about collaboration and sharing knowledge as an important element for the development of new ideas, processes, and working relationships. It means that each team member could engage thoroughly in the project, to propose solutions which cross boundaries in such a way that others not only understand, but also to which they can adjust their own solutions accordingly.

Research methodology

The research has been developed in the context of a professional design project in order to understand what really happens during the process of collaboration. The focus of the research was on the design approach and on the interaction between experts and non-experts participating in the design of a website interface.

As designer-researcher, we wanted to know what discussions and activities were fruitful or fruitless; what approaches were acceptable by all and carried out successfully or unacceptable and abandoned; in meetings, what motivated the collaborators to participate fully and in a constructive way or what made them become passive; and, what tools were helpful for demonstrating and understanding the complexity of the project (including design process and collaboration). The design research method, ‘Project-grounded research’ (Findeli, 1998, 2004) was privileged for this study. This kind of research, first called ‘Research through design’ by Frayling (1993), is about developing knowledge and theory related to design activity by going through a real design project. It conciliates theory and practice. In other words, conducting research and constructing knowledge become part of the design project.

This approach allows the development of our project towards the two poles ‘research through design’ and ‘design through research’ as Jonas mentions (2006, 2007). In recent years, this type of research has become a method also privileged among some researchers in HCI (for example, for Zimmerman and Forlizzi 2008, Löwgren 2004, and Fallman 2008). Fallman (2008) also brings up the two concepts: ‘research-oriented design’ to describe the user-centered design approach generally applied in HCI practice, and the concept of ‘design-oriented research’ “where research is the area and design the means”. In other words, by involving design activities in the research process, new knowledge is produced. Löwgren and Nagai (2008) talks about practice-based research and asks if we can construct knowledge about a phenomenon by designing for it. For Zimmerman and Forlizzi (2008), the research through design approach offers several benefits that compliment HCI research such as addressing wicked problems and allowing an “ongoing dialogue on what a preferred state should be”.

This research approach can deal with ‘wicked’ problems (Rittel & Webber, 1973), contrary to techniques of science and engineering, which deal with ‘tame’ problems. Alexander, Simon, and other thinkers also pointed out this distinction between design and science as we can see in the following well known quotes: “Scientists try to identify the components of existing structures, designers try to shape the components of new structures.” (Alexander, 1964) and “The natural sciences are concerned with how things are… design on the other hand is concerned with how things ought to be.” (Simon, 1996).

It is common practice today to bring together a multidisciplinary team, in a virtual or face-to-face setting, for solving various parts of the problems related to a design project. However, team members often have difficulties with sharing knowledge. They each have their own knowledge, operating procedures, their own ways in which they communicate about the design, and how they make representations of their ideas (Klinsmann et al., 2007).

Design activity, therefore, should take into account all contributing disciplines but also all human factors related to cognition, social and cultural influences. As Boyarski mentioned, (1998) “without primary consideration for the people using the artifacts we design, and the context for their use, –in short, the entire experience of use– we relegate design to a marginal and self-serving activity.” In HCI, this concern for the user is what distinguishes design disciplines from computer science and also from other ‘problem owners’ (for example, managers and clients).

Design model

Based on *interdisciplinary attitude* and *joint reflective practice* we introduced a design model (figure 1) geared to facilitate collaboration and knowledge sharing among team members of a complex project, while positioning the user at the center of the design process. The model, *environment for reflective collaboration*, allows for the construction of collective knowledge, which will be achieved by collaborative learning opportunities that combine theoretical and practical aspects.

a. the *interdisciplinary attitude* will allow openness to other perspectives and a willingness to share information. It means shared commitment, acceptance of approaches from other disciplines, and looking at the problem from various perspectives (Boyarski 1998). For us, the interdisciplinary attitude is the mind-set that encourages an informal teaching and learning dynamic. Once the information is contextualized (for the project at hand), it will be easier for all team members to understand diverse perspectives and to see the relevance of diverging viewpoints. To achieve good understanding as a team, the individual team members need to interact with others, and through a continuous process of learning each other's roles, responsibilities, priorities and practices, they will become aware of diverse aspects of the task (Gero & Kannengiesser, 2003). This process will encourage the team to adopt an attitude of critical thinking. As the team members become more familiar with the situation and with each other, interaction and collaboration become natural. We expect that through the commitment to an interdisciplinary attitude, the team will become more engaged in all aspects of the project.

b. through *joint reflective practice*, we bring together diverse knowledge and skills, allowing the team to notice interconnected problems, construct new knowledge, and to formulate the situation differently. HCI design situations are complex and problems are interconnected. The complexity is increasing continuously as we have to design for very diverse end-users of technology. So the design tasks require the confluence of a variety of expertise. As more people become involved in the design process, we also see more value conflicts. Schön (1983) emphasizes the "complexity, uncertainty, instability, uniqueness, and the value conflicts" of situations of professional practice and explains that these situations are not problems to be solved. They are problematic situations, which are uncertain and unclear, but they need to be understood. As reflective practice is associated with learning from experience, it will allow the team to change its perspective, gain new knowledge, and challenge the concepts and theories by which they make sense of knowledge. As a consequence of joint reflective practice, a project-specific team will bridge different understandings and through intense team interaction will produce new knowledge to deal with uncertainty.

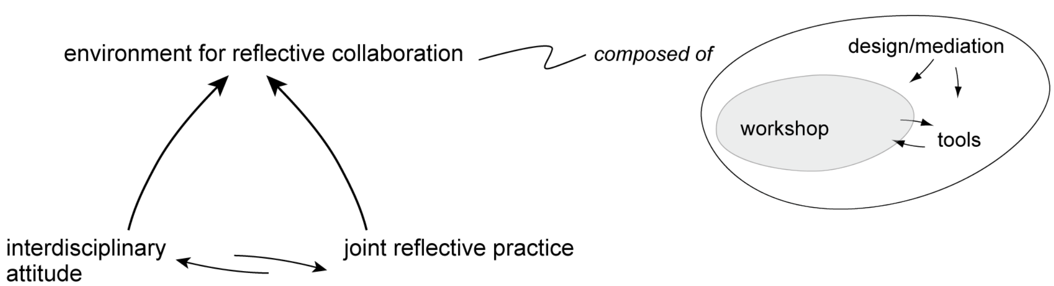

Figure 1: ERC, based on interdisciplinary attitude and joint reflective practice

Both the interdisciplinary and the reflective attitudes are essential for linking the knowledge of an individual team member to others in order to stimulate emergence of team expertise. We support this process with our proposed model *environment for reflective collaboration* (ERC). The model has the following objectives:

- to encourage contact between actors
- to incite knowledge sharing and develop a holistic vision
- to encourage critical thinking and direct feedback
- to reach consensus
- to make resources readily accessible to all at the opportune moment, and
- to advance the project in an efficient manner, on time, and while respecting the process

This model allows for collaborative learning opportunities that combine theoretical and practical aspects. It is composed of the following three elements:

- An intensive workshop to encourage joint reflective practice and collaboration, composed of a series of activities organized at the onset of the project
- Tools to support knowledge sharing and team performance (i.e. visual representation of processes, systems like wikis for contribution and access to information, etc.)
- Design as a method to facilitate collaboration and understanding between people

The workshop, the tools and the designer in the role of facilitator –to apply design as a method–, are strongly related.

The research was carried out through a real design project of a complex website for Princeton University. The design project became our field of research. This means that the theory was situated in the project and its implication on practice was directly observable. As we become more engaged with the project and the research, new questions emerged and modified the research throughout the project.

The client approached us to redesign a website. The existing one was designed a short time before this intervention, however it had technical flaws which seemed to be the single reason for the client's request to redesign. A careful analysis of the website made it clear that it was designed following the administrative structure of the institution and very elaborated visual elements were used to make the website attractive to users. Although most content was valid for reuse, the site had several shortcomings from a user point of view, including deficiencies for those who had to feed the site and keep it updated. These people, (who are another type of users), were not computer specialists. They were office staff members who had the responsibility of updating the site daily. They were also in direct contact with end users of the site and received regular feedback. A functional site was urgently needed to serve both groups, but very limited time was available for redesign and development of the website. However, the time constraint in this case was of help; the client accepted to make everyone involved in the project available for the redesign and the development of the site. The availability of these people for a set period of time was the needed condition for applying the mentioned design model through which, we aimed to translate disciplinary collaboration into new knowledge construction, useful for the purpose of the project.

A project team composed of eleven persons including office staff members, content experts, higher management, web programmers, and a designer was created. However, in most activities the workshop functioned with 6 or 7 team members. Based on the previous analysis of the project (i.e. through the design brief, meeting with project owners, research), its estimated complexity, and the knowledge about the team, the workshop was planned for 6 days.

The collaborative design process started with the intensive workshop. All project members were invited to engage in the predesigned activities in order to achieve the mentioned objectives.

We prepared a set of activities (e.g. creating personas, writing use scenarios) to support the collaboration during the workshop and planned to facilitate its progress. Visual representations of design and development process were shared with the team. Also the team developed a web-based system for gathering information about the project, which could be accessed when needed. As the main goal of the intensive design workshop was to redefine the information architecture of the site with a user-centered approach, it was clear that a common understanding of users' interests and needs was essential. The team participated in all activities and design activity became a method for better collaboration.

Discussion about the process helped the team to share information and develop a common understanding; it also helped them to realize the complexity of the project. The team worked together in redefining the objectives and priorities of the site and the methods to achieve them. They used their personas and use scenarios to structure the information architecture of the site, and to plan future steps. The team's focus remained on the users as it can be seen in the following anecdote regarding personas: After brainstorming, 5 sets of characteristics were defined. The team created silhouette-shaped cardboards for each persona, marked their characteristics on the cardboards, added a face and gave a name to each of them. During most activities and discussions, the cardboard silhouettes were placed on the table as if they were also assisting the meetings. In a few occasions while the team was working on the information architecture of the site, a team member (one of the office staff members) suddenly made comments on behalf of those personas and suggested a different solution.

We carried out the following roles: first as designer, we analyzed the project and designed, not the project, but the ERC (the workshop, the activities, the tools). Then as a mediator, we ran the workshop (created the activities and brought the team together to collaborate, made a synthesis of each step of collaboration, modified activities to fit the on-going project development, and supported the team to reach consensus). Finally, we worked on the actual project. Our research activity continued during the workshop: as designer-researcher we needed to learn from the situation in hand, to evaluate the actions and adjust new ones.

The principal expected results of the workshop were: better definition of the project where parameters and priorities were clarified, access to new knowledge, user-centeredness, and higher level of collaboration among the team. These elements led to a faster process for design and development and a more sustainable end-result focused on users.

Through the project-grounded research it became clear that the designer-researcher need to have an overall familiarity with the variety of disciplines involved in the project and be able to see the complexity of the situation rapidly. The research also showed how design could actively modify the project members' visions in order to promote the exchange of knowledge, while ensuring that the design activity remains concentrated on the user.

We noticed two main difficulties: 1. some specialized vocabularies, which were not understood by all team members, made participating in the discussion difficult. 2. some information and shared knowledge came at a wrong time, or with too much details when the team was not yet ready for it. Although later in the process the information was essential, at the time it created confusion and changed the focus of the collaboration. It became clear that because of the uniqueness of each project, adequate activities and tools needed to be designed for each situation. Examples of these tools are: visual representations of processes, systems for contribution and access to information (such as wikis), and tools for project coordinating (such as Basecamp), which give access to the on-going and growing knowledge of the project and which help its management.

Through this model, we sought to build the particular sense and the know-how for the project, to enrich and harmonize the understanding of the users' needs and motivations, and to create conditions for interdisciplinary exchange. We noticed that the dynamic and the productivity of the ERC depend not only on how the workshop plays out, but also upon the effectiveness of the designer/mediator to facilitate the events and to prepare and adjust the tools.

By achieving an interdisciplinary attitude along with a joint reflective practice, it became possible to encourage the design team, in the early stage of the project, to approach the design problem with a research stance, while keeping their focus on the end-users.

Conclusion

Applied to the mentioned project, the ERC model showed how the intensive collaboration of the team at the very early stage of the project, coupled with the mediation of the designer, directed the project toward a human centered design, reduced significantly the development time, and added value to the project by becoming a sustainable design.

We wish to turn back to the purpose of design research as explained earlier. The outcome of design research should satisfy the design research community, design practice community, and design education community. Clearly for each of these communities, the produced knowledge may have different value and relevance (Findeli, 2008). In other words, at this point, we are interested in the produced theoretical knowledge for the research, and the applicable knowledge for the practice.

The aim of the inquiry was to explore the design activity in the area of HCI and to develop a new methodological model intended to assist multidisciplinary teams designing thoroughly user-centered interfaces. This knowledge would be useful for a practitioners' community. It became clear that achieving this goal might only be possible by engaging all project team members in a joint reflective practice in the early phase of design. The joint reflective practice would lead to enhancing the shared understanding of the project, in clarifying the problematic, and in making the knowledge that is retained among stakeholders accessible to all. Finally, it stands to reason that only by bringing different and controversial viewpoints together does the framing and resolution of such complex design problems become possible. This is to say, by creating an environment that empowers the team to adopt an interdisciplinary attitude, new ideas for solving problems emerge.

However the activities geared to support the interdisciplinary attitude, as well as the joint reflective practice, which are the foundations of our suggested model, need to be designed and facilitated. For us, the designer should ensure this facilitation for a number of reasons that are related to her/his expertise as a designer. These include, among others: she/he is trained to develop a holistic view of the situation despite it's wickedness and fuzziness, has skills to diagnose problem areas, can communicate visually, can rapidly develop mockups and prototypes that would be used as tools for helping teams exchange ideas, and (referring to Cross, 1993, 2001), has a 'designerly' way of thinking, knowing and acting (referring to the specific tacit know-how of a designer). The designer needs to be trained for this new role that we call designer-mediator. Therefore it becomes important to consider the outcomes of research in design education. Additional knowledge and a set of new skills will be required: for example, to enable the designer to organize and run the environment, to facilitate the interactions among the team, to facilitate the achievement of the needed attitude, to keep the team focused on the goals, to create a synergy, to mediate the informal situation of learning and teaching, and so on.

Our next step is to present the model to three practitioners for peer review and validation. We will create a short questionnaire to verify if they deal with similar frameworks. Then we will discuss the process in detail to see if the model fits in their practice and if so, what makes the model sustainable in their practice. As raised by Manzini (2008) the transition toward sustainability is by "a radical change in ways of being and doing."

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Inspiring from the Works of Other Architects in Reinforcing Students' Creativity

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Abstract

The present article investigates "the role of influences of other architects' works" as a learning tool in order to improve the creativity of the architecture students. Firstly, the definition of creativity is discussed and then the view points of creativity in the sphere of architecture follows. Secondly, a model is presented on the need of the presence of creativity in the deep layers of a creative architectural work. In the presented model, the need of the element of creativity, at least in three major phases in the deep layers of an architectural work, will be explained.
Afterwards, the concern of "influences of other architects' works" is discussed by considering two main states of conscious and subconscious forms and then the article concludes that unlike the orthodox view point of some architecture teachers who believe that "influences of other architects' works" blocks the innovative architectural ideas, it can play a major role in at least two stages of the presented model of creativity and increases the possibility of reaching creative solutions by the architecture students.
As a supplementary, and to clarify the point that the treatment of teachers for the so-called influences has to change as students' cognitions of architectural works change, the concept of "cognition " itself will be discussed.
It must be mentioned that in some cases, the author has made use of polls containing the views of both the teacher and the student about the case study. These polls were answered by 10 architecture teachers of Tehran University and Shiraz University of Iran who had a broad experience in teaching the architecture material and also 40 students who were recently graduated from the colleges.

Keywords: creativity, architecture education, precedent-based design, cognition, the process of architectural design

In the present time, through a day by day progress in public media and information technologies like satellite TVs and the Internet, the subconscious influences on students made by other architects' work – either local or international – has been a challenging issue in Iranian architecture colleges. Sadly, by following orthodox view points, not only have problems been doubled but the quality of architectural education has also been challenged for the worse. As it may be expected, the side effects of this educational problem have affected the architectural businesses and have resulted in low-level imitations which have degrade and threaten Iran's contemporary architecture. (Zakeri, 2007, p107)

It seems obvious that a good resolution for this issue in architectural colleges, both fundamental and wise, must be investigated thoroughly. A good solution not only answers the questions of students and teachers when they face the issue, but at a higher level will suggest solutions in a wise, true, and constituent way for what that many professionals believe is threatening Iran's contemporary architecture system.

Due to the above challenges, the need for a deeper and more thorough investigation of the "influences of other architects' works" has to be clarified. The main purpose of this research is to measure how the subconscious influence of other architects' works, that results in blind imitations in architectural practices, where no teacher can review the works and turn it to a chance for creative inspiration that might create a better architectural education.

The need and importance of the issue

In the current conditions imposed by globalization and the everyday progression of information technologies like satellite TVs and the Internet, the process of familiarization and collecting information about architectural works for the architect–has achieved a new form and speed. If in the past this process was subject to voyages and personal encounters, or information being obtained from the books that were published *after* an architectural landmark was born, then today we clearly see that even before a project starts, architectural images are easily available both from the media or the Internet for the public to see. Such incomplete visions which often have immediate influence on the young minds of architecture students has caused very unfavorable effects on the quality of education in most architectural colleges of many developing countries such as Iran in the last decades. On one hand the youthful architecture students believe that they belong to modern times and have a burning desire to see the works of so-called avant-garde architects and look forward to seeing as many as works as they can from the media. On the other hand a lot of architecture teachers, due to their personal rules of creativity development, do not like what happens to their students. They think it may lead to blind imitation which is harmful for Iranian traditional architecture. They may suggest that students should be allowed a free and open-ended regime in which free expression is encouraged.

Figure 1 compares the interest in using internet to see the works of western pioneer architects, both for the teachers and the students. The figure partly shows the doubts and disagreements of many teachers regarding the issue. In the same time, most of the students showed interests to the issue indeed.

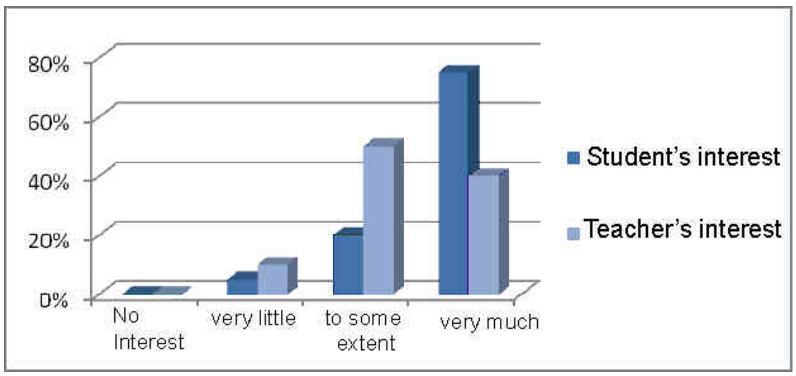
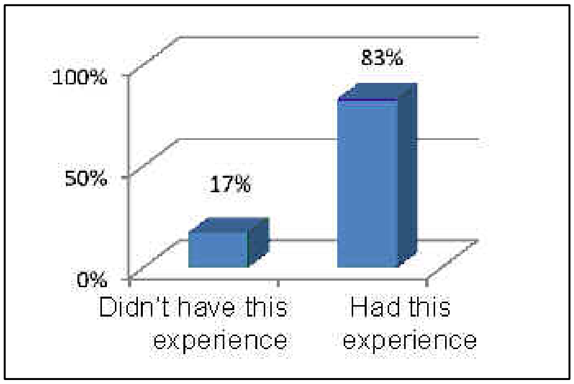


Figure1) Source: author

The point which underlines the issue of influence from outside sources the most are the statistical results which emerged from the answers of the newly graduated students when questioned about their use of other architects' works in their university projects. It is interesting that 83% of them confessed that they had had this experience before (figure 2) and even more interesting is that 70% of these people preferred to hide the issue from their respective teachers and only 30% of them - because of the special educational system of the teacher and aware of his agreement - told their teachers that the project had direct influences from the outside. Because some teachers believes that students have to solve real-world problems and they should pay attention to the acquisition of knowledge by visiting other architects works so their students feel free to be honest with them. But most of teachers do not want to accept the statistical results and try to limit their students.



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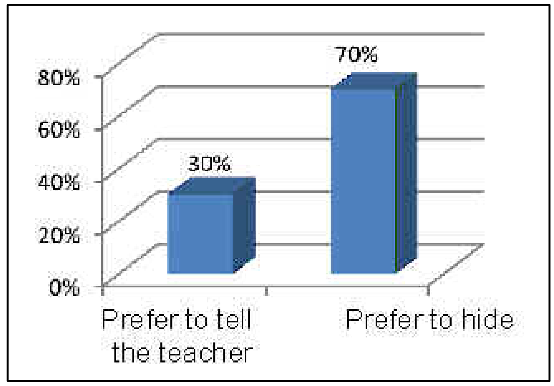

Figure3) Source: author

These results show that nowadays it is nonsense to discuss whether students are 'allowed' to be influenced by other architects or not. Whether we like it or not, many students are, and if they feel insecure with their teacher they will hide the issue from him/her (it is very natural that no teacher can claim that s/he knows every single architectural work on the planet). Unsurprisingly, 60% of the teachers said that they cannot completely recognize the possible outside influences on their students' works.

So, it would be better that in such situations, instead of disagreements or rows, we look for a solution not only to neutralize the threats on the quality of architectural education and the creativity of the students, but with the aid of good management of this issue we can also turn it into a chance and use it as a learning tool to develop the creativity of students.

Now the questions arise. Is it possible to use the influence of other architects' works as a learning tool to develop the creativity of architecture students or not? If the answer is in the positive, how can it be done? And at every stage of education, and according to the students' cognition, how it can be managed in the best way? To answer these questions, firstly we have to clarify a definition of creativity to know its origins, and to define what in particular ' creativity in architecture' means so that we can suggest methods to deploy the influences of other architects' works as a learning tool to develop the students' creativity.

Creativity and finding its roots in the history of art and aesthetics

Dr Shahram Pazouki believes the first person to talk about creativity in the history of art was Leonardo da Vinci. Before him, the only thing that mattered was mimesis not creation. The artist was someone who was subject to be an explorer instead of a creator. Da Vinci said for the first time that "the artist has to create instead of to imitate." From this time on, little by little, the focus on "subject" began. (Pazouki, 2005, p97)

On the other hand, one can say that subjectivity of creation began in harmony with the introduction of the modern philosophy by Descartes. In 18th century, when for the first time the term fine arts was introduced, art began to detach itself from industry, and 'creativity' began to show itself. In modern philosophy, creation stood facing the ancient concept of mimesis. When the arts, became subjective, then creativity in the arts found its meaning. In mimesis, the artist has an eye on the world where in the modern era, the artist looks inside himself instead. This landmark concept built by Descartes was then completed by Kant. In his *Critique of Pure Reason* he wrote that "the aping imitation must be substituted by creativity. If the arts want not to be imitative, they have to rely on the human subject. It means that they have to be the creatures of the human mind and for this genius must be developed."(Kant, 2001, p 188)

It is the case that artistic creativity which we talk about it today with ease, has been never discussed in some eras when the concept of creation was restricted to the High Almighty himself. Terms like 'creation', 'taste', and 'influence' are the fruits of modern thought and known only since Descartes introduced subjectivity into philosophical terminology. But today, creativity is a keyword in clarifying the process of design and creative education. Re-understanding and defining the word creativity can shed some light on its role in the process of designing. The famous Persian writer Ali Akbar Dehkhoda defined 'creative' as a noun for the Almighty and 'creativity' as something which can result in innovative forms. Omar Farouq defines creativity as a unique answer, both better and more suitable, to a problem. The "Advanced Dictionary of Psychology of Knowledge" defines creativity as "the power to find unordinary and high quality solutions for problems." According to the above, a creative person is someone who faces the data that every one of us may face, in a new way. (Mahdavinejad, 2005, p.58)

Creativity in architecture

After World War II, social scientists and engineers both concluded that for more optimization and productivity, creativity must be introduced in business and to do this, much discussion took place. During that time there were two viewpoints regarding creativity. One framed creativity as science and believed that it could lead human kind to progress and the other did not tolerate any scientific aspect and framed it through a totally metaphysical approach. Architects did not take part in the on creativity in the mid 50's where poets, writers, painters, sculptors, scientists, social scientists, and psychologists were the main discussants. Thus, most of the work done in this sphere has not been especially related to architecture and the relationship between the two is not worthy of note. (Antoniadis, 2004, p37)

Most of the theory available on creativity is either purely scientific or purely artistic. Alvar Alto, observed that architecture is a vast and multi-dimensional system that if we want to be creative in it, then we have to have a hand in a number of fields – some pure artistic and some pure scientific (like technology, structure, material, and equipment) and some professional – and be creative in such fields.

If we want to categorize the view points of architects and architecture theorists about creativity in architecture then we can establish two main categories:

1- The first group knows creativity as a sacred gift and prefers not to speak about it at all. Architects like Luis Sullivan, Frank Lloyd Wright, Alvar Alto, and Le Corbusier are in this group. As an example Frank Lloyd Wright defined the creative imagination as "the humanistic light in the human kind" and identified creative entities as they were related to gods. (Antoniadis, 2004, p39) According to Frank Lloyd Wright, Alvar Alto, and Le Corbusier, imagination and creativity is sacred and is clouded in metaphysics. Now it is obvious that why these giants disagreed with psychological research that tried to outline scientific formulas for their sacred imagination and creativity.

2- In the second group, people like Brian Lawson, Barnes Wallis, and Santiago Calatrava can be seen as the defenders of creativity as a learnable skill. They identify the creativity in architecture as a fine search of problems of design on one hand, and finding the precise, suitable, and even unique solutions for such problems on the other. Barnes Wallis said once that "I never had a novel idea. My deeds were just solutions." Santiago Calatrava known as a creative architect says that "all my projects were answers to specific problems." (Lawson, 2005, p176)

Today the second group has won the public’s interest. If we accept the second viewpoint then more or less we agree that creativity in architecture is something that can be taught and has a direct relationship with the process of researching the problem and the procedures for its solution and we do not have to meditate to find an answer from the heavens. To put it simply, in this model of creativity, the general conditions for one to create a work is that the first step is to discover the designing challenges with precision and then find precise answers for the problems.

The term ‘creativity in architecture’ like any other, has both a surface and a depth. The surface itself is not enough to be explored. What we see as a creative architectural work is, in fact, the surface of the phenomenon which has been manifested as a solution. By having an eye on ‘man's need’ as the main cause of the formation of any architectural work, a creative solution follows when ‘design problems’ are included in them. In the next step, the architect enters as the subject and through the use of ‘design tactics’ searches for a solution of the given problems.

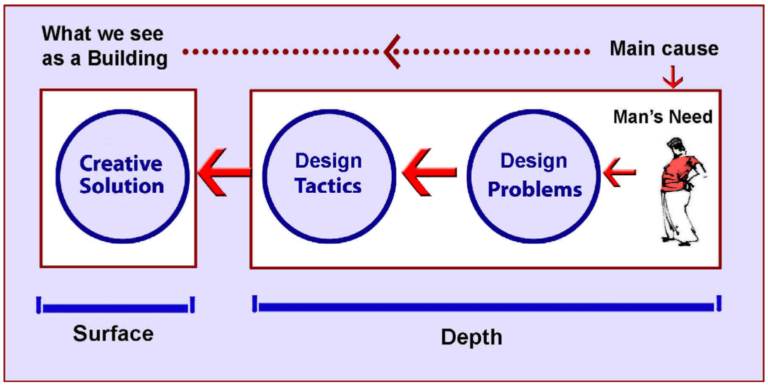

Figure4) Source: author

Thus the first stage, which has a vital importance, is to search and to identify problems which many have debated. Books like *"Problem Seeking*" by William Pena, and *"How Designers Think?*" by Brian Lawson, can be counted here. In my experience, Lawson's is one of the best and most comprehensive models of a variety of many designing problems **(Figure 5).**

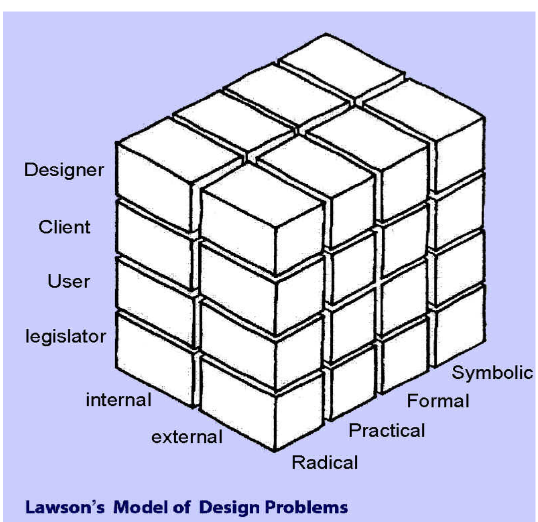

Figure 5) a model of design problems. (Source: Lawson: 2005)

For example, in figure 5, the group of people who can be counted as the origin of the problem seeking process can be categorized in four different subsets, the designer, the client, the user and the legislator. With more precise and detailed identification of internal or external problems – which an architect feels necessary for his project – the possibility of reaching a creative solution will be higher.

But this stage of problem identification itself cannot guarantee creativity. The next important step which has to be studied in depth is what is known as design tactics which are adopted to reach a creative solution. Tactics like Generation of alternatives, parallel lines of thoughts, or telling a story, can lead to a solution for the problems (Lawson, 2005, p212). By the use of different tactics one can find a number of solutions for any given problem. This is because the complexity of the designing process "can be divided, like any other problem, into smaller parts and by solving the problem parts one by one, then the general solution will be in hand." (Mahmoudi, 1999, p77)

After the stage of problem seeking and using design tactics, in the next step we must assign priorities, and also analyse and synthesize the differing solutions of the different problems to reach a final solution. A final solution usually takes shape by choosing from present solutions, or it can be a hybrid of them all.

Whilst creativity is also present at two previous stages, both in problem seeking and design tactics, it has to be said that in the final solution phase (see *Prioritization and final Analysis and Synthesis* in figure 6) that it reaches its peak.

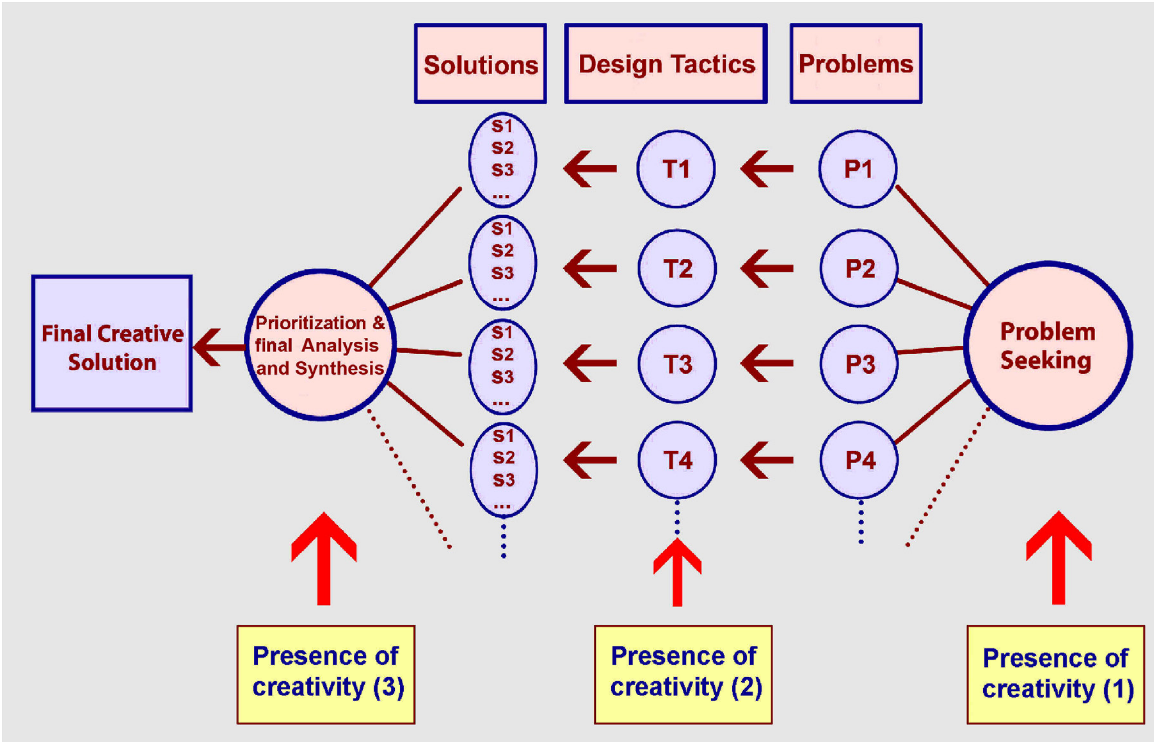

Figure 6) a simplified model which shows the importance of presence of creativity in the deeper layers of a creative architectural work. (Source: author)

By making use of the model of creativity presented a critique of many so-called ‘creative’ architectural works is made possible. For example; in critiquing the measure of creativity used in the design of The Guggenheim Museum in Bilbao by Frank Gehry we have to note the problems which arose in the problem seeking phase. We have to see whether he was creative in the problem seeking phase or not. Then it’s the tactics turn, and finally the final solution that he presented. For example we may find that in the case of the form of the building used to solve the problem of "attracting tourists to an abandoned city" the project has to have a high level of creativity, but in many other aspects we may see nothing. For example in the case of construction's cost to solve the problem of "inexpensive building" as a practical issue, the project has no particular creative solution.

The role of the influences of other architects' works in reinforcing creativity

The main issue of this paper is to determine at what level students must be familiar with previously made designs in order to develop their creativity.

In particular an issue here is the extent to which we should make design students aware of previous design work. One school of thought may suggest that students should be allowed a free and open-ended regime in which free expression is encouraged. Another might argue that designers have to solve real-world problems and they should pay attention to the acquisition of knowledge and experience. (Lawson, 2005, p155). In this field it is necessary to be familiar with Hertzberger (1991), Laxton (1969) and Kneller (1965) who salute the second school.

In his *Lessons for Students in Architecture,* Hertzberger wrote that:

> Everything that is absorbed and registered in your mind adds to the collection of ideas stored in the memory: a sort of library that you can consult whenever a problem arises. So, essentially the more you have seen, experienced and absorbed, the more points of reference you will have to help you decide which direction to take: your frame of reference expands.
>
> (Hertzberger 1991)

A study of design education in schools (Laxton 1969), concluded that children cannot expect to be truly creative without a reservoir of experience.

Kneller also clarifies, when he talks about creativity, that:

> "One of the paradoxes of creativity is that, in order to think originally, we must familiarise ourselves with the ideas of others . . . These ideas can then form a springboard from which the creator’s ideas can be launched. "
>
> (Kneller 1965)

Now the point of my argument is that the influences of other architects' works can be categorized into two main parts; which are conscious and subconscious influences. By this I mean if the student has used the solutions of other architects to solve design problems consciously or whether his own subjective experience, subconsciously and without his awareness, helped him to find the solutions.

A close relative to the phrase ‘subconscious influence’ is the term ‘schema’ in Gestalt psychology. Schema was firstly used by Bartlett who defined it as "the representative of an ordered and active set of past time experiences which is used for organizing and explanation of the future phenomena" (Lawson, 1384, p157). Gestalt psychologists paid specific attention to the way that the image of the outside world is represented inside mind. The Schema itself can be regarded as a form of subjective image of the individual's mind.

One cannot deny the role of schemas in creativity and the process of creative design as it has a direct relationship with the architect's experiences. The architects, consciously or subconsciously, makes use of their own experiences when they design a work.

As mentioned before the point at issue was, and is, the conscious influence from other architects' works on the architecture student. As I have previously observed a majority of the teachers are against this kind of influence and they see the inspiration of other architectural works as a blockage to the students' brilliant and creative ideas. On the other hand, according to the polls' results, most of the students, found these influences useful in development of their creativity though (figure 7). It has to be mentioned that the teachers' views differ depending at which level of the designing process the students are on. (figure 8).

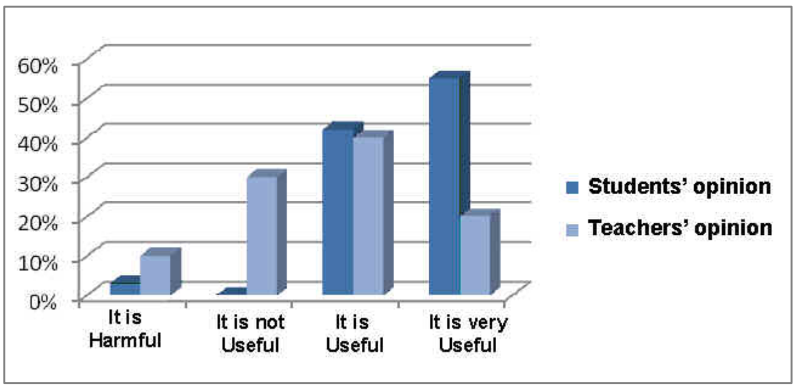

Figure7) Source: author

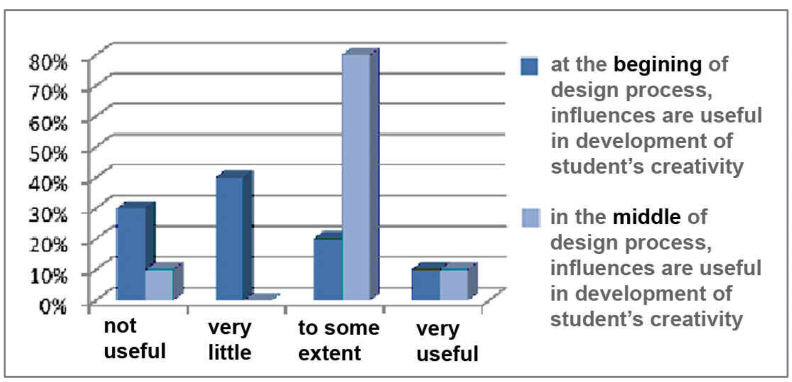

Figure8) Source: author

To briefly return to figure 6, it is clear that if the students use their inspiration based on other architects' works fairly, and if teachers manage and control this procedure, then no harm can be attributed to it and instead it can be used to improve the students' creative spirit. By looking at the model, which described the need for creativity in the deeper layers of a creative architectural work, we can find that inspiration from, and evaluations of, other architects' works can invoke feedback in the students' minds which can be useful in at least two stages of the model presented to improve students' creativity.

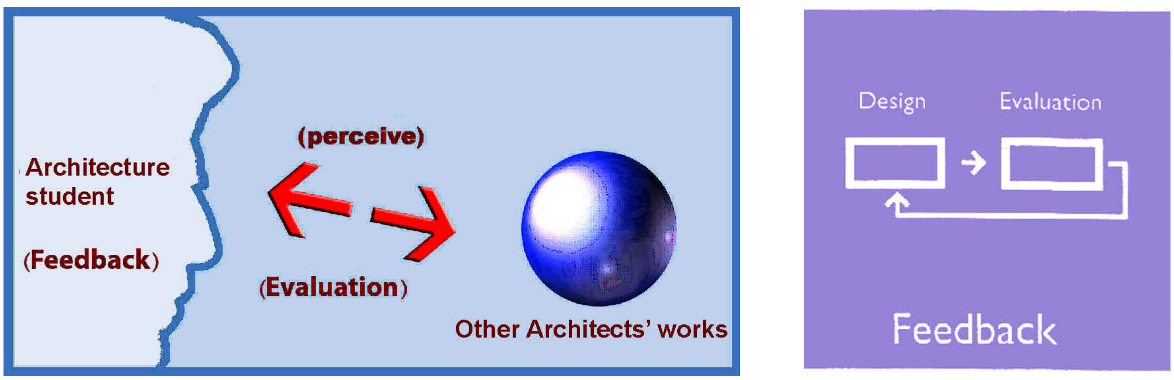

Figure9) Now by a look at the model, which described the need of creativity in the deeper layers of a creative architecture work, we can find that inspirations and evaluations of other architects' works can invoke feedbacks in the students' minds which at least can be useful in two stages of the presented model in the figure 6 to improve students' creativity.

Source: right side: Pena 2001, left side: Author inspired by The Three Worlds by Popper.

1. In 'problem seeking', these feedbacks, inspired by other architects' works in the primary stages of designing, can be very useful for the students. This can be used for example, to discover the problems which might be unknown to the other architects or it can lead to wrongly diagnosed problems by other architects or even answered incorrectly. Because precise problem seeking is a priority in reaching a creative solution, then such inspiration can play a major role in increasing the possibility of reaching a creative solution.
2 In 'design tactics', together with 'Analysis and Synthesis' creativity evoked by inspiration, can be identified as a useful tactic that leads to improvement.

So, if the model presented in figure 6 is accepted, one can hardly reject the role of influences of other architects' works in the primary or middle stages of designing process. Alternatively, if students face their teachers' orthodox views, they prefer to find a way out of the complex problems' labyrinth by use of other architects' works; there is the possibility of choosing a wrong method, for this pseudo-solution increases and may lead to blind imitations.

The students' way of cognition in leading their way of inspiration is important

Many theories have been developed to describe the types of cognition and their importance in problem identification and their respected solutions. In problem seeking and the design process, the Gestalt school has the upper hand in this kind of treatment for design problems. The Gestalt stresses cognition and as a result underlines the importance of thought.

The cognition factors of human thought have to do with becoming aware of and understanding classes of objects or ideas. This analytic ability to classify and recognise is of the utmost importance in everyday thought. For example, it would not be possible to study the differences between the structural systems employed in Romanesque and Gothic churches unless one could first recognise and classify such buildings. Guilford (1956) believes there are three ways of developing such a class system depending on whether the figural, structural, or conceptual content is used. Thus one might recognise a class by its figural properties. Children may initially recognise all four-legged animals as cows and only later look for further detail such as horns or tails. The second system of class recognition, by structural content, requires some functional relationship to exist between class members such as in the ‘complete the series of symbols’ type of IQ test question. Finally, one might recognise a class conceptually, such as architects or lawyers as being a group of people having passed certain examinations. For Guilford, then, these cognition factors influence our ability to define and understand problems whether they are to do with the appearance, function or meaning of objects. As Guilford (1967) himself points out, problems of figural and structural types abound in design and the ability to discriminate figural and structural classes is likely to be important to the designer. (Lawson, 2005, p 139)

The questions that future research can build on includes whether the understanding of the student of other architects' works remain unchanged in the university and after graduation, or whether the influence of such works on students depends on their ways of perceiving them? Is it possible to deploy an educational strategy to change the students' way of cognition, and use inspiration as a positive learning tool?

Comprehensive answers demand comprehensive future research, but as-is we can say that the student’s way of cognition, from the day s/he enters the university to the day s/he leaves the campus, can alter from figural to structural and in the end lead to conceptual cognition. As an example new students may understand an architectural work as figural, because at this level they cannot recognize the quality of the works, or are unable to distinguish between the different forms of the buildings, and their comments on the works may not stand that much above what ordinary people may say. Step by step, depending on their courage and courses they may pass, they begin to get familiar with different architecture schools and obtain some structural cognition and by discovering the 'hidden' ideas and theories behind the physical structures they step into a conceptual cognition of architectural work. One cannot precisely assign a cognition level to a given study period for a particular student. The students' cognition will change through factors like; how and what s/he studies or the circumstances that s/he grew up in. A first year student may have some structural or conceptual cognition where a fourth year student may have become stuck in figural cognition. What is clear is that figural cognition always appears during the college period. How it appears and by how much depends on the availability of other forms of cognition developing inside the student.

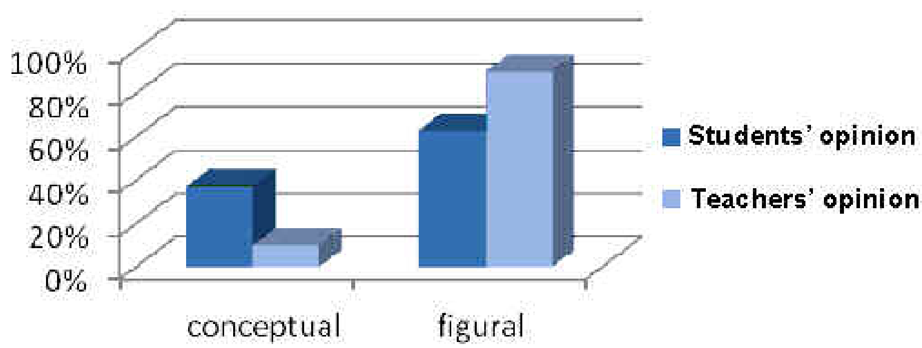

Figure10) Source: author

At each level of their development the student, either consciously or sub-consciously, may be under the influence of architectural works. By combining this influence with conscious thinking strategies like adaptation, imitation, inspiration, and developing critical thought and definitions and basic practices of creativity, we can suggest a theoretical model for creative inspiration. Using this model, we can change the three forms of student cognition, use it to improve the students' creativity and turn a perceived threat into a big chance.

Conclusion

We have seen so far that if we consider creativity as a layered phenomenon, to have a creative work on the surface needs problem seeking and design tactics in its layered depths.

Thus, there is no need to reject influences or inspirations from other architects' works as threatening according to our orthodox views. It can be used creatively through good management in the deeper layers of creating an architectural work. The role of influence can be highlighted in the problem seeking and design tactics layers which are the most basic and deepest layers in the making of a creative work. However, as mentioned earlier, an attempt to monitor the changes in the student's cognitions of architectural works, as an introduction to inspiration or influences, must be included.

So it is now clear that student's conscious inspirations or influences from other architects' works which can lead to blind imitation without a good management or by enforcing the orthodox views and threaten the architectural education, can be turned to a chance by a bit of care and attention and it can be used as a learning tool to improve the students' creativity.

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Integral design method in the context of conceptual sustainable building design

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Abstract

Global warming, shortage of fossil fuel and rising energy prices are endangering humanity. The built environment is responsible for a large part of the energy use and waste production. Traditional building design approaches essentially lead to redesign and optimization, whereas to meet the unique challenges for sustainability in the present day built environment, we need to go further and generate new concepts and knowledge that represent the necessary conditions to arrive at new sustainable design solutions.

This research set out to develop a method to create a more integral process that would create the opportunity to introduce a greater variety and amount of design knowledge from the outset of the conceptual design phase. The approach was tested by using series of workshops in which more than 100 experienced professionals participated. The Integral Design method [ID-method] developed here, given the right cultural environment, may in time lead to the generation of new building concepts that will allow us the opportunity to move beyond redesign and optimization. The necessity of concept creation is shown by C-K theory that defines design as the interplay between two interdependent spaces, knowledge space K and concept space C, which allows us to conceive of the possibility to transform the building design team's knowledge into new concepts.

Keywords

Integral Design, morphological overview, C-K theory, workshops

Many factors influence the sustainability of the built environment, however, man-made climate change and the measures that are needed to counteract such change seem to be by far the main problems of our time. To understand the impact of building design on the environment, recent research has shown that 40% of the total energy output of The Netherlands is consumed by the built environment, and this figure rises to 70% when social services such as healthcare are included [Uitdenbogerd 2007]. The fact that these rather worrying figures are the result of current building design approaches underlines the need for new, creative approaches that can achieve better results.

Therefore there is a clear necessity to better integrate comfort and sustainable energy systems in buildings [Opstelten et al 2007]. It is our belief that this can best be achieved by rejecting current design practice, and by organising relevant disciplines into functional, mutlidiscplinary design teams.The unsatisfactory cooperation between building design disciplines has resulted in calls for better organization of the design process [Friedl 2000, Wichers Hoeth and Fleuren 2001]. These calls gain more importance when we consider the increased complexity in current design processes arising from, amongst other things, growing sustainability demands. In this context, traditional approaches to organize and plan these complex processes may no longer suffice [Van Aken 2005]. First and foremost, a method needs to be developed to allow other, largely engineering, building disciplines to be integrated into the design process from the outset in a meaningful way. This re-evaluation of the design process and the individual disciplines within it should facilitate the inclusion of all relevant team members at the outset and give proper recognition to the influence their knowledge and input has on the final design. The standpoint in this research is that a more integral process will not only improve the design process, it will also create the opportunity to introduce a greater variety and amount of design knowledge from the outset of the conceptual design phase.

Methodology

In the early sixties design became an international concern. In the United Kingdom the Feilden Report concluded that design was of paramount importance and asked for more effective design management, more attention to customer requirements and asked for more cooperation in design teams [Blessing 1994]. The origins of new design methods in the 1960s were based on the application of 'scientific' methods derived from operational research methods and management decision-making techniques in the 1950s [Cross 2007]. However, in the 1970s came the rejection of design methodology by even some of the founding fathers themselves, such as Alexander and Jones. Fundamental issues were raised and design problems were characterized as 'wicked' problems, un-amenable to the techniques of science and engineering. This resulted in a proposal for a new generation of methods by Horst Rittel, moving away from attempts to optimize and towards recognition of satisfactory or appropriate solutions [Simon 1969]. In the 1980s engineering design methodology of the systematic variety developed strongly. A series of books on engineering design methods began to appear; Hubka [1980], Pahl and Beitz [1984], Cross [1984] and French [1985]. In fact, after the risen doubts of the 1970s, the 1980s saw a period of substantial revival and consolidation of design research. Since then there was a period of expansion through the 1990s right up to day: design as a coherent discipline of study was definitely established in its own right [Cross 2007]. Still there is no clear picture [Horváth 2004, Bayazit 2004] and many models of designing exist [Wynn & Clarkson 2005, Pahl et al. 2006, Howard et al 2008].

Even though design undoubtedly includes stretches of 'normal' ill-structured problem solving [Dorst and Rooyakkers 2006] any model or description method that tries to reduce design to ill-structured problem solving is bound to miss important aspects of the design activity [Hatchuel 2002]. Recognizing the fact that design is not a scientific or merely a problem solving activity, we wondered if any of the existing and largely neglected prescriptive design methods could help us to understand design by using them for research, rather than [as originally intended] for design activities. The motivation behind this idea was that, being developed on the basis of a scientific approach to designing, these prescriptive design methods 'automatically' meet the requirements for being methodical – one of the key characteristics of valid design research [Cross 2002]. We choose Methodical Design as developed by van den Kroonenberg as a starting point, as it is based on a synthesis of the German and Anglo-American design models of the mid seventies and using the analogy with Systems theory [Zeiler and Savanovic 2009b]. Within Methodical Design the design process is thought of as a chain of activities, which starts with an abstract problem and results in a concrete solution [Blessing 1994].

Morphological overviews within Integral Design

Starting from the prescriptive model of Methodical design a method was developed to articulate the relationship between the role of a designer as descriptor or observer within the design team and to reflect on the process [Zeiler and Savanovic 2009a, 2009b]. Methodical design was chosen as a starting point of development because it has exceptional characteristics [Blessing 1994]. The Integral Design model, an adapted model of Methodical Design, allows various design complexity to be separately discussed and generated [sub] solutions to be transparently presented.

A distinguishing feature of Integral Design is the intensive use of morphological charts to support design activities in the design process. Morphological charts were first used by Zwicky [Zwicky 1948]. By using morphological charts each discipline can look for all the necessary functions and aspects decomposed from the program of demands. All of the design team members have to come up with their interpretation and possible solutions to the design task. On the vertical axis of the morphological chart the required functions, sub-functions or aspects are recorded. The purpose of the vertical list is to try to establish those essential functions or aspects that must be incorporated in the product, or that the design has to fulfil. These are expressed in rather abstract terms of product requirements or functions. On the horizontal axis possible sub-solutions for these functions or aspects are given. The morphological chart gives an overview of aspect elements or sub-solutions that can be combined together to form overall solution proposals, see Fig. 1 combinations A, B and C. The proposals can be presented to the client and discussed. After which a decision can be made to proceed further or to do a backward iteration step in the design process.

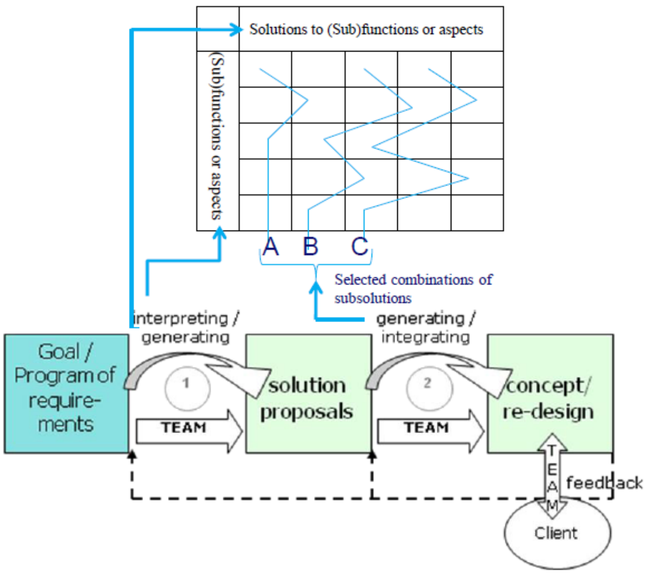

Figure 1: Program of demands as input for the morphological chart, sub functions on the vertical axis, the possible solutions as combinations of elements on the horizontal rows of the matrix. There is a possibility for feedback by the client as well as possible backward iteration loops.

As the morphological chart allows every designer to immediately see the results, they can discuss aspects that are unclear to them. The morphological charts made by each individual designer can be combined into a [team] morphological overview. The whole process is done in two steps: first the functions and aspects are discussed and then the possible related solutions see Fig. 2.

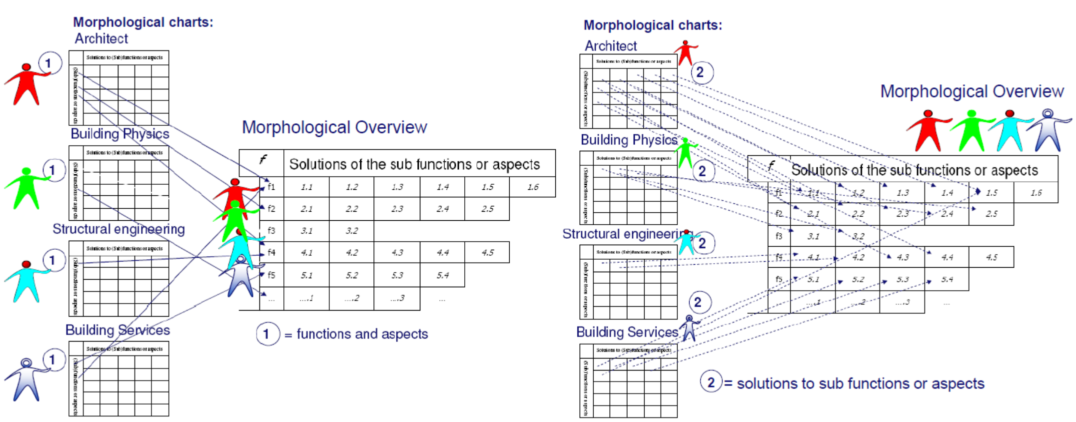

Figure 2: Building the morphological overview; Step 1; The Morphological overviews show the agreed functions and aspects [1] of the different morphological charts. Step 2: The Morphological Overview with the agreed on sub solutions [2] from the separate morphological charts

A morphological overview is generated [see Fig. 2] by combining the different morphological charts made by each discipline after discussion on and the selection of functions and aspects of importance for the specific design. Such a morphologic overview can be used by the designers to reflect on the results during the different design process stages. The advantage of this approach is that the discussion begins after the preparation of the individual morphological charts. As each designer uses his own interpretation and representation, in relation with his specific discipline based knowledge and experience, this gives an overview of different interpretations of the design brief resulting in a domain specific morphological chart from each design team member. In sum, this approach allows a greater freedom of mind of the individual designers and results in more creativity in interpretation of the design problem and generation of part solutions from the different disciplines. Morphological charts play a central role in facilitating the visualization of solution alternatives. Although the use of functional description and morphological charts is common practice in mechanical engineering design, there is scant evidence of their use outside of engineering or in a multi-disciplinary context. Within the approach described here, the possible input of 'soft' aspects adds a new dimension to the strict functional approach of a traditional morphological chart.

C-K theory

Pragmatic views of design as well as existing design theories [Yoshikawa 1981, Suh 1990, Gero 1996, Braha and Reich 2003] define design as a [dynamic] mapping process between required functions and selected structures [Hatchuel and Weil 2008]. Hatchuel and Weil argue that dynamic mapping is not sufficient to describe the generation of new objects and new knowledge, which, according to them, are distinctive features of design. Their statement that "there is no design if there are no concepts" [Hatchuel and Weil 2003, p.5] underpins the logic of C-K theory and of the present research. Generally speaking, design thinking is a creative process based around the transformation of needs into solutions. In this process existing knowledge and information about the actual needs of the principle forms the basis to work from. This often has to be transformed into new unknown concepts if solutions based on existing knowledge are not adequate. So, in this case, we have to develop from the known the unknown. As such we can make the distinction between the known [knowledge] and the unknown [concepts]. This distinction determines the core propositions of C-K theory [Hatchuel and Weil 2007].

Assuming that design thinking is related to design knowledge, and that knowledge is often something implicit, the definition of design by C-K theory [Hatchuel and Weil 2009] allowed us to approach design concepts as indicators of design thinking. C-K theory defines design as the interplay between two interdependent spaces having different structures and logics. This process generates the co-expansion of two spaces, space of concepts C and space of knowledge K. Within this research, in the case of a multidisciplinary building design team, the available knowledge within this team represents space K. Since C-K theory defines a piece of knowledge as a "proposition with a logical status for the designer or the person receiving the design" [Hatchuel and Weil 2002, p.11], all explicit representations of a design team's knowledge are considered to form part of space K. The overview of this knowledge is captured using morphological design tools. From the perspective of C-K theory, the initial object-design-knowledge that participants bring into design team defines space K. From here, two types of synthesis are possible: either the representations are combined, using the K→K operator, or are transformed, using the K→C operator, see Fig. 3. In this thesis the former possibility is explained as leading to 'redesigns' [RE], while the latter leads to 'integral design concepts' [ID]. Ultimately, evaluation of RE-design can only result in the same object-design-knowledge, while from ID-concepts new object-design-knowledge can be created.

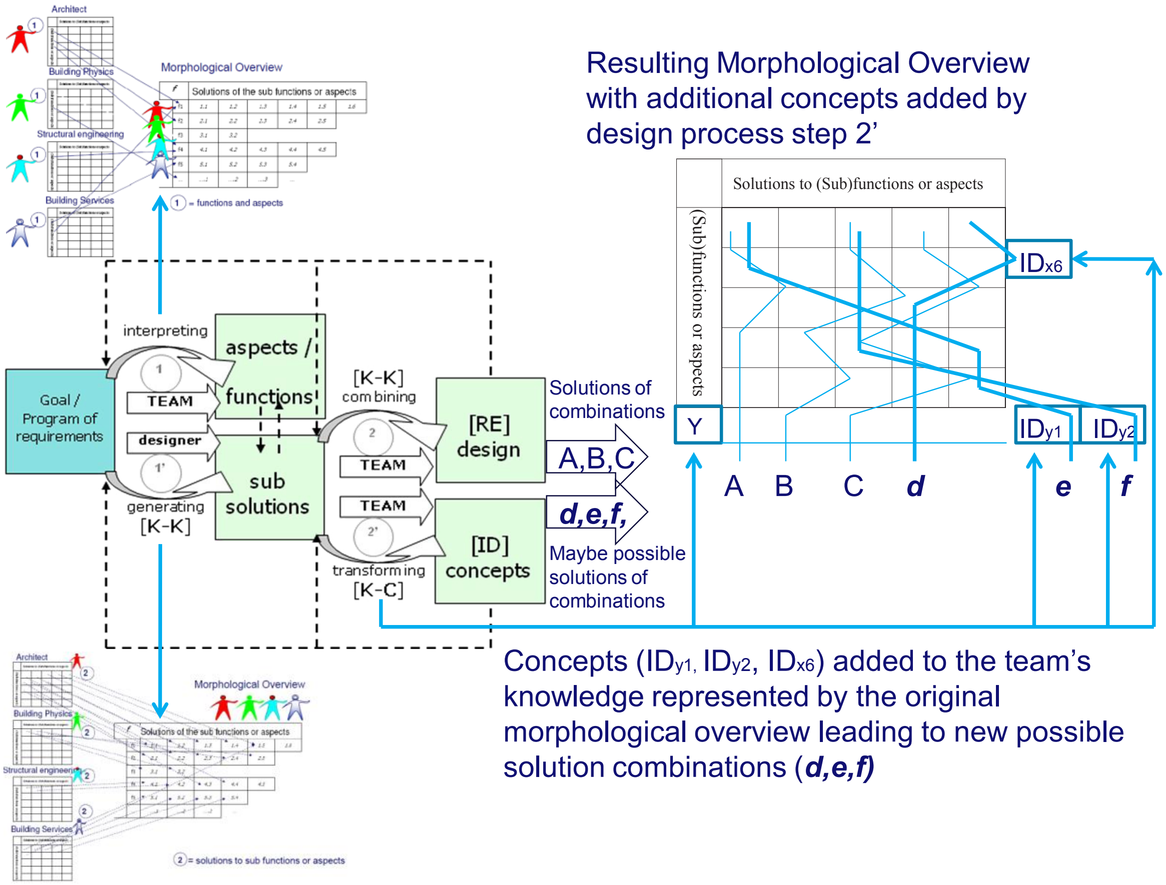

Figure 3: Integral Design model with C-K transformations, leading to solution of combinations [A,B,C] and leading to maybe possible solution concept combinations [***d,e,f***]

Within the ID approach, after the first step of generating discipline specific morphological charts and discussing the results as a team, the individual charts and combined into one morphological overview containing all of the useful sub solutions from the individual team members. The next step is for the team to take the knowledge and ideas from the overview and translate it into a proposed design solution. This step can take two forms:

I. design team combining sub solutions into RE-designs,
II. design team transforming object-design-knowledge into ID-concepts.

The ID-model wishes to force the focus on the distinction between redesign [K-K] and concept generation [K-C]. The elements ID_{x6}, ID_{y1} and ID_{y2} represent conceptual sub solutions as a result of the concept generation K-C, see Fig. 3. This distinction is crucial since, we firmly believe, that the development of new concepts is essential if we would like to generate creative sustainable solutions to the highly complex contemporary design problems that our societies face. In this research the main area of interest lies in the conceptual phase of the design process. In essence, in the current research ID-concepts are seen as essential for the creation of new, innovative building designs, which increase the possibility to ultimately realise sustainable building solutions. Perhaps more importantly, ID-concepts represent the potential for the definition of new object design knowledge, which can then be exploited to solve future design problems.

Experiments: Workshops for professionals

To test our approach of the morphological overviews and to determine if the approach led to positive effects for the professionals, we arranged workshops as part of a training program for professional architects and consulting engineers [structural engineers, building services engineers and building physics engineers]. On average these participants had 12 years of professional experience. An essential element of the workshop, besides some introductory lectures, was the design cases, on the basis of which the design teams worked and presented their ideas/design at the end of each session to the whole group. These design exercises were derived from real practice projects and as such were as close to professional practice as possible. Using workshops in which experienced professionals participated, a workable method was arrived at through iterative improvement of four key elements: design team, design model, design tool and design setting. The iterative development of the method results from housing the research within the Design Research Methodology framework [Blessing and Chakrabarti 2009]. In the current configuration [Fig. 4] stepwise changes to the traditional building design process type, in which the architect starts the process and the other designers join in later in the process, are introduced in the set up of the design sessions. Starting with the traditional sequential approach during the first two design sessions on day 1, which provide reference values for the effectiveness of the method [amount of integral design concepts], the perceived "integral approach" is reached through phased introduction of two major changes: first all disciplines start working simultaneously within a design team setting from the very beginning of the conceptual design phase and secondly the integral design model / morphological overviews are applied.

The second set up of the design sessions allowed simultaneous involvement of all design disciplines on a design task, which aimed to increase the amount of considered design functions/aspects. Additional application of morphological overviews during the set up of the third design session demonstrated the effect of transparent structuring of design functions/aspects on the amount of generated [sub] solution proposals. Additionally, the third setting provided the possibility of one full learning cycle regarding the use of morphological overviews so to correctly study in the fourth setting this process intervention of introducing the use of morphological overviews. All sessions were videotaped and additionally photographs were taken every ten minutes. The end presentations and all used material, sketches etc. were also photographed.

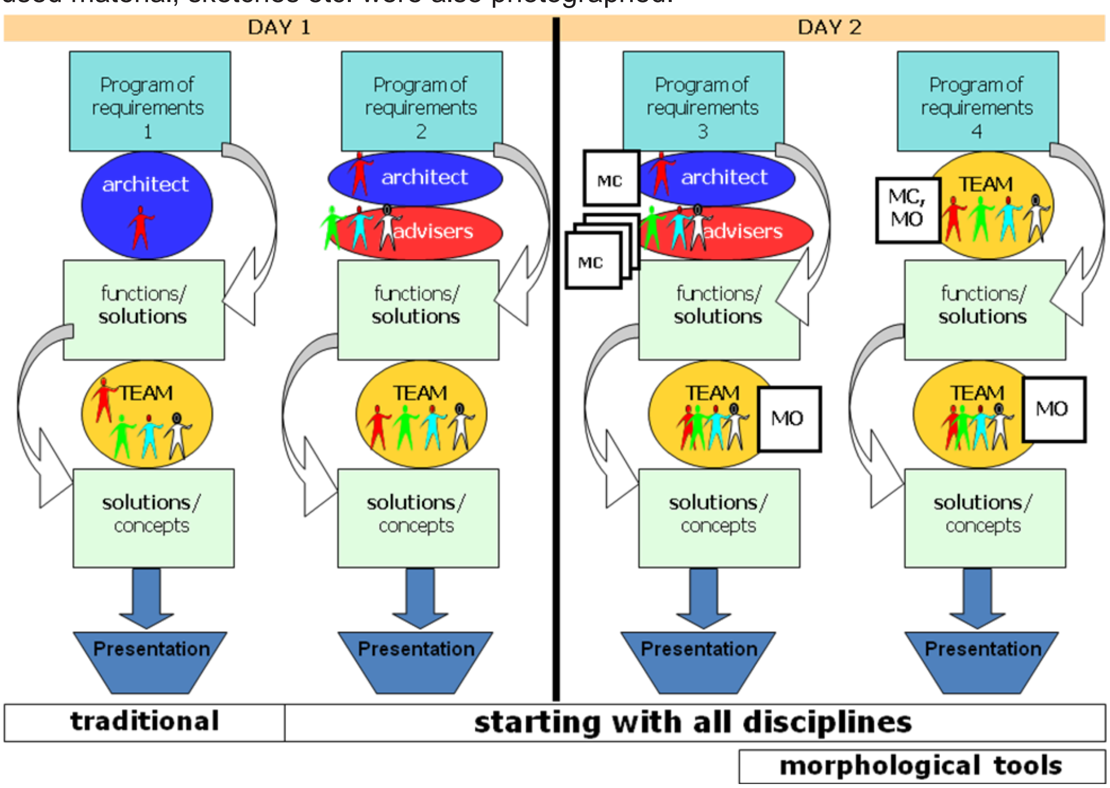

Figure 4: Workshops series 4 & 5, four different design set ups of participants and with or without Morphologic Overviews [MO] during the four design sessions within two days

Analysis I

The first goal of our research is to integrate engineering disciplines into a team design process and to share their knowledge at the outset of the conceptual design process. Therefore is it necessary to observe the actions by the participants during the conceptual design tasks. By this point in the research various observation methods and tools had been used Savanovic 2009]. Essentially, what was needed was a categorisation based only on functions/design aspects and solutions. Indeed, these are the things that participants needed to make explicit during the workshops. The idea appealed that the proposed design tool to structure these elements might just as well be used as a research tool to categorize them. Another advantage of using this tool is that it removes the need for live observation, which in early workshop set-ups had received consistently negative feedback from the participants and had also not yielded desirable results. For the sake of clarity, the tool in question is a morphological overview.

Here only a brief selection of all the results is given. The focus here is on the comparison of setting 1 session 2 [traditional building design setting] with that of setting 2 session 2 [where all disciplines work with the same information] and setting 4 [integral design setting with support of the morphological overview as design tool]. As an example only the process steps of one design team [group 1] is presented, as the process went similar for the other groups.

The compilation of the design team was such that only the architect was part of group 1 in all settings, the other members changed each time. More information and results are presented in Savanovic [2009].

Overall Workshop configuration of the workshops held in February 2008, is presented in table 1.

Duration	two days
Design sessions	4
Duration design sessions	2x2x120min [total 480 minutes]
Design task	Day 1 'parasite' & 'office'; Day 2 'renovation' & 'school'
Number of participants	19 in total, [day 1 – 18, day 2 – 16] 14 same for all four tasks
Architects	5
Building physics con.	4
Building services con.	7
Structural engineers	3
Observations by	Questionnaires, Photographs, Videos, all produced material collected

Table 1: Final two-day BNA-ONRI workshop

1st design setting, 'parasite' design task

Design session I: only architects, working individually - 5 architects

Design session II: team setting - 5 design teams

In design setting 1 each team was given the same design task: to design a 'parasite' structure to be placed on the building that the workshop was taking place in. For full description of the design task see Savanovic [2009]. All teams proceeded with the task in the same way. Initially, in the first design session, which lasted approximately 30 minutes, the architect worked alone on the design. Basically, this was done to mirror the status quo in which the architect is responsible for the original design, which is then presented to engineering disciplines. Following this, the other engineering disciplines of the design team joined the architect in order to discuss the proposed design. In this sense, the design team members of the engineering disciplines adopted the reactive role that is the norm in the status quo, and gave their reactions to different aspect of the design proposal. On the basis of these reactions the architect made adjustments to his original design. These adjustments led to improvements of the design.

In order to demonstrate what occurred in design setting 1, the work and analysis of one team is presented below, while the work of the other four teams can be found in Savanovic [2009]. After the initial design session I, in which the architect worked alone, all team members met in design session

II, to discuss the design. Here, the architect led the discussion. He did so by first explaining the considerations he took into account while working on his design. Through analysis of the session, these considerations were recorded in the Table 2 below. The analysis of each team's work started with the translation of the architect's explanation of the initial proposal at the beginning of second design session is into a table of aspects and sub solutions. This resulting sequential list is then structured in the architect's morphological chart. Then, on the basis of a review of the videotaped session,a table of aspects and sub solutions considered by the design team is structured in the design team's morphological overview. Design team 1 consisted of: architect [A], building physics consultant [BP], building services consultant [BS], and structural engineer [SE] [4 members from 4 disciplines].

Time (design session II)	Who	Aspect or sub solution	Description	Text/sketch or verbally
00h04min	A	Aspect (1)	Form	Text (session I)
00h04min	A	Aspect (2)	Materialisation	Text (session I)
00h04min	A	Sub solution (1-1, 2-1)	Contrasting to the existing building	Text (session I)
00h04min	A	Sub solution (2-2, 3-1)	Wood	Text (session I)
00h05min	A	Sub solution (2-3)	Open structure	Text (session I)
00h05min	A	Aspect (3)	Sustainability	Text (session I)
00h05min	A	Sub solution (4-1)	On (the existing building)	Text (session I)
00h05min	A	Sub solution (4-2)	Against (the existing building)	Text (session I)
00h05min	A	Sub solution (4-3)	Loose (from to the existing building)	Text (session I)
00h06min	A	Sub solution (4-4)	In the middle (of existing building)	Text (session I)
00h06min	A	Solution!	'Roof' on the existing roof…	Sketch (session I)
00h09min	A	Solution!	Loose, vertical spiral addition…	Sketch (session I)

Table 2: Aspects and [sub] solutions as explained by architect 1 to design team 1 [session II]

In order to allow comparison between different design teams and settings, these tables were reconfigured into the form of morphological overviews. The analytically derived morphological overview of team 1 is presented in Fig. 5. The aspects/functions and sub solutions originally brought to the table by the architect can be found as {A} in Fig. 6. After the discussion with the designer of other disciplines the team decided to work on different functions leading to the morphological overview of Fig. 6, which represents the final result of the design session.

Design aspects/ functions:	**Sub solutions:**			
(1) Form {A}	(1-1) Contrasting {A}			
(2) Materialisation {A}	(2-1) Contrasting {A}	(2-2) Wood {A}	(2-3) Open structure {A}	
(3) Sustainability {A}	(3-1) Wood {A}			
(4) [positioning]	(4-1) On {A}	(4-2) Against {A}	(4-3) Loose {A}	(4-4) In the middle {A}

Figure 5: Architect's morphological chart

Design aspects/ functions:	**Sub solutions:**			
(3) Sustainability{A}	(3-1) Wood {A}	(3-2) Heat pump {BP}	(3-3) Natural ventilation {BP}	
(4-1) On [positioning]	(4-1-1) 90° over the ex. building, on own legs {BP}	(4-1-2) 35-meter beams {SE}	(4-1-3) In line and partly over the ex. Building {BP}	(4-1-4) V-shaped columns {A/SE}
(5) Demountable {SE}	(5-1) flexible, prefab system {SE}	(5-2) plug'n'play building services {Team}		
(6) [Entrance]	(6-1) Independent {A}	(6-2) Extend existing entrance {A}		
(7) Flexibility {BS}	(7-1) Theatre at the end {A}	(7-2) entrance on west side {BP}		
(8) Orientation, sun {BP}	(8-1) roof wider than floor {A}			

Figure 6: Design team's morphological overview

2nd design setting, 'zero energy office' design task
Design session I all disciplines separately:
5 architects
3 building physics consultants
7 building services consultants
3 structural engineers
Design session II team setting: 5 design teams.

The analysis of the second design sessions of the second workshop design setting is based on videotaped design team activities. The resulting table of aspects and sub solutions considered by design teams during session II is structured into the design team's morphological overview. The goal of setting two was to make minimal changes to the status quo and measure the effect on the design process and the final product. To reach this goal at the beginning of the design process in design session 1 all disciplines were asked to respond to the design brief, as opposed to only the architect in the previous setting. In practice the participants worked together with members of the other teams from the same discipline. In effect, this led to the creation of four mono-disciplinary teams. All of these teams ended up with one finished product. The individual disciplines took this product back to the multidisciplinary team. These discipline-based responses were then brought to a team discussion in design session two. How much of this product was used in the multidisciplinary team and in what way was down to the representative of each discipline. The logic for following this procedure was to see if asking all disciplines to work on the task from the outset had any effect on the amount of aspects/functions and sub solutions that were generated by design teams during design session II. The analysis of the team work of design team 1 in design session II is shown in Fig. 7. Design team 1 consisted of: A, BP and BS: 3 members from 3 disciplines.

Design aspects/ functions:	**Sub solutions:**			
(1) Keep sun out {A}	(1-1) Trees {BP}	(1-2) Overhangs with PV panel{BS}	(1-3) reflective glazing{BP}	
(2) Light {BP}	(2-1) High-frequency lighting {BP}	(2-2) Solar tubes {A}		
(3) Heating {BS}	(3-1) office to storehouse {BP}	(3-2) TES {BP}	(3-3) sedum roof {BS}	
(4) [cooling]	(4-1) Adiabatic cooling {BS}	(4-2) Night ventilation {BS}	(4-3) air intake underground {A}	(4-4) In the middle {A}
(5)Electricity {A}	(5-1) Wind turbin{BS}			

Figure 7: Design team 1 morphological chart

In order to determine the effect of the set-up of setting two it must be compared to setting one. The main point of interest is to assess whether requiring individual disciplines to consider the task from the outset had any effect on the number of sub solutions generated when the individuals came together as a multi-disciplinary team. The comparison is presented below: table 3 contains the aspects and sub solutions generated by each individual team in setting I; table 4 contains the aspects and sub solutions from each individual team in setting II.

	Team 1	Team 2	Team 3	Team 4	Team 5	Average
No. of aspects	5	7	2	5	7	5.2
No. of sub solutions	13	16	12	16	17	14.8

Table 3: Aspects addressed and [sub] solutions produced by design teams [setting I]

	Team 1	Team 2	Team 3	Team 4	Team 5	Average
No. of aspects	5	2	3	3	3	3.2
No. of sub solutions	13	5	7	8	7	8.0

Table 4: Aspects addressed and [sub] solutions produced by design teams [setting II]

As can be seen from the table, contrary to what one might have expected, the intervention of introducing other disciplines into the design process from the outset did not result in the generation of a greater number of aspects and sub solutions. On the contrary, in setting two fewer aspects and sub solutions were generated than in setting 1, which was meant to represent the status quo.

3th design setting, 'renovation' design task

Team setting for both design sessions: 5 design teams.

Design setting 3 represented a learning-by-doing opportunity for the individual disciplines and the design teams. The ideal outcome would be that each team could clearly demonstrate successful use of the design tools during the design process. However, as a key part of learning is feedback, after the teams completed tasks set in setting 3, time was given to compare and appraise the teams' work and to answer any questions that arose. The results of this learning session are discussed in Savanovic [2009] but are not relevant in the context of this article.

4th design setting, 'school' design task

Team setting for both design sessions: 5 design teams

Design setting 4 represents the very last stage in the cycle of research in this research project. All of the individual interventions that were used in the earlier research stages are combined so that in setting 4 the ID-method can be tested. To be explicit, the elements that have been combined are: design team, design model, design tool and design setting. The analysis of the fourth workshop design setting, in which 5 design teams participated, of team 1 is here presented. Design team 1 consisted of: A, BS, SE: 3 members from 3 disciplines. In this setting, all of the design teams' proposed sub solutions were recorded directly on morphological overviews, see Fig. 8.

Design aspects/ functions:	Sub solutions:					
(1) Sustainability {Team}	(1-1) 'green' façade {A}	(1-2) PV/T shadings {BS}	(1-3) 'buffering' for humidity {A}	(1-4) roof garden {BS/A}		
(2) child-friendly, healthy {Team}	(2-1) Scale, identity {A}	(2-2) natural materials {BS/A}	(2-3) structure, protection {A}	(2-4) open façade, windows {A}		
(3) Natural ventilation {Team}	(3-1) HOLCOM ventilation {BS}	(3-2) higher classrooms {BS}	(3-3) walls for ventilation {BS}	(3-4) building orientation {BS}		
(4) Energy sustainability {Team}	(4-1) photo-voltaic thermal	(4-2) adiabatic cooling {Brief}	(4-3) air-inlet via underground {BS}	(4-4) CHP for winter {BS}	(4-5) floor heating {A/BS}	(4-6) sprinkler comb. cooling {A}
(5) Flexibility {Team}	(5-1) Columns {SE}	(5-2) Walls {SE}	(5-3) C/W Combination {Team}	(5-4) System plafond {A}	(5-5) 'Clear' plafond {A}	(5-6) HOLCOM floor {A}

Figure 8: Design team 1 morphological overview [design setting 4]

To conclude this section comparison is made between settings 1 and 4, and the research questions that were stated for setting 4 are answered. Table 5 contains information on the number of aspects and sub solutions generated by the teams in the setting four.

	Team 1	Team 2	Team 3	Team 4	Team 5	Average
No. of aspects	5	11	11	5	10	8.4
No. of sub solutions	24	26	39	20	46	31.0

Table 5: Aspects addressed and [sub] solutions produced by design teams [setting IV]

Result I: The use of the design tools and the team approach confirmed that goal was was realised

The comparison of design setting 1 and 2 presents the effect of introducing all the different designers from the start without using support. This led to a decrease of the number of aspects and subsolutions, indicating a less effective design process.
From the analysis of the workshops it could be concluded that the solution space, resulting from the number of functions and aspects considered, was significantly increased by applying the Morphological Overviews. A good example of this increase can be seen from the results from session 1 [without morphological charts and morphological overview] compared with the results of session 4 [with use of morphological charts and morphological overview]. Figure 9 clearly show that, as expected, more aspects and sub solutions were generated in setting 4 than in any previous setting 1 and 2. The increase of the number of considered functions and aspects leads to a larger number of partial solutions, which implies an increased problem-solution space, defined as the number of aspects times the number of solutions, see Fig. 9.

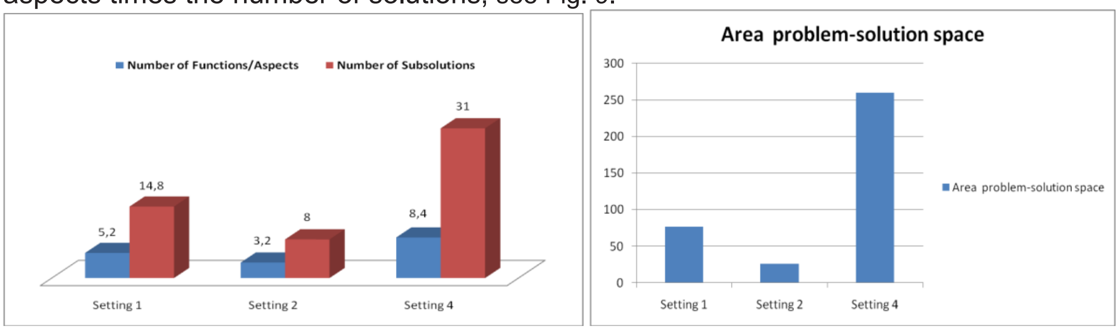

Figure 9: Comparison of the number of aspects/functions and the number of partial solutions being generated by the design teams in design session 1 & 4 and as an overall indication the 'problem-solution' area

Result II: Transformation of initial design knowledge to concepts

The results of analyzing the transformation of initial design knowledge into design concepts with the help of morphological charts and morphological overview showed that the Integral Design method did prove successful in facilitating the inclusion of engineering knowledge from the outset of the conceptual design phase. This in itself rendered the design process more efficient as it removed an unnecessary iteration, that is, the architect beginning the design task on his own before receiving input from engineering disciplines. However, what the disciplines within design teams ended up doing in many instances amounted to no more than seeking to fit solutions to design tasks. In essence, the design teams' approaches could best be categorised as 'integrated' rather than the desired 'integral' design, leading to redesigns [RE] rather than the desired integral design concepts [IDC]. This research therefore cannot claim to have realised the aim of using the ID-method to arrive at integral design concepts.

Conclusions and further research

The ID(Integral Design)-model is relevant to demonstrate the need for the explication of individual disciplines' object-design-knowledge. Additionally, the model can focus design teams on this object-knowledge in order to encourage the creation of ID-concepts. Although object-design representations can be driven by individual interpretations of the design task, in order to arrive at integral design concepts it is necessary that at a certain point the team agrees on design aspects / functions.

The main characteristic of the ID-method is the use of design teams' object-design-knowledge as 'building blocks' for either redesign [RE] or integral design concepts [ID]. The clear distinction between the two, redesign and design concepts, is only possible by using C-K theory. Building object-design-knowledge is discipline based, and to get an overview of the knowledge needed to produce a sustainable building concept in a specific context implies a team design approach as the first prerequisite. Research has shown that a highly promising way to get different disciplines truly working together is in a face-to-face setting [Abadi 2005, Emmitt and Gorse 2007]. Our experiences through the workshops and the feedback from the participants confirmed this. In addition, creating a workshop environment allowed professionals to work openly and freely, without the burdens that a laboratory setting bring with it.

The results showed that the ID-method did prove successful in facilitating the inclusion of engineering knowledge from the outset of the conceptual design phase. This in itself rendered the design process more efficient as it removed an unnecessary iteration, that is, the architect beginning the design task on his own before receiving input from engineering disciplines. However, what the disciplines within design teams ended up doing in many instances amounted to no more than seeking to fit solutions to design tasks. In essence, the design teams' approaches could best be categorised as 'integrated' rather than the desired 'integral' design. This research therefore cannot claim to have realised the aim of using the ID-method to arrive at integral design concepts. Nonetheless, the ID-method represents a set of necessary conditions for the creation of integral design concepts. More importantly, reflected by the expressed satisfaction of the majority of the participants, the ID-method represents an important step in what is argued as a necessary change in current building design practice.

In the next stage of the research the use of so called C-constructs will be investigated to stimulate the creation of new concepts. These C-constructs, sometimes called C-projectors, are used by Hatchuel and Weil in their KCP [Knowledge-Concepts-Proposition] workshops [Hatchuel et al 2009] to stimulate the forcing of concepts. The KCP workshops were held in different companies in France and more recently in Volvo in Sweden [Elmquist en Segrestin 2008, 2009]. The use of C-constructs could lead to increased effectivness of the Integral design workshop, and especially to an increase of the solution space by stimulation the transformations of K-C and C-K. In this research morphological analysis combined with the C-K [Concept-Knowledge] theory was used to explain the different design steps that take place in the conceptual design phase. Further research will start with a different approach for the analysis of the two final workshops series. A literature study will be done to determine analysis methods for conceptual design sessions: especially methods from linguistics and argumentation theory [Stumpf and McDonnell 2002, Dong 2007, Dong 2009]. Based on this analysis a new support tool will be developed and tested in new workshops series.

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