ONTOLOGY OF DESIGNER-USER INTERACTION PATTERNS IN THE DESIGN PROCESS

JAEHYUN PARK
TOKYO INSITUTITE OF TECHNOLOGY
PARK.J.AI.@M.TITECH.AC.JP

ARKALGUD RAMAPRASAD
UNIVERSITY OF ILLINOIS AT CHICAGO
PRASAD@UIC.EDU

ABSTRACT

In this study, we develop an ontology of designer-user interaction patterns in the design process. As the business-design paradigm has shifted from being industry-oriented to a customer (user)-centered one, the designer-user interaction has become critical to identifying the design requirements and the design's functions, and hence in creating better outcomes from the design process. Yet, previous studies on designer-user interaction in information systems, organizations, and design in general have not formalized the forms of designer-user interaction, their sequence, and their evolution in the design process. We address this gap as a research problem. To do this, we ask the following research question--What ontology of designer-user interaction patterns is associated with design innovation, design refinement, or design co-creation in the design process? Based on Churchman's system theory as a theoretical foundation, one of the authors conducted qualitative interviews with thirty-five designers. From this, he collected ninety-nine design project narratives as research data, and analyzed them using a grounded theory approach. Based on this ontology, this study presents a case study (a project narrative) of how designer-user interactions could function in creating a design innovation.

INTRODUCTION

Design environments have become more complex for creating new design artifacts. As Redstrom (2006) argued, the current business-design paradigm has shifted from industry-oriented to a customer (user)-centered one, in which the meaning of design has been enhanced from visible functionalities of products and systems to invisible interaction and experience of services. In this business-design era, companies have increased their product knowledge in developing features and functions of existing products, even as they do not have enough knowledge of their customers and their behaviors. To decrease the companies' gaps of knowledge about customers, new product developers (e.g. designers) need to pay more attention to understand users and their information environment.

Since Moholy-Nagy (1947) user-centered design (UCD) and participatory design (PD) research communities have sought to theorize the importance of interaction between designers and users for understanding and improving the design process. Doblin (1987) called for more systematic design approaches theorized two design dimensions. First, design as process consisting of analysis, genesis, and synthesis. Second, design as state, with three levels of complexity. With these two dimensions, he proposed six types of effective design methods in a design matrix. The matrix expanded the meaning of design and focused on the importance of system approaches in the contemporary design contexts. Some UCD and PD researchers have argued the importance of interactions between designers and users (Cross, 2001; Ehn, 1993; Kyng, 1991); however, previous studies on designer-user interaction in information systems, organizations, and design in general have not formalized the forms of designer-user interaction, their sequence, and their evolution in the

design process. This study addresses this gap as a research problem.

This study explores an ontology of designer-user interaction patterns in the design process and asks the following research question--What designer-user interaction patterns is associated with a design innovation, design refinement, or design co-creation? To address this research question, this study adopts Churchman's system theory as a theoretical foundation to understand the interaction patterns of how designers could interact with actual users in the design innovation, refinement, and co-creation.

As an empirical evidence, one of the authors conducted qualitative interviews with thirty-five designers who have design project narratives with actual users in the design process. Based on this, he collected ninety-nine design project narratives as research data, and analyzed them using a grounded theory approach (Charmaz, 2006; Strauss & Corbin, 1990). Based on this analysis, we seek to theorize an ontology of designer-user interactions patterns. As a result, the ontology of designer-user interaction has five components: (1) Participants, (2) Roles, (3) Functions, (4) Types of design outcomes, and (5) Design objectives. Each dimension is articulated as a taxonomy. To demonstrate how the ontology of designer-user interaction, this study presents a case study of how designer-user interactions could function in creating a design innovation in a design process.

This study makes three contributions. First, it theorizes the ontology of designer-user interaction systemically and systematically. Second, it provides a practical guideline of how designers could interact with actual users (customers) in the design projects. Third, it highlights a design vocabulary for explicating the knowledge of how current user-centered design practitioners could invite, interact, or co-create with actual users in the design process.

LITERATURE REVIEW

In previous studies, participatory design (PD) community has considered the designer-user interaction in their research disciplines.

Early PD research has focused on enhancing multi-stakeholders' collaborations, and it has dealt with the complexity of emerging design requirements, stemming from different people, organizations, and technologies in a design process. The primary question of PD literature is how end-users can contribute to the process of design development as co-designers (Schuler & Namioka, 1993), and it deals with organizational techniques that participants can use to manage their conflicting interests in a design process (Mumford & Ward, 1968).

Based on the significance of participation design (PD), the participatory design literature consists of the collective resource to system design (CRA) (Bjerknes, Ehn, & Kyng, 1989), information systems development (Bansler, 1989; Dahlbom & Mathiassen, 1993; Hirschheim & Klein, 1989; Suchman, 1998), and computer supported cooperative work (CSCW) (Bansler, 1989; Greenbaum & Kyng, 1991). From this research, I can summarize participatory design (PD) and related works in in Scandinavia that can help designer-user interactions.

The tradition of meta-design considers that PD research offers a context-centered design approach that outlines conflicting interests and suggests a solution from the design process (Kyng, 1996; Suchman, 1998). The contexts for design proposition deals with the organizational context of design in order to discover the conditions for effectively organizing projects and for incorporating organizational techniques and tools. Also, the context-centered design approach investigates the effectiveness of cooperating tools and techniques among participants in PD.

Fischer & Scharff (2000) proposed 'meta-design' characterizing activities, processes, and objectives to create new media and environments that allow users to act as designers and be creative in the context of a particular system and participatory design processes. Fischer (2003) argued a fundamental objective of meta-design to create socio-technical environments that empower users to engage in informed participation. The suggested model explains how designers could incorporate users with the three conceptual stages: seeding, evolutionary growth, reseeding. This model demonstrates how designer-user interactions could support meta-design in the design process. Fischer & Giaccard (2006) outlined the diversity of designers and users stemming from passive customer to meta-designer in the designer development. With this categorization, they demonstrated how designers could provide the opportunities of users as designers addressing and overcoming the problems of closed systems. This meta-design approach involves seeing the designer-user interaction as a collaborative construction of mutual knowledge with which design problems are defined and solutions are created. It shifts the focus from how users' current knowledge is revealed to designers to how the interaction expands designers' and users' knowledge. This approach works better for the actual design process where not only solutions but also problems evolve over time (Dorst & Cross, 2001; Suwa, Gero, & Purcell, 2000). Based on this approach, designers and users are encouraged to think beyond the knowledge within a person, department, or problem domain by reframing the current design problem and finding solutions from various domains.

PD research has emphasized user-driven innovation in design methods and the concepts of collaboration. Buur et al. (2000) argued a critical issue of utilizing video in the ethnographic data or fieldwork materials, because visual data and material are the core objects to reflect real interactions with users and participants in the design process. Especially, non-participated

stakeholders (e.g. designers, managers, and IT developers) could reflect the real moments of interactions in the fields based on the raw data. Buur & Bødker (2000) argued 'design collaboratorium' as a design approach that creates an open physical and organizational space where designers, engineers, users and usability professionals meet and work alongside each other. It illustrates how it is possible to reframe usability work and it discusses the new usability competence such as event-driven ways of working known from participatory design. Burr et al. (2004) posited the limitation of tangible user interaction of how projects and service design processes could highlight a particular user's tasks and contexts. To address this, they suggested two tangible user interactions techniques: (1) Hands-Only Scenario and (2) Video Action Wall. The Hands-Only Scenario is a 'close-up version' of the dramatised use scenario, while the Video Action Wall is a technique of 'live post-its' on a (projected) computer screen. Little snippets of action videos running simultaneously help designers understand user actions by the qualities they represent. Buur & Matthews (2008) overviewed three of the dominant approaches for engaging with users in co-innovation of products and services, in which they compared the three perspectives in terms of goals, methods and basic philosophy and discussed research directions of what they see as fundamental to the development of user-driven innovation.

In summary, the PD research community has developed four research concentrations. First, it has highlighted the importance of multi-stakeholders' collaborations. Second, it considers meta-design as a context-centered design approach to outline conflicting interests and suggests a solution between designers and users. Third, PD research has supported to user-driven innovation in design methods and the ideas of design collaboration. Considering this research concentration into designer-user interactions, the PD research have contributed theoretical and practical propositions to identify problems and solutions in-between IT and human-centered innovation. Yet, previous studies on designer-user interaction in UCD and PD in general have not formalized the forms of designer-user interaction, their sequence, and their evolution in the design process. We address this gap as a research problem.

THEORETICAL FOUNDATION

To address the research question, we invite Churchman's system theory as a theoretical foundation. In his system approach, Churchman (1968) defined 'a system is a set of parts coordinated to accomplish a set of goals' (p. 29). With this insight, he highlighted the importance of causality among parts, sub-systems, and systems for supporting the whole system and summarized five steps of system thinking approach as follows: 1) the total system objectives and, more specifically, the performance measures of the whole system; 2) the system's environment: the fixed

constraints; 3) the resource of system; the components of the system, their activities, goals and measures of performance; and 5) the measurement of the system (p. 29¬30). In these five steps, he represented the ways for identifying a system as a whole and the relational components as the system partners.

Based on this theoretical definition, this study adopts his system theory as a conceptual framework for arguing the casual relationships between designer-user interaction and their resulting outcomes. To explore an ontology of designer-user interaction, we seek to identify the ontology of designer-user interaction as the design whole, while we regard each component of designer-user interaction and resulting outcomes as the design parts. By this understanding, this study categorized five components as design parts in order to support whole designer-user interaction ontology. The five components are: 1) participants, 2) roles, 3) functions, 4) design, and 5) outcomes. In detailed, the participants and the roles could characterize major stakeholders, and functions could identify designer-user interaction characteristics. The design summarizes objectives of design such as design innovation or refinement sequences. The outcomes deal with the design measurement. Based on Churchman's system theory approach, we seek to identify an ontology of designer-user interaction in the sequences of design innovation, refinement, and co-creation.

METHODOLOGY

As a qualitative research, one of authors sought to analyze actual designer-user interactions in their real project episodes. During the interviews, he asked three questions about how designers could interact with actual user and incorporate their design outcomes in the design process. The first question was to collect their design innovation project narratives, while the second question was to acquire designers' refinement project narratives with actual designer-user interactions. The third question was to understand co-creations between designers and users in the design process.

This study collected ninety-nine design project narratives from the thirty-five designer interviews. In the data collection, the thirty-five interviewees (participated designers) tried to share their project episodes on each question. As Table 1 shows, the collected interview data presents the different number of data on each question. It has thirty-two innovation, twenty-seven refinement, and forty co-creation project narratives.

Project Narratives	Number of Data	Design Artifacts		
		Products	Systems	Services
Innovation Project	32	12	11	9
Refinement Project	27	11	12	4
Co-creation Project	40	18	15	7
Total	99	41	38	20

Table 1: Collected Interview Data

To understand generative actions between designers and users, this study transformed all transcribed design project stories as visual process sequences to understand the micro dynamic patterns of how designer-user interaction went through a procedural path in creating design outcomes over time. In this analysis process, this study used the sequence diagrams as an analytic tool for exploring the patterns between the designer-user interaction in the design innovation and refinement sequences.

This data analysis followed the three steps of the grounded theory approach (Strauss & Corbin, 1990): from open, to axial, and to theoretical coding processes. In the open coding step, this study reviewed every single line of project stories to clarify codes, themes, and memos in the transcribed project stories. Also, it analyzed designer-user interactions and the applied methods in the design processes. As a result from the open coding, it outlined each project story with characteristics of designer-user interactions and applied design methods over time. Based on the open coding process, ninety nine project process diagrams were synthesized, which represent designer-user interactions and the applied design methods in the process of design projects in the axial coding step. In this step, one of author compared the similarities and differences and sought to categorize the project diagrams. After the axial coding process, he performed a theoretical coding process to incorporate the given process diagrams to synthesize patterns between designer-user interaction and their resulting outcomes in the sequence of design innovation and refinement.

ONTOLOGY OF DESIGNER-USER INTERACTION

Based on this analysis we theorize an ontology of designer-user interactions patterns shown in Figure 1. A detailed description of ontological analysis is provided by Ramaprasad and his co-authors (Ramaprasad & Syn, 2013a, 2013b; Ramaprasad, Syn, & Win, 2014). The ontology has five dimensions: (1) Participants, (2) Roles, (3) Functions, (4) Types of design outcomes, and (5) Design objectives. Each dimension is articulated as a taxonomy.

Participant		Role		Function		Design		Outcome	
User	[as]	User	[+]	Participation	[for design]	Innovation	[for]	Efficient	[design]
Designer		Designer		Virtual		Discovery		Effective	
				Real		Validation			
				Interaction		Strategy			
				Designer-driven		Refinement			
				User-driven		Problem analysis			
				Co-creation		Methods			
				Rhetoric		Testing			
				Dialectic		Reflexivity			

Illustrative Components (out of 2*2*6*7*2 = 336 components):

User as user participation $_{virtual}$ for design innovation $_{validation}$ for efficient design.

User as designer $_{designer-driven}$ interaction for design refinement $_{testing}$ for effective design.

Designer as designer co-creation $_{dialectic}$ for reflexivity for effective design.

Designer as user co-creation $_{dialectic}$ for design innovation $_{discovery}$ for efficient design.

Figure 1: Ontology of Designer-User Interaction Patterns in the Design Process

Figure 1: Ontology of Designer-User Interaction in the Design Process

The left two dimensions capture the two key participants in the design process and their roles as themselves and the other. Thus a User can play the role of a User or of a Designer, and the Designer can play the role of a Designer or a User. These four combinations can be in the context of the three Functions (the third dimension) – Participation, Interaction, or Co-creation. It must be noted that the Participation may be Virtual or Real; Interaction may be Designer or User-driven, and Co-creation may be Rhetorical or Dialectic – they are shown as subcategories of the taxonomy of Function. The combination of Participant + Role + Function may be with reference to Innovation in design, Refinement of design, or Reflexivity in design – the three are shown as the taxonomy of Design. Within Innovation the focus may be on Discovery, Validation, or Strategy; and within Refinement on Problem analysis, Methods, or Testing. These are shown as subcategories in the Design taxonomy. Last, the final outcome may be an Efficient or an Effective design.

Concatenating an element from each of the dimensions, left to right, with the connecting words and phrases generates a natural English sentence which can be a component of the designer-user interaction pattern in the design process. There are 336 components encapsulated in the ontology. Four illustrative components are:

1. User as user participation virtual for design innovation validation for efficient design.

2. User as designer designer-driven interaction for design refinement testing for effective design.

3. Designer as designer co-creation dialectic for reflexivity for effective design.

4. Designer as user co-creation dialectic for design innovation discovery for efficient design.

The 336 components can be said to define the system of designer-user interaction. A select set of components can be used to define the pattern of a design process systematically. We illustrate the application of the ontology in the following case study.

CASE STUDY

To present an ontology of designer-user interactions, this study illustrates a case study (Yin, 2009) of how designer-user interactions could identify the components of designer-user interaction ontology in the design process.

A Project Story Reflecting Ontology of Designer-User Interaction

The design project episode of Alpha Company presents two different cycles. First cycle deals with designers' interactions in their everyday activities, in which designer (participant) takes the role of designer (designer as designer) functions a designer-driven for design discovery for new innovations. On the other

hand, the other cycle involves the designer-user interactions in a temporality in the design process, in which user (participant) takes the designer role functions user-driven validation and discovery for new innovations. At the second cycle, the designer and the users change their roles (designer as user and user as designer) function the co-creation (rhetoric and dialectic) for effective design innovations.

This Alpha Company project episode presents how everyday designers' discovery and validation can be incorporated by the temporal designer-user interaction (e.g. once a month in this case) in the process of product-service design development.
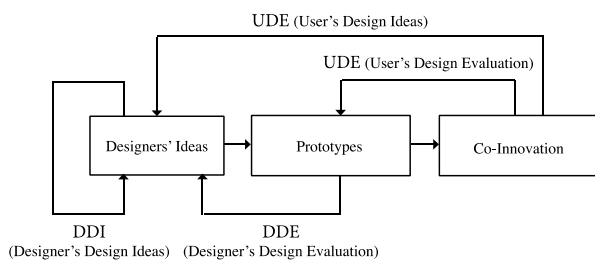

Figure 2: Alpha Company's Project Story

As Figure 2 presents, the Alpha Company's project story demonstrated a routine which identified designers' discovery and validation among designers (designer as designer) in their everyday activities and interactions (designer-driven innovation). With these design ideations and concept development, designers created fast prototypes as the temporal outcomes from their actions. To create fast prototypes, the Alpha designers used two prototype tools (Axura and Invision), and they validated their prototypes with their internal designers and product managers. This discovery and validation cycle supported how designers could develop their design ideas and create potential business-design opportunities.

Based on the discovered and validated prototypes, in the second cycle, the Alpha Company designers performed a co-creation session (user-driven innovation / co-creation) with real users of the Alpha systems. To conduct this co-innovation session, a general manager of Alpha invited real users every month to validate Alpha's new design ideas and prototypes. This co-op innovation acted as a collaboration session to share how Alpha designers deeply considered their users to create new products, services, or concepts for generating user values in their everyday design activities and interactions. By this monthly session, designers' everyday routine was transformed by the cycle of users' validation and discovery. In this moment, users acted as designers. This co-creation and co-evaluation as parts of the second cycle reinforced or expanded the designer's ideas, concepts, and prototypes in the design process.

As this project episode presents two inter-related cycles: designers' ideas, feedback about their resulting outcomes (e.g. prototypes) in the first cycle; and users'

feedback and their suggesting ideas for designers' ideas in the second cycle. In this project, the different types of prototypes act as boundary objects, which connect everyday's designers' interactions reflecting on users and their temporal interactions. As the Alpha Company episode presents, this highlights how designers can effectively communicate with both designers and users. Here, design prototypes perform as boundary objects to reinforce and expand different knowledge boundaries between designers and users in the design process.

IMPLICATION AND CONCLUSIONS

This research explores an ontology of designer-user interaction patterns in the design process, and two contributes are summarized for the communities of the designer-user interaction.

First, it theorizes the ontology of designer-user interaction concerning the Churchman's system approach. In previous research, designer-user interaction has theoretically considered the importance of designer-user interaction in management science, information systems, and other design associated studies. Particularly, user-centered design (UCD) and participatory design (PD) research communities have developed the concept of designer-user interaction. In UCD, previous studies suggested design dialogues of how designers could communicate with users and effective methodologies. On the other hand, PD studies have highlighted co-creation between designers and users in order to achieve ideal interactions among multiple stakeholders in the design process. Thus, these communities have identified ideal and theoretical propositions of how designers could interact with actual users. Yet, this study highlights the gap between ideal and actual designer-user interactions, and it empirically explores the ontology of designer-user interaction based on qualitative interviews.

Second, it provides a practical guideline of how designers could interact with actual users (customers) in the design projects. Prior designer-user interaction studies have theoretically identified concepts of how designers could interact with actual users; however, it remains limitations for practitioners how they could interplay with real customers in the contexts of design process. With this gap, this research outlines the whole interaction between designers and users from a large amount of project cases (collected ninety nine project narratives), and it suggests an ontology of designer-user interaction. Therefore, this research would give a practical action plan for the UCD and PD researchers and practitioners.

Third, it highlights a design vocabulary for explicating the knowledge for current user-centered design practitioners. Since user-centered design (UCD) approach and participatory design (PD) have spread out designer-user interaction in research and practice areas, they have addressed weaknesses and improved the traditional client-centered design methods and

managerial decisions by ethnographic research, user interviews, usability testing, or ergonomic studies. Broadly, this research has effectively brought / invited users into design place; however the established design methods and models have limitations. They must overcome the requirements of current IT and systems, user experience, innovation, and service design practitioners. Complex business environments call for multiple aspects, methods, and relationships with users in creating successful management and innovation applications. Yet, in reality, there were no directions and guidelines to identify users and communicate with them. Therefore, this study suggests positive directions for practitioners to develop a set of practical manners and new design vocabularies with users in the design process.

REFERENCES

Bansler, J. (1989). Systems development research in Scandinavia: Three theoretical schools. Scandinavian Journal of Information Systems, 1(1), 1.

Bjerknes, G., Ehn, P., & Kyng, M. (1989). Computers and democracy : a Scandinavian challenge. Aldershot: Avebury.

Buur, J., & Bødker, S. (2000). From usability lab to "design collaboratorium": reframing usability practice. Paper presented at the Proceedings of the 3rd conference on Designing interactive systems: processes, practices, methods, and techniques.

Buur, J., Binder, T., & Brandt, E. (2000). Taking video beyond 'hard data'in user centred design. Paper presented at the Participatory design conference.

Buur, J., Jensen, M. V., & Djajadiningrat, T. (2004). Hands-only scenarios and video action walls: novel methods for tangible user interaction design. Paper presented at the Proceedings of the 5th conference on Designing interactive systems: processes, practices, methods, and techniques.

Buur, J., & Matthews, B. (2008). Participatory innovation. International Journal of Innovation Management, 12(03), 255-273.

Charmaz, K. (2006). Constructing grounded theory : a practical guide through qualitative analysis. London [u.a.]: SAGE.

Churchman, C. W. (1968). The systems approach. New York: Delta Books.

Cross, N. (2001). Designerly ways of knowing: Design discipline versus design science (The 1920s and the 1960s, two important periods in the modern history of design). Design Issues, 17(3), 49-55.

Dahlbom, B., & Mathiassen, L. (1993). Computers in context : The philosophy and practice of systems design. Cambridge,Mass.: NCC Blackwell.

Doblin, J. (1987). A short, grandiose theory of design. STA Design Journal, Analysis and Intuition, 6-16.

Dorst, K., & Cross, N. (2001). Creativity in the design process: co-evolution of problem–solution. Design Studies, 22(5), 425-437.

Ehn, P. (1993). Scandinavian design: On participation and skill. Participatory design: Principles and practices, 41-77.

Fischer, G. (2003). Meta-design: Beyond user-centered and participatory design. Paper presented at the Proceedings of HCI International.

Fischer, G., & Giaccardi, E. (2006). Meta-design: A framework for the future of end-user development End user development (pp. 427-457): Springer.

Fischer, G., & Scharff, E. (2000). Meta-design: design for designers. Paper presented at the Proceedings of the 3rd conference on Designing interactive systems: processes, practices, methods, and techniques.

Greenbaum, J. M., & Kyng, M. (1991). Design at work : cooperative design of computer systems. Hillsdale, N.J.: L. Erlbaum Associates.

Hirschheim, R., & Klein, H. (1989). Four paradigms of information systems development. Communications of the ACM, 32(10), 1199.

Kyng, M. (1991). Designing for cooperation: cooperating in design. Communications of the ACM, 34(12), 65.

Kyng, M. (1996). Users and Computers-A Contextual Approach to Design of Computer Artifacts. DAIMI Report Series, 25(507).

Moholy-Nagy, L. s. (1947). Vision in motion: P. theobald.

Mumford, E., & Ward, T. B. s. (1968). Computers: planning for people. London: Batsford.

Ramaprasad, A., & Syn, T. (2013a). Design Thinking and Evaluation Using an Ontology Proceedings of the European Design Science Symposium (EDSS) 2013. Dublin, Ireland.

Ramaprasad, A., & Syn, T. (2013b). Ontological Meta-Analysis and Synthesis Proceedings of the Nineteenth Americas Conference on Information Systems Chicago, IL, USA.

Ramaprasad, A., Syn, T., & Win, K. T. (2014). Ontological Meta-Analysis and Synthesis of HIPAA Proceedings of PACIS 2014. Chengdu, PRC.

Redstrom, J. (2006). Towards user design? On the shift from object to user as the subject of design. Design Studies, 27(2), 123-139. doi: 10.1016/j.destud.2005.06.001

Schuler, D., & Namioka, A. (1993). Participatory design : principles and practices. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Strauss, A. L., & Corbin, J. M. (1990). Basics of qualitative research : grounded theory procedures and techniques. Newbury Park u.a: Sage Publ.

Suchman, L. (1998). Human/machine reconsidered. Cognitive Studies, 5(1), 1.

Suwa, M., Gero, J., & Purcell, T. (2000). Unexpected discoveries and S-invention of design requirements: important vehicles for a design process. Design Studies, 21(6), 539-567.

Yin, R. K. (2009). Case study research: Design and methods (Vol. 5): sage