2005

Discovering and Extracting Knowledge in the Design Project

John Zimmerman
Carnegie Mellon University

Shelley Evenson
Carnegie Mellon University

Jodi Forlizzi
Carnegie Mellon University

Follow this and additional works at: http://repository.cmu.edu/hcii
Discovering and Extracting Knowledge in the Design Project

John Zimmerman  
Human-Computer Interaction Institute and School of Design  
Carnegie Mellon University  
5000 Forbes Avenue  
Pittsburgh, PA 15213  
johnz@cs.cmu.edu

Shelley Evenson  
School of Design  
Carnegie Mellon University  
5000 Forbes Avenue  
Pittsburgh, PA 15213  
evenson@andrew.cmu.edu

Jodi Forlizzi  
Human-Computer Interaction Institute and School of Design  
Carnegie Mellon University  
5000 Forbes Avenue  
Pittsburgh, PA 15213  
forlizzi@cs.cmu.edu
Abstract

Over the last twenty years, the rapid adoption of the graphical user interface followed by the emergence of the World Wide Web has created an increasing demand for interaction designers and interaction design research. Knowledge generated by interaction designers is needed not only by other designers, but also by researchers and practitioners from other disciplines. This evolution has generated increasing pressure for more refined models of design research and design research dissemination.

To address this problem, we first explore the evolution of design documentation, detailing how it has evolved to meet the changing needs of designers. Then we present an opportunity map detailing where design projects produce knowledge. The map reveals areas for creating and communicating knowledge that is specific to interaction design, yet generalizable to a larger community that participates in interaction design.

Keywords

Design research, design documentation, design project, design case, interaction design, experience design.

1. Introduction

Design research, as grounded in the discipline of interaction design, has been growing in importance and influence. In the past twenty years, the scope of interaction design and related research efforts has expanded largely due to (i) the rapid acceptance of graphical user interfaces, (ii) the emergence of the World Wide Web as a communication medium, (iii) the introduction of mobile computing and communication devices, and (iv) research advances in computer agents, robotics, and ubiquitous computing. As a result, both the need for interaction designers and the complexity of interaction design challenges have increased.
This convergence of increasing demand and increasing complexity has produced a need for interaction design research that benefits designers as well as researchers and practitioners in and outside the field of human-computer interaction.

Interaction designers assist in designing appropriate and desirable products, and also in generating tools, methods, theories, and knowledge. However, the oral nature of the design process (Schon, 1983) often traps knowledge developed during a design project within individual designers and their artifacts. Instead of submitting research papers for peer review that can be accessed by large numbers of researchers through libraries, designers generally take a more social approach by conducting collaborative discussions, verbal critiques, and by entering final designs in competitions. The knowledge shared in discussions and critiques influences the design of the final artifact, but this knowledge is rarely captured in a formal way for the benefit of others. Instead, the knowledge spreads informally in the community (Wenger, 1999). This prevents designers from extending each other’s work and from building a collection of shared discoveries. What designers and authors writing about design produce instead are books that focus on deconstructing the influence of an individual designer’s work or the work within a larger design movement. Examples of these include books documenting the product design of Phillipe Stark (Stark, 1996) and books documenting the Bauhaus movement (Bartram, 2004).

Experts have offered many models of design research. These include: Nigel Cross’ three design research classifications: design epistemology, design praxiology, and design phenomenology (Cross, 1999); Susan Roth’s classifications: concrete & specific, conceptual, and theoretical & philosophical (Roth, 1999); Daniel Fallman’s classifications of design-oriented research and research-oriented design (Fallman, 2003); and Richard Buchanan’s classification scheme: clinical, basic, and applied (Buchanan, 1996).

While these models help in clarifying the processes, methods, and outcomes of design research, we have chosen in this paper to focus on
knowledge developed in the course of a design project, a type of research Buchanan refers to as clinical (Buchanan, 1996). Almost all design work conducted today resides within a project; therefore, we feel the best opportunity for increasing the output and significance of design research comes from identifying area in a project where knowledge can be extracted and documented for a larger audience.

In this paper we offer a brief overview of the history of design documentation, detailing how the documentation has evolved to meet the changing needs of the design community. We then offer an opportunity map detailing where knowledge can be produced and extracted in an interaction design project. Finally, we offer some insight into future work developing design documentation for better dissemination of research findings.

2. Evolution of Design Documentation for Extensibility

Disciplined design project documentation most likely began in earnest just after World War II at the Hochschule fur Gestaltung in Ulm. Their documentation of the systematic approach to design included not only the outcomes of design work, but also a rationale. The work influenced a generation of designers in Europe and abroad. In the book Design Coordination and Corporate Image, Henrion suggests that design coordination (later known as house style and eventually corporate identity) related to the organization and processes of an entire company (Henrion et al. 1967). He viewed corporate culture, behavior, market conditions, strategies, products, services and communications, and design as all needing to be coordinated. A process he described as “…an essentially complicated thing”. The strategies for coordination were documented in standards manuals, with the idea that these models and explanations would help manage corporate decisions. Henrion also stresses that the coordination should not be static, but instead continuously adjusting and improving.

This approach flourished in the United States. Examples include the design documentation produced by Lou Dorfsman “coordinating” CBS and Paul
Rand’s identity programs for IBM and Westinghouse. However, over time most documentation became examples of what to do (and more often what not to do) when applying an identity across an organization’s communication materials—far from the Henrion ideal. Inclusion of a rationale or how to think and build new expressions lost favor to documents detailing consistent application of visual identity. Coordination became less and less a part of the social network of the design community and instead fell to marketing managers within an organization.

During the 60s and 70s, mainly in the US and UK, a group of academics, including J. Christopher Jones (Jones, 1970) and Christopher Alexander (Alexander, 1970), conducted significant work in design methods and founded the Design Research Society. They also began publishing the Design Methods Journal. The society and the journal they produced brought together perspectives from engineering, architecture, design and ergonomics. The work they published began to define an approach to knowledge sharing across the boundaries of conventional design disciplines, and among psychologists and other scientific disciplines.

In the early 80s, at Fitch Richardson Smith, John Rheinfrank and others merged ideas from design methods, coordination and identity, producing a different kind of design documentation. The first example, produced for NCR, focused on communicating (coordinating) the design of the shift from conventional cash registers to new computing devices (thinking machines). The design document employed an introduction, series of models, and specifications to produce the coordination effect.

A more profound example comes from Fitch’s work to address usability across the range of Xerox’s reprographics products as well as to account for future extensions in printing and multifunctional devices. The work lasted over several years and culminated in a guidelines document and an extended rationale document. The extended rationale, called Principles for Constructing Communicative Objects and Object Systems for Interactive Dialogs, detailed the design and rationale for every element of a machine to support positive interaction (Xerox, 1985b) (see Figure 1). The goal was to help Xerox’s staff
understand the multidisciplinary research findings and principles that drove the design approach as well as provide a lens for extending the work in future products. The Xerox guidelines and rationale document communicated reusable information for extensions in design (Xerox, 1985a). These were truly guidelines designed for designing.

Figure 1. Pages from Xerox' Reprographics Products Guidelines.

The introduction of the Macintosh in 1984 inspired a rapid proliferation of screen-based interfaces and created an entire new need for both interaction designers and for more guidance on design for interaction. As more designers became involved in creating complex systems, they continually encountered the need for designs that could easily be extended. This was a return to Henrion’s model of coordination as continually adjusting, only instead of a focus on constant improvement, these design documents were intended to aid the
evolution of software interfaces as new features and methods of interaction were developed. This shift made guidelines and rationales much more important than a list of identity or interaction rules. In a similar vein, Xerox developed the principled design of direct manipulation interfaces (Bewley et al. 1983).

Each operating system began to publish specified interface standards. Basic principles for interaction began to appear in the standards guides. An example from Apple, the Apple Human Interface Guidelines, included interface design principles such as metaphors, consistency, and aesthetic integrity (Apple, 1992). The documentation of these design principles, which grew out of the design efforts to create the operating system (design project), created both a singular language for interaction designers to converse in and laid a foundation from which new interaction design models could emerge.

Other firms have also produced similar documents but under other names. Meta Design often includes a comprehensive rationale for their work in the form of project or process documentation. The documents offer the potential to extend the design system by documenting the knowledge created during the design process and capturing it in a rationale in order to help others reproduce design results. The difference is that these client driven documents are not published, trapping the design knowledge in the participating designers and within a set of locked documents.

The production of these standards manuals by companies like Meta and Apple made development of next generation products much easier. However, these documents offered almost nothing to designers working on similar or related projects. For example, one project explored how users become attracted to and oriented to desktop computers. To find the answer, these companies pulled out insights from their research findings and implications. In documenting only the specific rationale (insights), these documents lost the ability to communicate more generalizable knowledge found in the raw findings and their specific implications. This kind of knowledge may have been discussed at conferences and seminars, but since design conferences rarely produce written proceedings, the knowledge fades over time, forcing a process of constant re-
discovery. Reaching a broad, multidisciplinary audience remains a challenge for this community. Some designers have successfully published work in the proceedings of the Conference on Human Factors in Computing Systems (CHI) and Conference on Designing Interactive Systems (DIS), but there is still an opportunity to address a wider audience than the academics and researchers that attend these conferences.

In 2001 and 2002 the AIGA Experience Design community and members of the CHI community collaborated on an event called the CHI2002|AIGA Experience Design Forum. The primary purpose of the Forum was to showcase case studies in experience design. The Forum brought a broader design community together with the CHI community. At the Forum, participants defined a case as “an articulate presentation of the justified understanding of the experience of real users of a designed and delivered artifact” (AIGA, 2004b). A broader based conference called Designing for User Experiences (DUX) followed a year later. The extended DUX model added practice studies, design research studies and sketches to design cases.

Designers participate at DUX by filling out a case study template and submitting it through peer-review process for presentation at the conference and/or addition to the AIGA case study archive. The templates include: an abstract, a problem statement, roles within the design team, timeline of the project, design process (including research, ideation, and iterative design), and a short description of the solution. By making the archive freely accessible, the DUX community hopes to “build a teachable and learnable body of knowledge…” (AIGA, 2004a).

DUX provides a forum for documenting design projects and process, but more than just process information can be derived from design cases, especially if the work extends across a range of products or services. DUX cases provide anecdotal information about specific design projects. The case studies are designed, and probably limited to, an audience of designers, and are not searchable or linkable across content sub-topics. While a step in the right direction, DUX cases have limited extensibility and reach a limited audience.
3. Knowledge production in design processes

In order to illustrate opportunities for extraction and documentation of knowledge created during design projects, we propose the following knowledge opportunity map (see figure 2). The top of this map details stages of a traditional user-centered interaction design process running from defining the design problem to reflecting on the final solution and other's reaction to this solution. At each step along the way, designers have opportunities to capture the knowledge they generate. The flow of these opportunities funnels from the broad discoveries made early in a project to more project specific discoveries made toward the end.

![Knowledge Opportunities in the Design Process](image)

**Figure 2.** Knowledge Opportunities in the Design Process.

During the Define stage of a project, designers typically build rough visual models to better understand the problem space, seeking input from the technical development staff and from the marketing and business units involved. This stage provides opportunities to capture internalized representations of the user from these different groups. This information, while not usually generalizable, can prove quite valuable in developing methods for communicating observed user needs back to these groups. The information potentially becomes more generalizable when several projects have been completed. Researchers can look for the nature of the shift from existing model to future model or how attitudes
about the target demographic have changed and look for triggering products and/or service models that effected this change.

The *Discovery* phase involves fieldwork where designers explore user needs and contexts. Often seen as the domain of behavioral science, designers have a long history, particularly in product design, of conducting clinical research in this phase. Research conducted here is almost always of value to other designers and non-design researchers working on project with either similar contexts or similar demographics. A great example of this can be found in the video ethnographies done by the Doblin Group for SAS Airlines (Doblin, 1998). The videotapes they made of air travelers advancing their suitcases over and over as they snaked through the check-in lines are of value to any researcher exploring different contexts around air travel. This data is valuable to architects expanding, remodeling, and designing new airports; to airlines exploring new service opportunities; to suitcase manufactures; and to many others. The discovery phase is particularly valuable to interaction designers because it reveals cognitive and task models users currently employ to meet their needs.

*Synthesis* involves the exploration of implicit and explicit relationships between user needs, products, services, and contexts. This phase often reveals gaps in current product offerings or between the cognitive and task models employed by users and the companies making products and services. The knowledge generated in this phase may not be as generalizable as that gained in the discovery phase; however, this knowledge almost always goes far beyond the confines of the individual design project. For example, a design project focusing on keyless entry to automobiles may discover gaps between how families use their minivans and how car manufacturers imagine they use their minivans. Recording these discoveries in documents outside of the traditional design case increases the chance they can be effectively used for other automotive innovation projects.

The *Construct* and *Refine* phases form the nucleus of an iterative design process. Designers quickly generate and evaluate concepts based on relationships and opportunities identified in the Synthesis phase that relate to the
specific project. While most of the knowledge generated in this phase relates specifically to the project, much of it is still generalizable. A good example of this can be found in the Stroke interaction method (Zimmerman et al., 2004). Developed specifically for navigating long lists of options on an LCD-touch-screen remote control, this interaction method could generalize to navigation of long lists on many touch-screen devices.

Finally, the Reflect phase also provides opportunities to generate and document knowledge valuable to designers and other researchers not related to the specific project. Three clear opportunities stand out. The first involves reflection on the design process. Design researchers can examine their own process throughout the case and identify opportunities for increasing efficiency. Also, through the collection of reflections and summaries of many case studies, designers can begin to develop models that allow them to more accurate estimate both the time and resources needed for future projects. Second, designers can monitor how the intended user group accepts a product or service. Linked with both the stereotype user models identified in the Define phase, the user mental and process models detailed in the Discovery phase, and the outcomes of evaluation conducted in the Construct and Refine phases, this information can help better determine possible deltas between design intention and design acceptance. Third, reflection on the final design with a reexamination of opportunities identified in the Synthesis phase can lead to new product concepts, new design projects, and new directions for technological development with documented market potential.

4. Conclusion

Rapid growth of interaction technology and devices has lead to an increased need for interaction design research. In this paper we have focuses on the design case as an unexploited opportunity to capture and share design knowledge. We have presented an opportunity map that provides an initial framework for exploring new models of project documentation that makes the
knowledge generated available to a much wider audience. This is a necessary evolutionary step in the development of design documentation. Our future work will develop a specific model of design case documentation that allows more generalizable knowledge to be easily integrated and retrieved by designers and by researchers and practitioners from other disciplines.

5. References

1. AIGA (2004a) Case Study Archive, AIGA Website: http://www.aiga.org/content.cfm?ContentID=989.


