Synergizing Positivistic and Aesthetic Approaches to Improve the Development of Interactive, Visual Systems Design

Michael R. Gibson, Department of Design, The University of North Texas, Denton, Texas, USA

Daniel Peak, Associate Professor, Information Technology and Decision Sciences, The University of North Texas

Victor Prybutok, Professor, Information Technology and Decision Sciences, The University of North Texas

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.

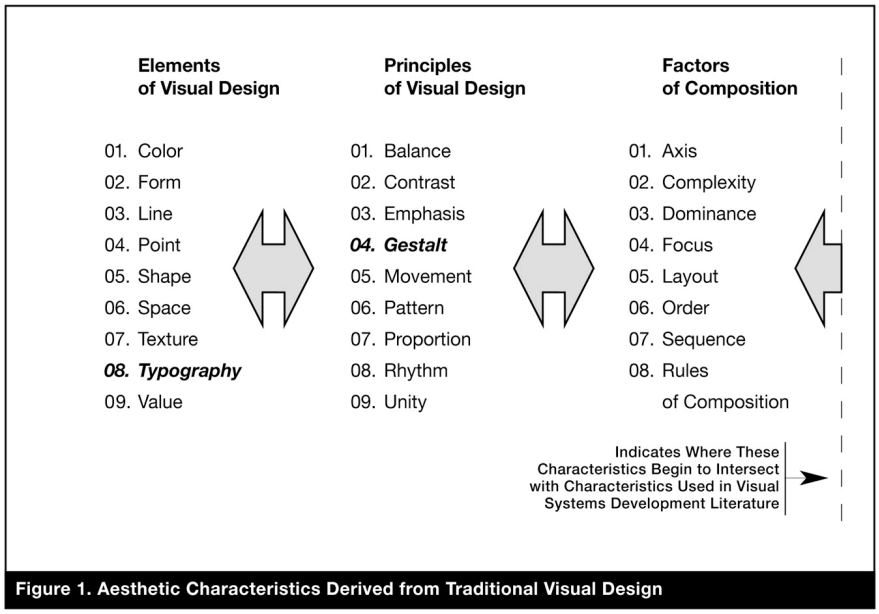

Figure 1. Aesthetic Characteristics Derived from Traditional Visual Design

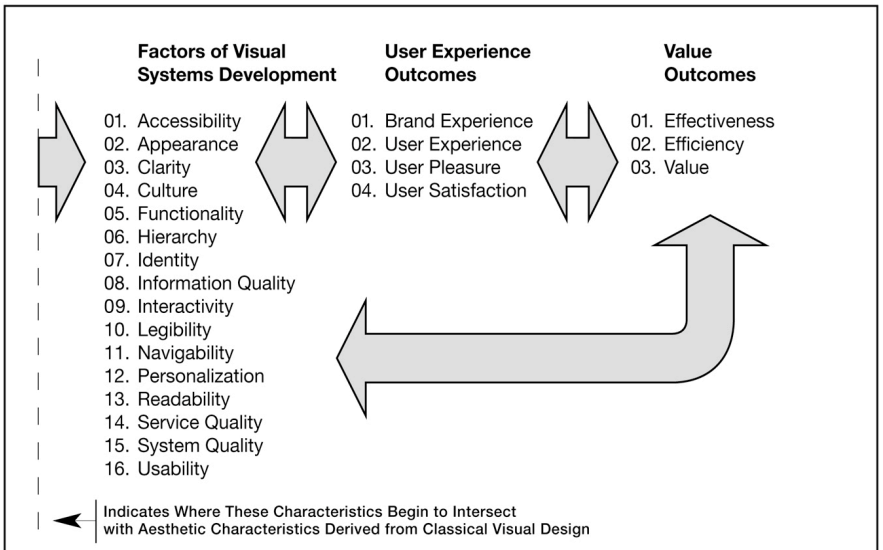

Figure 2. Functional Characteristics Derived From Visual Systems Development Literature

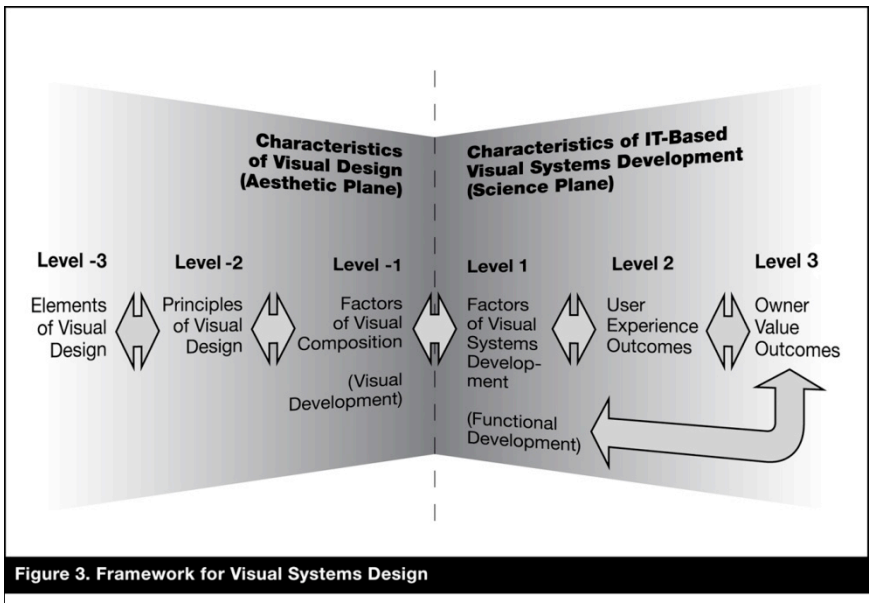

Figure 3. Framework for Visual Systems Design

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.

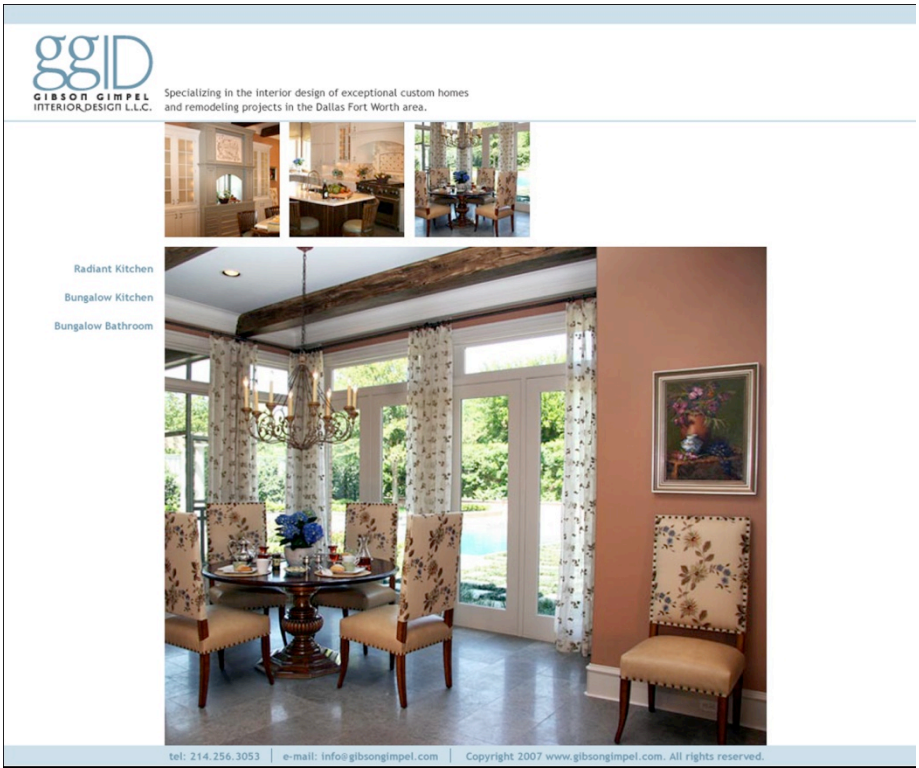

Figure 4. The original ("control") web interface used in the Study

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).

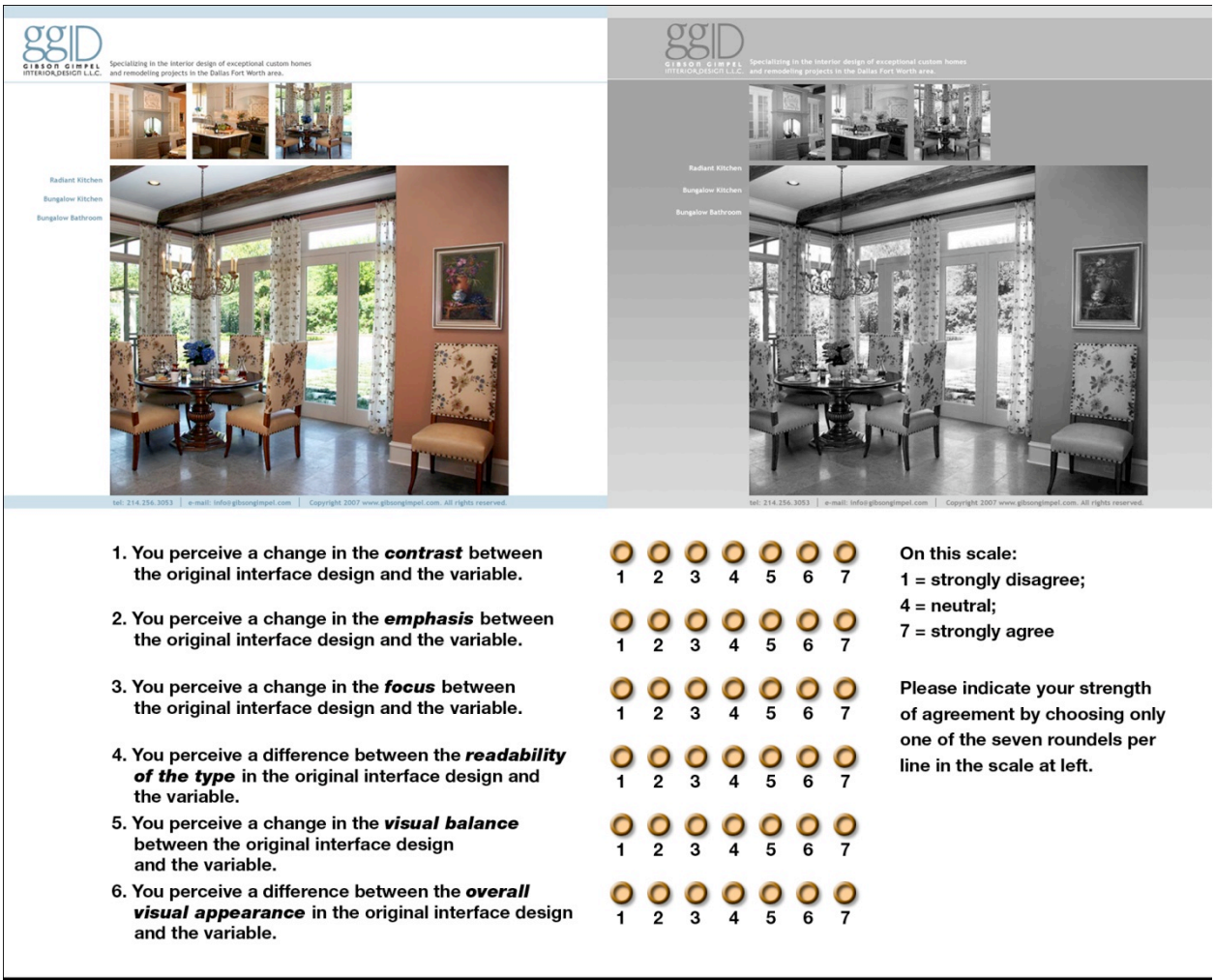

Figure 5. A sample page from the Pilot Survey, depicting the control interface and a manipulated interface as the participants in the Study encountered them. Each time a participant encountered one of these comparisons (six were used), he/she was asked to respond to the six statements that appeared immediately 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

Michael R. Gibson

Michael R. Gibson teaches communication design studio courses, as well as design research, criticism, history, theory and interactive media at The University of North Texas (UNT) College of Visual Arts and Design (CVAD). He is also the Program Coordinator for UNT CVAD's graduate programs in Design with concentrations in Innovation Studies. These programs immerse graduate students from a diverse array of backgrounds in learning situations wherein design research operates as a means to utilize design methods to reveal or generate new knowledge that emerges during their engagement in select design processes. Associate Professor Gibson has managed a strategic design consultancy since 1987, which has afforded him numerous opportunities to attempt to bridge the divide between the practical demands of professional practice and the need to account for how the results of design processes affect and are affected by a broad spectrum of social, technological, economic, environmental and political issues. His original and applied research projects have addressed issues in freshwater conservation and management, the marriage of positivistic and aesthetic research paradigms in interactive visual systems design, children's and women's health, media ethics, and the introduction of design pedagogy in select middle school settings.

Daniel Peak

Daniel Peak is an Associate Professor in the Information Technology and Decision Sciences Department in the College of Business at the University of North Texas. He has extensive information technology (IT) consulting experience in the corporate arena, and has serviced clients as diverse as Chase Manhattan Bank, The Atlantic Richfield Company (ARCO), Prodigy, IBM, Pacific Bell, Ernst and Young and The Union Pacific Railroad Company, among others. He has also published extensively to document his research in the areas of IT alignment planning, information science system service quality, IT education, and the evolution of media technology in select academic disciplines.

Victor Prybutok

Victor R. Prybutok is a Regents Professor of Decision Sciences in the Information Technology and Decision Sciences Department and Coordinator of the ITDS Department Doctoral Program in the College of Business at the University of North Texas. He served as the Director of the Center for Quality and Productivity in the College of Business at the University of North Texas (UNT) from 1991 to the summer of 2008. Dr. Prybutok has made numerous presentations on quality control,

including the Keynote Address and CEO session at the College of Osteopathic Health Care Executives Annual Conference and the American Osteo-pathic Hospital Association Trustee Forum (March 29–April 1, 1992). He has authored over 90 journal articles, more than 70 conference presentations / proceedings, and several book chapters in applied and theoretical areas of information systems measurement, quality control, risk assessment, applied statistics, and the instruction of statistics. Journals where his published articles have appeared include *The American Statistician, Communications of the ACM, Communications in Statistics, Data Base, Decision Sciences, European Journal of Operational Research, IEEE Transactions on Engineering Management, MIS Quarterly, OMEGA: The International Journal of Management Science,* and *Operations Research.*