The Design Enterprise: Rethinking the HCI Education Paradigm

Anthony Faiola

Introduction

Every discipline has its own evolutionary path upon which its practitioners should reflect to better assess the future. Having come of age, the field of human-computer interaction (HCI) is no exception. As such, it is appropriate to ask some fundamental questions regarding the development of HCI education and its impact on design and deployment of technologies that increasingly transform our lives at home and at work.

In the conclusion of their paper, "Distributed Cognition: Toward a New Foundation for Human-Computer Interaction Research," Hollan, Hutchins, and Kirsh[1] state that for HCI to advance in the new millennium, "We need to better understand the emerging dynamic of interaction in which the focus task is no longer confined to the desktop, but reaches into a complex, networked world of information and computer-mediated interactions." They argue that, for people to pursue their goals in collaboration in a social and material world, they will require a "new theoretical basis and an integrated framework for research."[2]

The claim made by Hollan, Hutchins, and Kirsh[3] questions whether or not educators are attending to the kind of curriculum development that will allow for the emergence of a new generation of interaction designers[4] who understand the dynamics of socio-behavioral contexts in which interactive systems might best be built. Echoing this call, Carroll[5] expressed his concern about the next generation of HCI professionals who, he suggested, may have little or no understanding of HCI theory as a multidisciplinary science.

The multidisciplinary development of HCI over the last twenty years suggests a further need for advanced learning models from scholars who are willing to resolve the current tension between traditional course content and the role of design in the strategic planning and synthesis of product creation.[6] Pedagogical models employed by many HCI and design programs will risk becoming increasingly short-sighted if they do not provide students with knowledge domains that can account for understanding design, social context, and business strategies in addition to computing.

A curriculum that delivers all these can only be achieved through a rethinking of HCI pedagogy by which students learn the theory and best practice of design as a unified approach to

1 J. Hollan, E. Hutchins, and D. Kirsh, "Distributed Cognition: Toward a New Foundation for Human-Computer Interaction Research," *ACM Transactions on Computer-Human Interaction* 7:2 (2000): 174–196.

2 Ibid.

3 Ibid.

4 Interaction design (ID): The phrase "interaction design" has evolved out of a growing need to recognize the role that "design" plays in the development of emerging technologies. ID includes a special consideration for the complexity of the features, functions, and capabilities that newer technologies bring to the user. Although interaction design draws upon the traditional theories and practices of HCI and interface design, it clearly emphasizes human-centered design as the primary model upon which to secure the goals and preferences most desired by users. Hence, designers often consider interaction design as a discipline that places more emphasis on user experience (referred to as "user experience design") and the processes of designing for both human and system behavior to better solve interaction problems that users confront on a daily basis. As opposed to traditional HCI professionals, who hold degrees in computer science and cognitive psychology, interaction designers are often from traditional backgrounds in visual communication and industrial design. In this paper, the author is using the term HCI in the broadest sense to speak to both HCI and interaction design educators and professionals.

5 *HCI Models, Theories, and Frameworks: Toward a New Multidisciplinary Science,* J. M. Carroll, ed. (San Francisco: Morgan Kaufmann, 2003).

knowledge management. In sum, the HCI discipline is in need of a holistic approach, a broader research structure for building design knowledge. This model, referred to as the *Design Enterprise*, serves as an integrated framework for managing knowledge domains and operators in order to enhance the design and overall assessment of interactive products. This model addresses many of the pedagogical limitations of traditional HCI, as well as the newer challenges that interaction design educators will face as they attempt to equip their students for the future of IT.

Beyond User-Centricity—Approaching Design as Knowledge Management

Cockburn and Bell[7] remarked that when computer science (CS) faculty discuss software development, "the usability of the interface is viewed critically," which questions its true value in the design process. Conversely, they outlined that one learning goal in CS should be to provide analytical tools that can lead to critical insight and a better means to assess the relative merits of software design. In other words, in addition to an HCI perspective, a comprehensive understanding of user input, the system, and user output, should be taught as part of a communication cycle,[8] whereby the designer is well informed of the relevant context of user actions.

Interestingly, a gradual acceptance of the human-centered model has taken hold in many HCI programs since Cockburn and Bell published their paper. This is support by Shneiderman,[9] who noted that we are "now in the "second transformation of computing, in which the shift from machine-centered automation to user-centered services and tools, are enabling users to be more creative." This pedagogical transition, which he refers to as the Copernican shift, is marked by a focus not on what machines can do, but on what users can do, being supported, enhanced, empowered, and enabled to extend their existing creative and cognitive abilities to fulfill their personal or community-related desires.[10] Confronted with the new reality of the Copernican shift, many technologists have adapted to human-centricity as it displaces computing at the heart of system design.

Looking further ahead, the shift toward "human-centered design" has only provided a marginal transition toward a far more complex problem space of new and emerging technologies. For example, Barnard, May, Duke, and Duce[11] outline a dynamic shift away from theorizing and experimentation with product concept modeling found in the pure science of cognitive psychology and toward the "boundless domain." They state that:

> Everything is in a state of flux: the theory driving the research is changing, many new concepts are emerging, the domains and type of users being studied are diversifying, many of the ways of doing design are new and much of what is being designed is significantly different.[12]

6 Anthony Faiola, "New Media Usability: HCI Curriculum Focus in the School of Informatics, IUPUI," *ACM Interactions—New Visions of Human-Computer,* 9: 2 (2002): 25–27; Anthony Faiola, "The Copernican Shift: HCI Education and the Design Enterprise" in *Human-Computer Interaction: Ergonomics and User Interfaces: Vol. 1 Theory and Practice, Part 1*, J. Jacko and C. Stephanidis, eds. (London: Lawrence Erlbaum Associates, 2003); D. Fallman, "Design-Oriented Human-Computer Interaction" (paper presented at the CHI2003 Conference on Human Factors in Computing Systems 2003); and J. Löwgren and E. Stolterman, *Thoughtful Interaction Design* (Cambridge, MA: MIT Press, 2005).

7 A. Cockburn and T. Bell, "Extending HCI in the Computer Science Curriculum," in *The Proceedings of the Third Australasian Conference on Computer Science Education*, Brisbane, Australia, ed. David Carrington, 113–120 (New York: ACM Press, 1998).

8 Ibid.

9 B. Shneiderman, *Leonardo's Laptop: Human Needs and the New Computing Technologies* (Cambridge, MA: MIT Press, 2002).

10 Ibid.

11 P. J. Barnard, J. May, D. J. Duke, and D. A. Duce, "Systems Interactions and Macrotheory," *Transactions on Computer Human Interactions* 7 (2000): 222–262.

12 Ibid.

Barnard, et al.[13] also assert that what originally was a confined problem space with a clear focus and a small set of usability methods is now much broader in scope. It is a "vast problem space, with a much less clear focus and a bricolage of methods and theories." Rogers[14] continues in the same vein by arguing that design methods unheard of in the 1980s have been "imported and adapted from far afield to study and investigate what people do in diverse settings." She cites ethnography, information design, cultural probes, and scenario-based design as examples of evolving design methods and conceptual developments. Specifically, she alludes to this shift as a "major rethinking of whether, how, and what kinds of theory can be of value in contributing to the design of new technologies."[15]

Advancing Design

Shifts in the Role of Design

Winograd's[16] unprecedented insights into software engineering shifted the focus of product development from computing to design. Kapor[17] asserts that "architects, not construction engineers, are the professionals who have overall responsibility for creating buildings." He argues that although engineers play a vital role in product development, they take their direction from the design of the building, which has already been established by the architect, as documented in their blueprints. In the same way, the design of a system's architecture and interface components should be directed by a holistic understanding of "use and user needs through a process of intelligent and conscious design."[18]

Norman's[19] early work in the psychology of HCI also reflects a fundamental paradigm shift in understanding the design of interactive products. For example, he suggested that well-designed artifacts should reduce the need for users to remember large amounts of information. In the section titled "The Conspiracy against Memory" (*Design of Everyday Things*), Norman[20] highlights our inability to freshly retain many items, i.e., the way these items work and the way they relate to one another. He asserts that the human mind is limited in its ability to think deeply about any given topic, primarily because of the restricted capacity of working memory. For this reason, visual aids are necessary to support cognition and avoid human error. Hence, designers need to find ways to arrange features in complex systems that are visible, reduce information in memory,[21] and reflect human logic. Recently, Norman[22] argued that "affect and emotion are not as well understood as cognition, but are both considered information processing systems, with different functions and operating parameters." He goes on to note that, "the surprise is that we now have evidence that aesthetically pleasing objects enable you to work better." He stresses that design affects human emotion and changes how well we perform cognitive tasks.

13 Ibid.

14 Y. Rogers, "New Theoretical Approaches for Human-Computer Interaction," *Annual Review of Information, Science, and Technology* 38 (2004): 87–143.

15 Ibid.

16 *Bringing Design to Software,* T. Winograd, ed. (Reading, MA: Addison-Wesley, 1996).

17 M. Kapor, "A Software Design Manifesto" in *Bringing Design to Software,* T. Winograd, J. Bennett, L. DeYoung, and B. Hartfield, eds. (New York: Addison Wesley, 1996), 1–16.

18 Ibid.

19 D. A. Norman, "Cognitive Engineering" in *User-Centered System Design: New Perspectives in Human-Computer Interaction,* D. A. Norman and S. Draper, eds. (Hillsdale, NJ: Lawrence Erlbaum Associates, 1986); and D. A. Norman, *The Design of Everyday Things* (New York: Doubleday Currency, 1993).

20 D. A. Norman, *The Design of Everyday Things* (New York: Doubleday Currency, 1993).

21 Ibid.

22 D. A. Norman, *Emotional Design: Why We Love (or Hate) Everyday Things* (New York: Basic Books, 2004).

Re-Defining Design: Design as Knowledge Management

The first challenge associated with design is its definition. This is because, first, design denotes both form and process, and second, design can be applied within many disciplines, e.g., computing, engineering, and the traditional design disciplines. Last, in the minds of most academics, design is mere form-making, giving visual style to interactive products. As Buchanan[23] states: "Design ... is not focused solely on form-giving." Rather, designers, "explore not only form and function, but also form and content, because content is what human beings seek in digital experiences." [24]

In his text, *Design Methods*, Jones[25] outlined that "design" is a hybrid term that includes art, science, and mathematics. Jones argues that, "both artists and scientists operate on the physical world as it exists in the present." [26] However, the designer is forever bound to "treat as real that which exists only in an imagined future." [27] As such, design, as opposed to other arts and sciences, is a deeply embedded process of discovering patterns of knowledge that can formulate new solutions. DeBono[28] suggests that this process is not objective analysis, but subjective rearrangements of knowledge into restructured patterns or frames of information. In this context, design becomes the convergence of knowledge, innovation, and the hope that a concept will be realized.

Ultimately, design is an intellectual process of exploration and discovery, wherein the design team "exploits the experience of searching for a problem structure in order to transform an initial brief (insight) into a final design." [29] Furthermore, the author suggests that design processes embody the conception and management of ideas in response to an existing problem space. Subsequently, design becomes a process that must bond a product's purpose and identity with its value.

Owen[30] states that "design has its own purposes, values, measures, and procedures.... areas of knowledge and ways of preceding that are very special." He concludes that it seems perfectly sensible that there should be "ways of building knowledge that are especially suited to the way design is studied and practiced." [31] By grasping the broader meaning and significance of design, HCI professionals and educators should go beyond the rudimentary aspects of design as mere visual communication. The striking implications of design for traditional HCI educators is their need to understand the *enterprise of design* as a process of sifting, forming, and refining of knowledge through multiple and evolving processes of conceptualization. Moreover, as recommended by Lim and Sato,[32] designers need a broader and more diverse disciplinary perspective from which to develop clear plans to manage knowledge that can inform the creative process. Lim and Sato go on to suggest that within these rather sophisticated design information structures, designers create an "effective knowledge-intensive design environ-

23 R. Buchanan, "Human-Centered Design: Changing Perspectives on Design Education in the East and West," *Design Issues* 20:1 (2004): 30–39.

24 R. Buchanan, "Good Design in the Digital Age," *AIGA Journal of Design for the Network Economy* 1:1 (2001).

25 J. C. Jones, *Design Methods* (New York: John Wiley & Sons, 1980).

26 Ibid.

27 Ibid.

28 E. DeBono, *Lateral Thinking: Creativity Step by Step* (New York: Harper & Row, 1990).

29 J. C. Jones, *Design Methods* (New York: John Wiley & Sons, 1980).

30 C. L. Owen, "Understanding Design Research: Toward an Achievement of Balance," *Design Studies* 19:1 (1998): 9–20.

31 Ibid.

32 Y. Lim and K. Sato, "Development of Design Information Framework for Interactive Systems Design" (paper presented at *The 5th Asian International Symposium on Design Science*, Seoul 2001).

ment that reinforces their capability of accessing, exchanging, capturing, and generating knowledge in design activities"[33] to guide design teams through the development process of organizing information for interactive systems.

Another discussion surrounding "design knowledge" centers on the work of Löwgren and Stolterman,[34] who argue that thoughtful interaction design is about design reflection (i.e., a process that is built on a "thorough understanding of the design process, design ability, the designed product, and design as part of a larger context"). This larger context includes a culture that acknowledges "design as knowledge construction."[35] Here, the emphasis is not placed on artifact production, but rather on "retrospective reflection," where designers provide "arguments and ideas that could explain a specific design."[36] They suggest that this novel perspective of design is a process of design management, or "designing the design process."[37] There is a great deal of literature that contributes to design theory and managing the design process, but little that addresses the construction of design knowledge, i.e., a design process that is "created, invented, and designed."[38] Their design theory offers a complementary perspective of design in which the main product is design knowledge, as well as its construction and management. In this paradigm, the stakeholders are diversified to include critics, clients, users, and others who all share in the processes and interactions that comprise the construction of design knowledge. Here, "design is a social process, which means that communication with other participants is crucial."[39]

The Design Enterprise Model and a Proposal for HCI Education

The traditional model of HCI education has evolved primarily from within CS programs, in which a range of knowledge domains are rarely represented.[40] Although some HCI programs have made considerable progress in developing multidisciplinary curricula, for the most part, they have not had an invested interest in or commitment to the design, social science, and business of product development. Also, despite a considerable amount of course content on computing, cognitive theory, and interface design, HCI students still lack an adequate understanding of problem-solving as an integrated enterprise that is human-centered and design-managed.

The author argues that convergence theories might suggest a novel pedagogical framework for building, organizing, and managing design knowledge that lends itself well to HCI.[41] The author refers to this framework for building design knowledge as the "Design Enterprise Model" (DEM). Although the human-centered model is not new to HCI, DEM extends the potential of HCI by emphasizing design as a unifier for managing knowledge domains. The primary domains include: social science, design, business, and computing (see Table 1). Like design, HCI must move away from being a self-contained discipline by recognizing the "new skills and

33 Ibid.

34 J. Löwgren and E. Stolterman, *Thoughtful Interaction Design* (Cambridge, MA: MIT Press, 2005).

35 Ibid.

36 Ibid.

37 Ibid.

38 Ibid.

39 Ibid.

40 S. Douglas, M.Tremaine, L. Leventhal, C. E. Wills, and B. Manaris, "Incorporating Human-Computer Interaction into the Undergraduate Computer Science Curriculum" (paper presented at the *SIGCSE 2002 Conference*, Covington, KY, 2002).

41 P. J. Barnard, J. May, D. J. Duke, and D. A. Duce, "Systems Interactions and Macrotheory," *Transactions on Computer Human Interactions*, 7 (2000): 222–262; Y. Lim and K. Sato, "Development of Design Information Framework for Interactive Systems Design" (paper presented at *The 5th Asian International Symposium on Design Science*, Seoul, 2001); J. Löwgren and E. Stolterman, *Thoughtful Interaction Design* (Cambridge, MA: MIT Press, 2005); C. L. Owen, "Understanding Design Research: Toward an Achievement of Balance," *Design Studies* 19:1 (1998): 9–20; and Y. Rogers, "New Theoretical Approaches for Human-Computer Interaction," *Annual Review of Information, Science, and Technology* 38 (2004): 87–143.

Table 1
The Design Enterprise Model

Knowledge Operations	Social (Human & Culture)	Design (Graphic & Interaction)	Business (Market Value & ROI)	Computing (Building & Testing)
I. Theory (Foundation)	1. Cognitive psychology 2. Anthropology 3. Sociology & social informatics 4. Cross-cultural communication	1. Interface Design: Visual communication & information design 2. Interaction Design: Human-centered design theory (General theory of human action / behavior)	1. Local and global markets 2. Product and market value 3. Product business strategies 4. Return on investment (ROI)	1. System modeling and computing theory 2. Usability and HCI theory 3. Testing measures
II. Application (Processes)	1. Contextual Profiling 2. Ethnography: • Observation • Interviews/questionnaires • Focus groups • Interpretation & Analysis 3. User Modeling: • Human need, • Diversity, • New social groups	1. Problem space development 2. Product requirements 3. Conceptual modeling: 4. Rapid Prototyping 5. Dynamic Prototyping 6. Design Iteration Tools 7. Participatory design, etc.	1. Apply business strategies • Create a better targeting of customer needs • Achieving market goals 2. Integrate market value & product design • Increase product value for the user • Increase economic value for the company	Building Tools 1. Scripting / HTML 2. Flash / Director 3. Visual Basic 4. Other Testing Tools 1. Usability Testing: • Time-on-task studies • Questionnaires / Surveys 2. Heuristic Inspections 3. Observation / Interviews
III. Management (Administrations)	1. Coordinate assets within an interdisciplinary design team 2. Deploy existing skill-sets through cross-disciplinary dialogue 3. Facilitate communication that can profit all the stakeholders within the design enterprise. 4. Administer design processes to better guide teams in the documentation, organization, and sharing of information across knowledge domains.	1. Direct the prototype design process of user interfaces & other system components that account for: • Visual clarity and aesthetics • Utility, functionality, and usability 2. Manage the innovation/creation process of new technologies that have portability with functionalities: • Wireless and distributed • Networked information utilities	1. Manage user and market research for a better understanding and application of business and design knowledge. 2. Create an effective business environment that reinforces the capability of accessing, exchanging, capturing and generating new knowledge within the design process.	1. Observation / Interviews 2. Oversee product building and testing 3. Oversee quality control of product design and testing procedure 4. Oversee integration and summation of data analysis 5. Make final recommendations and prepare presentation.

new methods in the design process."[42] As Buchanan suggests, referring to the evolution of the design field, design education has sought a "harmony among the different kinds of knowledge needed to make effective and valuable products. It seeks to balance and integrate aspects of the fine arts, engineering, and social science in the activity of design thinking."[43] Cooper and Press[44] also suggest that design research will continue to combine science, social science, humanities, and practice-based principles, becoming increasingly interdisciplinary to order to solve "real-world" problems.

When speaking of design in the context of DEM, the author is referring to a means of administrating the enterprise of knowledge acquisition and modeling to facilitate product creation (e.g., conceptualization, development, coordination, and execution). In DEM, all knowledge domains and operators are transferred to design as a central repository for providing designers with a knowledge map. Although human-centricity is a focal point of a product's life-cycle, design establishes order, organization, and administrative cohesion in applying the four knowledge domains. In other words, user goals, needs, and preferences are imperative, but design is pivotal for putting to practice the knowledge domains and administrative processes.

The author proposes a theoretical shift in domain knowledge for HCI and interaction design students.[45] In addition to developing mainstream concerns for traditional content areas common to HCI, DEM recommends a more in-depth concern for product building. This is done through a well-orchestrated process wherein teams develop solutions based on a single cohesive and integrated design framework that draws upon specified knowledge domains and operators.

At the same time, students learn about social context, design, business strategizing, and product building and testing from the theoretical, best practice, and administrative perspectives (i.e., the operational aspects of the knowledge domains). The operations include: (1) theory, which provides the fundamentals of conceptual knowledge for students in each of the four knowledge domains, (2) application, which provides the tools and techniques, and (3) management, which provides the necessary coordination of domains and operators to maintain cohesion throughout DEM.

A highlighted overview of the four domain areas follows.

Social

To achieve a deeper understanding of individual and collective human processes, students need to acquire a fundamental understanding of the social sciences. Only then will they be able to effectively assess the complexity of the problem space assigned to human-computer interactivity. Our understanding of the psychology of HCI and system design was born in the late 1970s. Referred

42 R. Buchanan, "Human-Centered Design: Changing Perspectives on Design Education in the East and West," *Design Issues* 20:1 (2004): 30–39.

43 Ibid.

44 R. Cooper and M. Press, *Academic Design Research* (2005 [cited June 12, 2005]. Available from www.designcouncil.info/.

45 A. Faiola, "The Copernican Shift: HCI Education and the Design Enterprise" in *Human-Computer Interaction: Ergonomics and User Interfaces: Vol. 1 Theory and Practice, Part 1*, J. Jacko and C. Stephanidis, eds. (London: Lawrence Erlbaum Associates, 2003).

to as the human-information processor,[46] a methodology called Goals, Operators, Methods, and Selections (GOMS), revolutionized the developers' ability to predict user interaction with reasonable accuracy.

In the new millennium, the integration of cognitive modeling into HCI course content has become commonplace. However, another transition is required in HCI curricula to achieve an integration of the practice of social science within system design. HCI students need a comprehensive understanding of the psychology and sociology of HCI in both theory and practice, as well as the ability to rapidly employ empirical methods in design situations.

Beginning with psychology, Sutcliffe[47] argues that a "basic problem is how theory-based knowledge can be conveyed to designers who are not experts in cognitive science." For example, cognitive models are essential for progressing theory that underlies HCI, but how they are applied to HCI design problems presents a "barrier for delivering HCI knowledge."[48] Here, Sutcliffe refers to HCI knowledge as the "insights and predictions that are generated from theoretical analyses about why a design should be usable and which design properties should be selected to ensure usability."[49] However, as Sutcliffe argues, knowledge must be traceable for designers, and examples serve as a powerful means of anchoring usability arguments. Therefore, the necessity for better knowledge transfer to design must be addressed by HCI educators.

Ethnography and other social design processes that emphasize contextual strategies[50] are becoming more important in providing the rationale for human-centered design. Since the mid-1980s, ethnographic approaches have been considered[51] a viable approach to providing a more in-depth analysis of system design. The advent of this new tool caused system designers, for the first time, to seriously consider human interaction with computers in context. This movement was prompted when computer systems moved out of the laboratories and into the workplace.[52] Hughes, King, Rodden, and Andersen[53] state that, "Given this turn to the social and the need to study the real-world character of work, drifting toward sociology through ethnography is almost a natural inclination."[54]

Ethnography gives system designers a way to understand a social setting as it is perceived by those involved in that setting, making the contextual world of the human and computer visible through a detailed description of activities observed.[55] Ethnography is one demarcation that separates quantitative and qualitative approaches to social science research. For this reason, it demands a considerable degree of commitment to immerse oneself within a social context to gain a clear understanding of the interactive elements under study. One of the most valuable attributes of ethnography is that it enables designers to do what traditional usability methods, such as time-on-task studies, cannot. Observation and interview sessions allow the user to co-direct a dialogue of inquiry.

46 S. K. Card, T. P. Moran, and A. Newell, *The Psychology of Human-Computer Interaction* (Hillsdale, NJ: Lawrence Erlbaum Associates, 1983).

47 A. Sutcliffe, "On the Effective Use and Re-Use of HCI Knowledge," *ACM Transactions on Computer-Human Interaction* 7:2 (2000): 197–221.

48 Ibid.

49 Ibid.

50 H. Beyer and K. Holtzblatt, *Contextual Design: Defining Customer-Centered Systems* (New York: Morgan Kaufmann, 1998).

51 L. A. Suchman, *Plans and Situated Actions: The Problem of Human-Machine Communication* (Cambridge: Cambridge University, 1987).

52 J. Grudin, "The Computer Reaches Out: The Historical Continuity of Interface Design" (paper presented at the *ACM CHI'90 Conference on Human Factors in Computing Systems: Evolution and Practice in User Interface Engineering*, 1990).

53 J. A. Hughes, V. King, T. Rodden, and H. Andersen, "Moving Out from the Control Room: Ethnography in System Design" (paper presented at the *ACM 1994 Conference for Computer-Supported Cooperative Work*, New York, 1994).

54 Ibid.

55 C. Geertz, "Thick Description: Toward an Interpretive Theory of Culture" in *Readings in the Philosophy of Social Science,* M. Martin and C. C. McIntyre, eds. (New York: Basic Books, 1994), 213–31.

In this way, the designer and user can co-interpret and co-design by sharing ideas and solutions and an overall understanding of design problems. This co-invested collaboration is done through design techniques such as design ethnography, participatory design,[56] and pluralistic (cognitive) walkthroughs.[57]

HCI programs have a responsibility to emphasize an integrated approach to design that transcends a preoccupation with system tasks and technology to achieve a methodology that is human and humane.[58] As Myers[59] states, it is necessary to improve our understanding of human thought and action through an interpretation of humans in context. Gouveia and Gouveia[60] concur when they suggest that qualitative findings from ethnography can provide additional results to inform user metrics and refine human measurement.

Within the social science domain, interpretive methodologies such as ethnography have found acceptance among HCI professionals as a viable means to inform system design. Nardi[61] points out that the real significance of these methods has been their ability to make visible to the technologist the things and actions of a contextually social world. And Hemmings and Crabtree[62] state that the appeal of ethnography continues to follow the recognition by designers that the development of software increasingly relies upon social circumstances. This assertion is affirmed by the fact that traditional quantitative techniques systematically deconstruct human action in the work place and, in so doing: (1) obscure or misrepresent the empirical process within a particular socially organized environment, and (2) fail to give adequate attention to the social nature of work.

It is the author's belief that social science theory and practice, and the broader inclusion of the interpretive approach found in DEM, can provide designers with significant knowledge about: (1) social and organizational phenomena that can inform human-centered processes, and (2) the contextual settings as perceived by those involved, and a description of the activities observed.

Design

The author suggests that, although design encompasses a broad area of study as applied to system engineering, it can be divided into two interrelated parts: interface design (the design of static visual form) and interaction design (the design of dynamic behavior). Historically, design schools have programs that emphasize each area, with some overlap in curricula structure. However, when considered together, they pose a number of challenges for HCI students, because of the growing complexity of user groups, culture, and social interaction, paralleled with the integration of multiple platforms, information, and media outlets. Because of the breadth of knowledge needed in HCI, DEM provides the basics of design as they apply to the iterative process. Depending on the constituents of the HCI program, faculty can emphasize whatever areas they see fit.

56 Participatory design: Emerging from Scandinavia in the early 1970s, participatory design is an approach that involves users as equal partners in the design process, designing the product in cooperation with the design team. Several models of how to carry out this technique have been developed since its inception. See also J. Preece, Y. Rogers, and H. Sharp, *Interaction Design: Human-Computer Interaction* (New York: John Wiley & Sons, 2002), 306–311.

57 Pluralistic walkthroughs: Another form of cognitive walkthrough that integrates user participation into the process of assessment of prototype design. As with cognitive walkthroughs, pluralistic walkthroughs simulate a user's interaction process at each step of executing a task. Driven by the scenario, the user and design team check to see if task goals are being fulfilled, while noting memory, cognitive overload, and overall ease of use.

58 Humane: To truly be "responsive to human needs and considerate of human frailties" (J. Raskin, *The Humane Interface* [New York: Addison-Wesley], 7), HCI design must grasp the relationship between context, cognition, and technology. Hence, a greater concern for humane technologies is argued from the position that: (1) a broader underpinning of epistemology should form the base of human-computer interaction design methodology for system design, and (2) current software design remains traditional, with outdated research models that do not pay adequate attention to social context, human limitations, and the enhancement of human creativity and processes of learning; A. Cooper and R. M. Reimann, *About Face 2.0: The Essentials of Interaction Design* (New York: Wiley & Sons, 2003).

59 B. A. Myers, "A Brief History of the Human Computer Interaction Technology," *ACM Interactions* 5:2 (1998): 44–54.

Graphic design, as applied to interface design, is largely dominated by the visual (image and text) conventions of interface components, such as windows, menus, icons, and other desk-top metaphors. Both the individual and collective composition of these components takes into consideration their interrelatedness to the overall architecture of the product. Interaction design, on the other hand, requires problem-solving skills in visualizing the behavioral contexts and problems that occur when humans encounter the dynamic action required to use an interactive product.

The author's application of design has been to integrate design concepts into prototyping exercises, in which students spend considerable time generating static and dynamic prototypes that test for concept validity and usability. In each design project, it is critical to reiterate the need for students to understand graphic and interaction design as a deeply interrelated user-centered processes that must focus on user goals, experiences, and needs, relative to the required system tasks. In this way, students will come to appreciate the impact of visual and interaction design on a user's experience.

Greenberg[63] asserts that "good design" is a matter of providing students with knowledge concerning what is usable to people, as well as the techniques of implementing interfaces. "Good design" requires careful consideration of many issues and patience in testing prototypes with real users.[64] In Norman's[65] recent discussion of design, he suggests that emotion is a factor for assessing "good design," which he argues should "embody both beauty and usability in balance." This recent emphasis in Norman's writings is evidence of a move from considering HCI in simple functional terms to a richer understanding of other factors that should contribute to the success of a design solution.

Going further, Löwgren and Stolterman[66] note that the design process should be contextually dependent. In other words, the designers should thoroughly consider the relational environment in which the product will be used. They hold that everything from societal laws to ideological considerations (democratic, cultural, etc.) can be a means to evaluate the quality of design. In fact, oversimplifying the application of "good design" in an ever-changing social context results in unsophisticated design thinking. Rather, HCI students must learn that: 1) "good design" is neither ambiguous nor overly systematic, and 2) design thinking includes a profound concern for human-centricity, while formulating insight from knowledge gained through understanding social contexts.

In conclusion, designers must develop an ability to judge what is or is not good design by "critically and independently formulating" their own "assumptions and beliefs."[67] This formulation process remains very personal and requires that designers use the full range of intellectual tools acquired throughout their career as researchers and practitioners.

60 L. B. Gouveia and F. Gouveia, "Evaluative Ethnography and Systems Design: Can It also Be Used to Assess Presence?" (paper presented at the *5th Annual International Workshop PRESENCE 2002, International Society for Presence Research*, Universidade Fernando Pessoa, Porto, Portugal, 2002).

61 B. A. Nardi, "Activity Theory and Human-Computer Interaction" in *Context and Consciousness: Activity Theory and Human-Computer Interactions,* B. A. Nardi, ed. (Cambridge, MA: MIT Press, 1996), 7–16.

62 T. Hemmings and A. Crabtree, "Ethnography for Design?" (paper presented at the *International Workshop on "Interpretive" Approaches to Information Systems and Computing Research*, London, 2002).

63 S. Greenberg, "Teaching Human-Computer Interaction to Programmers," *ACM Interactions* 3:4 (1996): 62–76.

64 J. D. Foley, A. V. Dam, S. Feiner, S. and J. Hughes, "Computer Graphics: Principles and Practice." (New York: Addison Wesley 1990).

65 D. A. Norman, *Emotional Design: Why We Love (or Hate) Everyday Things* (New York: Basic Books, 2004).

66 J. Löwgren and E. Stolterman, *Thoughtful Interaction Design* (Cambridge, MA: MIT Press).

67 Ibid.

Business

Although interactive product design needs to accommodate for marketing inputs from business and management, ideation and interaction design is often hampered and reduced to trivial interfaces that limit the impact of the overall process. Unfortunately, most economic models supporting business fail to recognize the benefit and related value that design and design management can offer. On the contrary, relative to the constraints of business priorities, product design must be about "creative and innovative thinking ...[where] the complexity of the process demands conceptual clarity from the design." [68]

For this reason, Norman[69] argued that designers must be educated about business strategies and processes, business culture, and business language, without becoming business professionals. As Laurel[70] suggests, the old model of market research was focused on developing packaging, branding, and an overall strategy for persuasive advertising. However, in the emerging paradigm, "the process is being inverted, with design research as a front-end method, informing the development of products and services from the concept stage forward." [71]

At present, many HCI students still have limited understanding of marketing and business strategies, and the relationship between design value and market value. Because human needs and target markets are more complex than ever, interactive product designers must identify individual needs and usability issues within the context of product marketability. As Laurel[72] explains, the process is much more about studying individuals, contexts, cultures, forms, history, and "even business models for clues that can inform design" and therefore amplify the designer's ability to "smoothly transmit values through design." In support of this perspective, Donoghue[73] notes that design and product usability are linked to revenues and profits as never before. She recommends that user experience should drive profitability based on a business strategy. Increasingly, successful user experiences are the most effective means to deliver a firm's value proposition to customers. She states: "Successfully leveraging the Internet [or any other interactive platform] requires that companies develop customer experiences that satisfy customers and drive profitability." [74]

Tiwana[75] states that achieving a good fit between the "design and its business objectives requires organizing and integrating the specialized expertise, skills, and perspectives of various project stakeholders into an appropriate, coherent, and practical solution." For example, knowledge about customer needs and requirements must be embodied not just in the "conceptual design, functionality, and features of the system, but also in intermediate design artifacts such as contracts, development plans, requirements, and specifications." [76]

68 Ibid.

69 D. A. Norman, "Making Design Successful within the Constraints of Business" (lecture notes from *Humans, Interaction, Technology, and Strategy (HITS) Conference*, Chicago Institute of Design, 2003).

70 *Design Research: Methods and Perspectives,* B. Laurel, ed. (Cambridge, MA: MIT Press, 2003).

71 Ibid.

72 Ibid.

73 K. Donoghue, *Built for Use: Driving Profitability through the User Experience* (New York: McGraw Hill, 2002).

74 Ibid.

75 A. Tiwana, "An Empirical Study of the Effect of Knowledge of Integration on Software Development Performance," *Information and Software Technology* 46: 13 (2004): 899–906.

76 Ibid.

An understanding of the relationship between consumer behavior and purchase influences, can directly improve product value and the way designers reflect on their strategic plan of research and development. Moreover, the type of research methodology to be assigned to students should teach them the most accurate, relevant, and expedient means to extract data. Raising this type of awareness and understanding between market influence and product value can help students make more precise correlations between ideation and human needs and preferences. Issues such as culture, demographics, and target branding demand an explanation that links theory to specific examples. This type of immediate application is especially necessary in today's hyper-social world of interactive media and 24/7 connectivity. Without course content that is tailored for current and emerging markets, HCI design students will not be equipped for future enterprises, which will demand making associations between particular users/consumers and design solutions.

HCI students should ultimately understand how to leverage the knowledge of social context and design with existing business conditions in order to more easily attach tangible value to the product. In fact, market planning should serve as a core component of building product knowledge while applying the craft of good design. What this means for HCI students is that best practice should resemble good market research within a highly iterative design process.

Computing

In brief, computing in the context of DEM is narrowly defined as the theory and application of building and testing interactive products, whether it be a static or dynamic prototype. Many, if not most, students in existing HCI or design programs have a relatively sound comprehension of information technology, programming, and/or software applications. However, few have a grasp on system design in relation to HCI theory and usability practice. For this reason, DEM provides both the theory and tools for conceptualizing, building, and testing interactive products. Simultaneously, students learn a broad range of quantitative and qualitative testing techniques that converge in their final thesis research. In addition to product testing, students learn research design and methodologies that allow for a scientific approach to analyzing quantitative and interpretative data.

Relative to design curricula, McCarron[77] notes that designers are being increasingly pressured to know more about research methodologies that can yield empirical results beyond the common use of focus groups. As a result, design schools are developing Ph.D. programs that provide their students with research skills, not only in data testing and analysis, but also skills that enhance their problem solving abilities. Clement Mok argues that the benefit of a Ph.D. in design is that they produce designers who have the training to do product analysis from a much broader perspective.[78] The goal

77 C. McCarron, "The Matter of Degrees: The Ph.D. in Design," *Communication Arts* 41:11 (2000): 256–70.

78 Ibid.

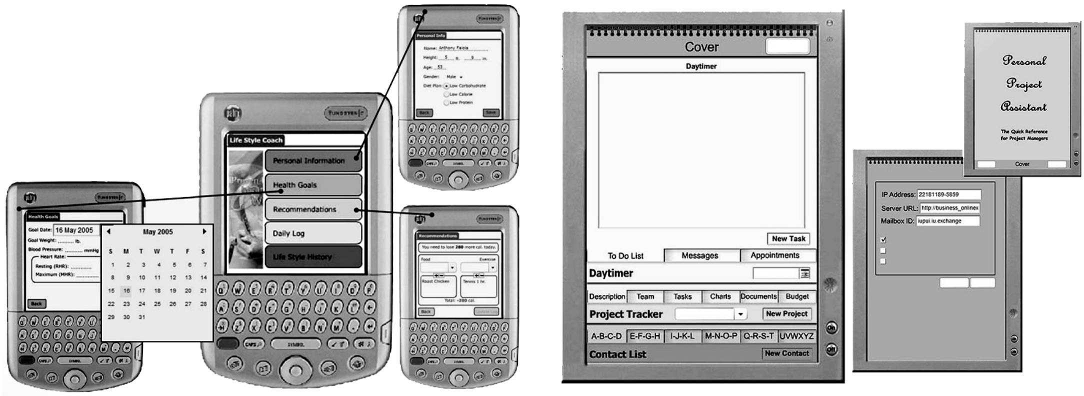

Figure 1
Illustrations of dynamic prototype interfaces of two student projects, the "Life-Style Coach" (left) and the "IT Manager" (right). © 2006 P. Taksaphan, C. Newlon, & A. Faiola.

of these programs, in part, is to: 1) advance the discipline by building an original body of knowledge through empirical research, 2) push the boundaries that have traditionally defined design, and 3) further develop the field so that it may emerge as a credible research discipline.[79]

DEM Applied to HCI Graduate Education

The application of DEM has been exploratory in the HCI Graduate Program at Indiana University Purdue University Indianapolis, School of Informatics. The program uses DEM as a curriculum blueprint that includes twelve courses made up of core requirements, electives, and a thesis. For students to comprehend the breadth of DEM's content domains, they collaborate through the life-cycle of numerous projects that integrate theoretical constructs, the application of processes, and the management of design knowledge (see Table 1).

Accumulative knowledge building occurs as students pass through each course within the program. It is noteworthy that because DEM is a new pedagogical model, it is under regular enhancement. Based on the analysis of student questionnaires and interviews, periodic modifications are made to learning outcomes, e.g., course project strategies, lecture content, and overall curriculum. These changes aspire to allow the HCI program to take better aim at moving learning targets influenced by the theoretical developments in the scholarly discipline and job specifications in industry.

DEM Applied to HCI Student Learning Case Study

Many HCI student projects call for teams of three or four, which are created with a mixture of skill-sets, genders, ethnicities, and student backgrounds. The development of the final prototype and report reflects the team's comprehension and application of various parts of the DEM framework acquired from the course text and supplemental materials, class lectures and discussions, and the actual process of design and design validation.

79 Ibid.

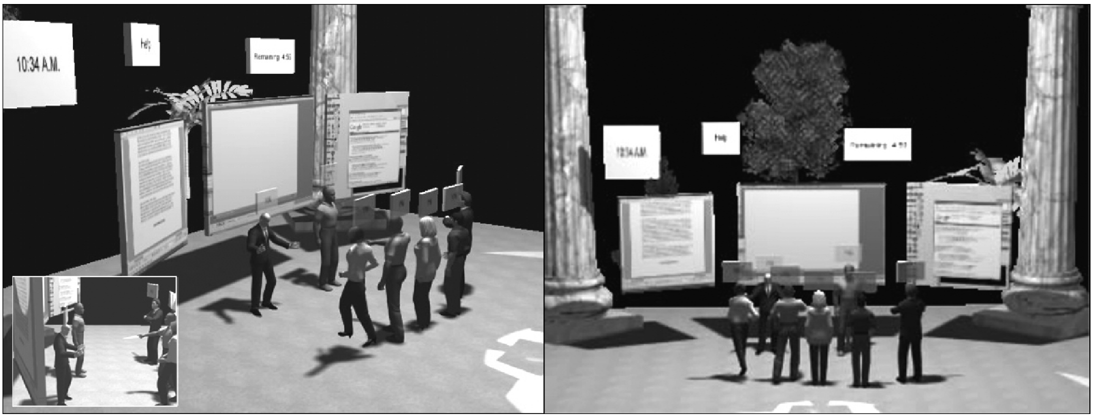

Figure 2
Illustrations of digital prototype depicting the 3D distance conferencing environment with user avatars of the product "MeetingSuite." © 2006 F. Fleming, N. Gray, D. Mann, J. Weber, & A. Faiola.

As shown by the HCI project case studies below (see Figure 1 and 2), the students' first step is to investigate the conditions and context of product use. Securing the adequate research data results in knowledge building of: (1) potential markets and users (local and global communities), and (2) economic, social, and (3) cultural contexts surrounding the identified problem space. Teams then design a compelling and innovative conceptual model through a methodology that directs team members to reflect on the existing problem solutions. Core to the learning process, students integrate and apply theory and design knowledge across the DEM knowledge domains obtained throughout the semester and throughout their graduate experience, right up to their final thesis project.

For example, one product called the Life Style Coach was designed to address the growing problem of obesity and the sedentary lifestyle by providing users with a support system to track diet and exercise, trade-off diets against exercise, and get recommendations to help meet those goals. Another team project, referred to as the IT Manager, was designed to assist in the management of teams and team oriented projects. The product was designed to integrate a range of management tools for IT manager support, including legal pads, loose-leaf organizers, laptops, PDA's, and DayTimers. (See Figure 1, left and right illustrations.) Lastly, a team designed a product that provides fundamental meeting support tools (e.g., audio, video, graphics, voice, text and streaming video of participants) for business conferencing for individuals and groups in a full-immersion virtual environment. (See Figure 2, left and right illustrations.)

In each case, design management and project strategizing is integral to the process of knowledge building and documentation. Issues investigated included: (1) the prospective technologies needed, (2) users and the overall target audience, (3) usability goals and user experience expectation, (4) design problem space and solution, (5) features/specifications and functionality, and (6) product scenarios. Deliverables included prototypes, documentation of cognitive walkthroughs, usability testing, and data collection, and analysis. In each project, students were required to submit detailed reports on methods of problem-solving, conceptualization, product usability, and user preferences.

Conclusion

As Arias, Eden, Fischer, Gorman, and Scharff[80] outline, the history of HCI has brought about "new challenges that center on the long-term theories of design, systems, technology, and media." Artifact creation, however, must be supported with knowledge of design processes and the ability to manage large amounts of information relevant to the design task in the context of different (disciplinary) perspectives of the problem. From this multidisciplinary perspective, DEM strives to deliver to HCI educators a broader range of tools, techniques, and theoretical models that are unified under a single framework.

Traditional HCI theory and methods are foundational, but limited, for delivering a full range of knowledge that can equip students for future trends of emerging technologies. Moreover, HCI programs that provide a broader curriculum must avoid the disconnect that often frustrates students from forming a clear and cohesive comprehension of the various domain areas within the discipline. Hence, the challenge HCI faculty face is building programs that demonstrate a shift to a broader, but more cohesive model that can address new knowledge domains that are well managed processes for designing new technology.

Faculty involved with core courses that center on HCI or interaction design must help students to learn the interplay between form, function, human need, social context, and business strategies, while highlighting the fact that designing interactive products draws upon multiple knowledge domains. As such, knowledge acquisition and knowledge building are structured processes, controlled by management channels that direct the procedure of doing and evaluating. In this process, students ask questions, obtain answers, and make decisions to build knowledge[81] that issues in effective products that benefit society overall.

In the real-world of designing interactive products, there are many constraints related to budget, technology, and team skill-sets and knowledge. Although these issues are diverse, they are addressable if HCI educators are prepared to provide students with solutions derived from a unified understanding of design as an enterprise of knowledge building. For this reason, DEM provides a holistic approach to help students connect the complexity of user needs and product requirements through design as knowledge management.

As HCI design students acquire skill-sets from multiple disciplines, the outcome will bring forth not only new design, but also

80 E. Arias, H. Eden, G. Fischer, A. Gorman, and E. Scharff, "Transcending the Individual Human Mind Creating Shared Understanding through Collaborative Design" (paper presented at the ACM Transactions on Computer-Human Interaction 2000), 85–87.

81 C. L. Owen, "Understanding Design Research: Toward an Achievement of Balance," *Design Studies* 19:1 (1998): 9–20.

a hybrid of new knowledge about design processes and intellectual inquiry that will extend the discipline. DeBono[82] suggests that the process of bringing forth new ideas (human knowledge) is a method of science. For HCI to advance as a pedagogical discipline, it must have a branch of thinking that can move it beyond the inevitability of formal thought that merely embraces "design and usability" as its sole call-to-arms. Rather, the collective domains of knowledge that have converged within HCI must now evolve and ultimately venture beyond the formal boundaries of the field to provoke new dialogues and new definitions of what it is and what it will become.

82 E. DeBono, *Lateral Thinking: Creativity Step by Step* (New York: Harper & Row, 1990).