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

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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).

DESIGN CAPABILITY

GENERIC

Those capabilities which are shared by designers across a wide range of specialisms

DESIGNERLY THINKING

Evaluative Linear Vertical

Creative Simultaneous Lateral

Diagonal thinking Solution led approach Wicked problems

Object language : 2D – 3D

Design Drawings

Concept sketches
Development drawings
Measured drawings

SPECIALIST

Those capabilities and domain related knowledge which distinguish designers in particular areas:

eg:

Architecture
Automotive Design
Craft
Engineering Design
Fashion Design
Furniture Design
Graphic Design
Interior Design
Jewellery
Product Design

Portfolio: Passport to enter the community of practising designers

COMMUNITY OF PRACTICE OF DESIGN

Mutual Engagement
Designers engaged in actions whose meanings they negotiate within the group

Joint Enterprise
Design practises which become the property of the Community created over time

Share Perspective
Routines, work, tools, ways of doing things, stories, gestures, symbols, actions or concepts produced and adopted by the design community
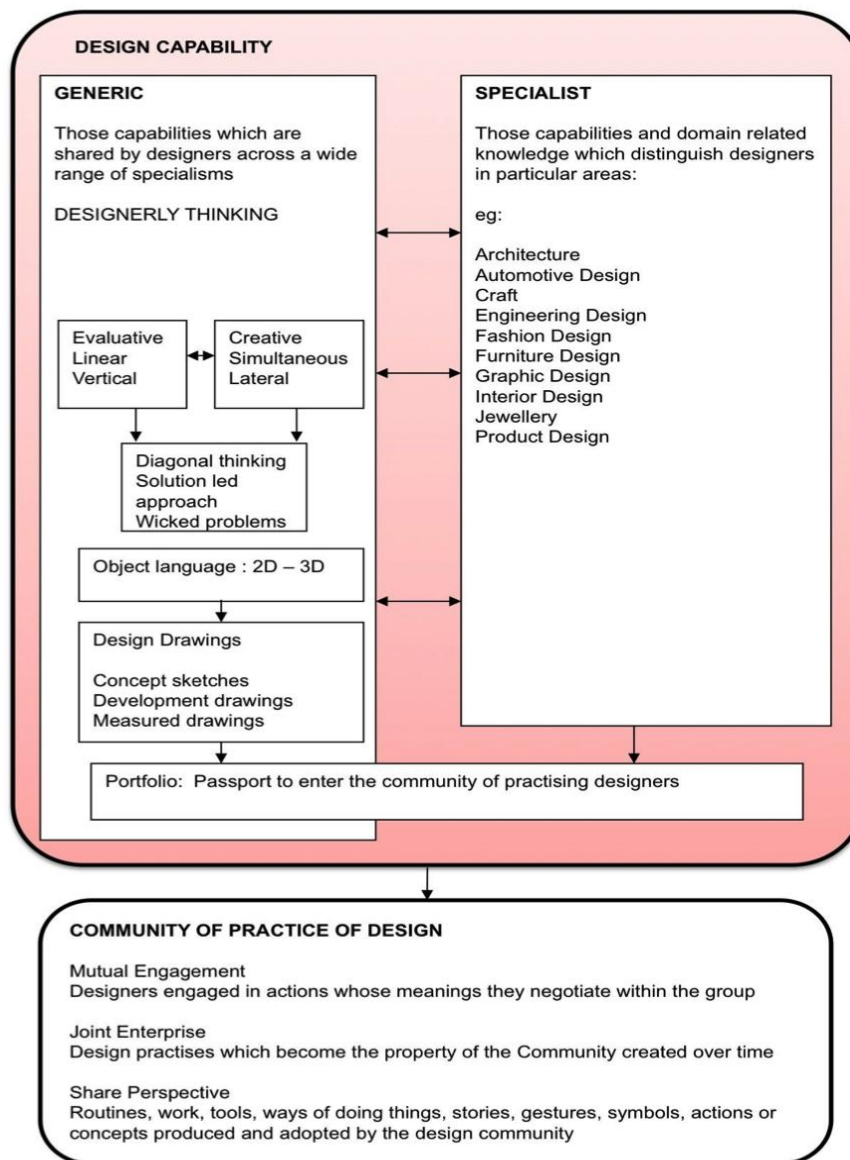
Figure 1 Design Capability Model

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.
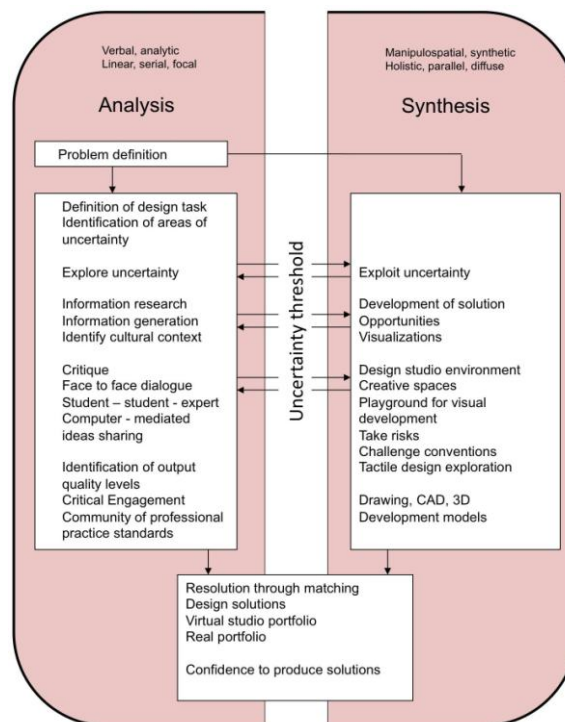

Figure 2 Analyses – Synthesis Modes

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

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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).

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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

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