Transforming User Information into User Knowledge: A Multiple Case Study

Isil Oygur, Bahcesehir University, Turkey

Abstract

This paper reports a multiple case study conducted at six design consultancies from the fields of architecture, industrial design, and interior design. The data was collected through short-term field studies at each consultancy. The focus was on exploring how designers know about users while designing. According to the constructivist learning theory, the learner is not a passive receiver of information. Instead, learning requires construction of knowledge from information. In line with this theory, it was observed that in their design process, designers at studied consultancies did not always utilize the user information available to them as it is. Instead, designers' references to users were more abstract and interpreted in character. Thus, user is a *constructed* phenomenon in the design process. There are multiple personal and organizational mediators that play a role in the construction of designers' user knowledge. Through these mediators, designers transform the user information into user knowledge and utilize this user knowledge, which is in the form of tacit user model, within their design process.

Keywords

User has been an intense area of study in academia and practice of all design disciplines over the past 30 years. An increasing number of firms employ design researchers conducting user research. Many books and articles have been written on different aspects of user in design (e.g. user-centered design, user experience, user involvement). Conferences have been held. Communities have been established. Educational programs focusing on user involvement have been launched. Despite these efforts and resources, a holistic understanding of user as a design factor and its influence on the act of designing have yet to be clarified (Boztepe, 2007; Melican, 2000; Sleeswijk Visser, 2009) with studies exploring the designers in action.

To study the user from a different perspective, this study specifically looks at *how designers learn about the user* and uses the constructivist learning theory from education literature as its theoretical framework. Constructivist learning theory came out as a reaction to old inscriptive approach to teaching. According to this theory, learning is not passive absorption of information. Instead, learning is a process of constructing knowledge (Duffy & Jonassen, 1992; Merrill, 1991; Resnick, 1989; Savery & Duffy, 1996). While knowledge is individually constructed and dependent on one's existing knowledge and experience, there are also external factors in this knowledge construction such as context and collaboration (Resnick, 1989; Savery & Duffy, 1996). Thus, information and knowledge are not the same.

In the context of this paper, learning is the transformation of user information (the unprocessed user data) into user knowledge (the user information that is tacit to the designer). The knowledge processing in design is claimed to be distinct from the knowledge processing in the sciences (Cross, 2001; Lawson, 1990). It is characterized by abductive reasoning (Kolko, 2010; Rowe, 1987), tacit knowledge (Friedman, 1997), and

reflective practice (Schön, 1983). A study on designers' user knowledge required a research design that can yield to collecting data on these characteristics of design. For this purpose, this study was structured to observe designers in-situ.

Designers working at six design consultancies were observed while they were performing their every day tasks. 10 business day visits were made to each consultancy. Data was collected using semi-structured interviews, participant observations, free listing exercises, project walkthroughs, surveys and document analysis. The studied design fields were selected to represent different scales of design. The consultancies were from the fields of architecture, industrial design, and interaction design (two consultancies from each field).

In this paper, the user phenomenon is studied without any focus on the differences between different design fields (i.e. architecture, industrial design and interaction design). Instead, the aim was studying design as a discipline. In the time of data collection, three of the studied consultancies (one from each field) had established departments for conducting research including user studies. Differences were observed in the designers' construction of the user in these consultancies compared to the ones without established research departments. Those differences are reported elsewhere (Oygur, 2012) and the focus in this paper is not on how design research affects the construction of the user.

I first review the literature that informed this study. In this section, the nature of the design activity is reviewed together with the constructivist learning theory. The description of the data collection and analysis processes is followed by the part that reports research findings and analysis simultaneously (findings from each case study are available in Oygur 2012). The analysis of the research data is grouped under two sections, one looking at the user information available to designers and the other focusing on the construction of designers' user knowledge. The conclusion section summarizes the paper and indicates possible implications and areas of future research.

Designing and designers' user knowledge

Design can be described as a creative activity that is shared by a diverse range of professions (e.g. architecture, fashion design, interaction design, landscape architecture). Despite its wide area of practice, the activity of design still lacks a clear definition (Lawson & Dorst, 2009). Through the history of design, scholars (e.g. Archer, 1984; Darke, 1979; Roozenburg & Eekels, 1995; Ulrich & Eppinger, 2004) offered descriptive and prescriptive models of the act of designing. These models have served as tools for analyzing the design activity. However, they have also been criticized for not being easily applicable in design practice and for neglecting the nature of this activity as it takes place in everyday practice (Cross, 2001). Today, we still have limited information regarding the "designerly ways of knowing" (Cross, 2001) as they take place in everyday context.

Although there is no clear definition of how designing takes place, knowledge construction in design is claimed to be different from the knowledge development in science (Cross, 2001; Lawson, 1990). Some of the ambiguity regarding the design activity comes from the nature of design problems. Design problems, as some problems from other fields, are ill-defined by nature (Buchanan, 1992). Solving these problems require a different approach to problem-solving. Some of the most cited characteristics of the design activity are the abductive reasoning it involves, the tacit knowledge it depends, and the reflective practice it exercises.

Design process is mostly associated with abduction compared to deduction and induction (Groat & Wang, 2002; Rowe, 1987). Rather than moving from specific to general or general to specific situations, the development of design solutions involves a creative leap

through an abduction process. While Cross (1997) observed this moment of abductive reasoning in his studies, the creative leap is a tacit process. According to Polanyi (1967), "we know more than we can tell" (p. 4). This is the very essence of tacit knowledge. In addition to the codified knowledge that designing involves, this internalized tacit knowledge is at the very core of creative process and explains why it is harder to describe, explain, teach, and share how designing happens. Schön (1983) describes this type of problem-solving as "reflective practice." As soon as a solution is proposed, the designer evaluates it, defines other problems related to the solution, and proposes a new solution in answer to the problems. Thus, reflection-in-action as it takes place in design can be interpreted as a learning process. Designers learn the dimensions of a design project better as they propose design solutions.

There are similarities between the previously cited characteristics of designing (i.e. abductive reasoning, tacit knowledge, and reflective practice) and the knowledge construction as described by constructivist learning theory. Constructivist learning theory developed over the years with the influence of Piaget (1977), Dewey (1938), Rorty (1991), von Glasersfeld (1989), and many others as a reaction to the old inscriptive method of teaching. This theory is built upon the constructivist nature of knowledge development. It is important to make a distinction between information and knowledge. While information is explicit, knowledge is processed information (Blackmer, 2005). And, learning is the transformation of information into knowledge (Duffy & Jonassen, 1992; Merrill, 1991; Resnick, 1989; Savery & Duffy, 1996). Thus, knowledge is constructed and it is significant to understand the dynamics of construction process.

According to the constructivist learning theory, learning is personal. Prior knowledge and experience are central to knowledge construction (Merrill, 1991; Resnick, 1989). "Learning is a constructive process in which the learner is building an internal representation of knowledge, a personal interpretation of experience" (Bednar, Cunningham, Duffy, & Perry, 1992, p. 21). There are also external influencers in this learning process. Situated knowledge affects learning and thus, knowledge construction is context dependent (Resnick, 1989). Here, the term context is very inclusive and involves both the physical environment and non-physical issues. The collaboration and active involvement that is offered by the context plays a positive role in the learning (Savery & Duffy, 1996). In this pedagogical approach, instructor is not a didactic teacher. Instead, instructors are participants who facilitate the learning process (Brownstein, 2001). Collaborators (e.g. students sharing the same classroom) also take role on each other's learning (Savery & Duffy, 1996).

Although it has been criticized for its effectiveness compared to traditional approaches to teaching (Mayer, 2004), today, several types of constructivist learning approaches are developed and applied under the perspective set forth by constructivist learning theory (e.g. problem-based learning, case-based learning, and situated learning). Scholars from design have used this theory to structure their design education (e.g. Gul, Williams, & Gu, 2012; Hmelo-Silver, 2004; Kolodner, 1995; Smith & Smith, 2012). In addition to providing support in educational context, this theory offers another perspective to study how knowledge construction in design takes place and how design happens.

According to Lawson and Dorst (2009), "design can be seen as learning" (p. 34). Designers learn about projects as they design (this is also in line with the theory of design being a reflective practice as defined by Schön (1983)). Solutions that are proposed also bring new problems with them. More to the point, designers keep learning as they move along a design project. Especially in design consultancies that offer design services for a wide range of artifacts, this learning style is more dimensional. In these consultancies, designers not only learn about a project as they design but they also learn about different kinds of projects and different aspects of each project throughout their professional life.

User is one of the aspects of a design project that designers need to learn about. While user has always been an important factor in every design project, with the increased attention to user-centered design practices, user involvement in design, and designing pleasant experiences, the user phenomenon has increased its significance. In spite its role in projects; we still have very little knowledge about how designers learn about the user, or how designers construct user knowledge. Constructivist learning theory has the potential to bring more clarity to this mental process by giving us the chance to define how designers build user knowledge in the form of user models.

Methodology

In order to study the research question of "how do designers know about the user?", I took a qualitative approach. A multiple case study was conducted at six design consultancies in order to observe a variety of practices in design. The number of consultancies to be studied was defined based on the research design and time limitations. All the consultancies are located in the US. In this study, specific consultancies were targeted based on their firm size, profile, and portfolio. The final selection of the consultancies from a list of possible candidates was based on convenience sampling. Because of the confidentially reasons, the name, identity, and any information that can be easily connected to consultancies were not used in this paper.

In order to render a holistic perspective on design as a discipline, three design fields working with a range of design outcomes (e.g., space, consumer product, interface) were selected. Examining diverse design fields was expected to uncover different aspects of user information processing within design. These fields are architecture, industrial design, and interaction design. In order to collect comprehensive data and to search for differences, I studied two consultancies from each field, one with an established design research department (the ones with the labels ending with 2) and one without (the ones with the labels ending with 1). As explained earlier in the paper, the focus in the following analysis is not on the differences between the consultancies with research departments and those without. Instead, I only reported the commonalities among all six design consultancies. A short summary of the studied consultancies is included in Table 1 and detailed description of each case is available elsewhere (Oygur, 2012).

Table 1: The summary of the descriptive information of studied consultancies. The information does not reflect any branch of the consultancies other than the observed ones.

	Service	Size	Departments	Types of projects
Arch1	Architectural design	Medium	Design department	Education Healthcare
Arch2	Architectural design Research & strategy	Large	Design department Research department	Healthcare Civic Corporate Science Education
ID1	Industrial design Engineering design	Medium	Design department Engineering/technology department	Consumer electronics Medical devices Industrial products
ID2	Industrial design Interaction design Research & strategy	Medium	Design department Research department	Consumer electronics Consumer goods Transportation
IxD1	Interaction design	Medium	Design department Engineering/technology department	Flash games Websites Online advertising Applications Videos

	Service	Size	Departments	Types of projects
IxD2	Interaction design Research & strategy	Large	Design department Research department Engineering/technology department	Websites Online advertising Applications Social media campaigns Environmental installations

The research design was tested with a pilot study at an architectural consultancy. Any changes to the data collection tools were made based on this experience (data collection tools are available in Oygur, 2012). The main research data was collected with 10 business day visits to each consultancy. In this period, I did participant observation of design teams, conducted semi-structured interviews with designers, design researchers, and an executive from each consultancy, did project walkthroughs with designers and design researchers, collected free listing exercises from designers, design researchers, developers and engineers, conducted surveys with designers, creative directors, and design researchers, and did document analysis of brochures, marketing materials, and project related documents. A total of 31 semi-structured interviews, 21 project walkthroughs, 143 free-listing exercises, and 134 surveys were analyzed.

The primary methodological construct underpinning the analysis process was an adapted version of grounded theory as defined by Sarker, Lau, and Sahay (2000). Distinct from other applications of grounded theory, this version gives the researchers the flexibility of using a theoretical lens while explaining the substantive theory. While following an inductive analysis process with the steps of initial, focused and theoretical coding, I also utilized the constructivist learning theory before finalizing my theoretical coding. Codes from case analyses yielded to thirteen categories that were then utilized for answering the research question.

As with any qualitative research, the generalizability of the research is a limitation of the current study as well. My study is based on a snapshot of 10 business day visits (minimum of 40 hours of observation) at each consultancy. Thus, my findings only represent the design processes that I got the chance to observe within this time period. It is also important to note that this study was conducted as part of my doctoral research. Data collection and analysis required a significant time commitment. Within this timeframe, changes were made within each of the consultancies and my research findings do not reflect these changes. Furthermore, the cases (consultancies) I studied might not be representing how user-centered design takes place in every design consultancy in the US. My findings should be tested with findings from other consultancies.

Mapping the user information

At the first level of analysis, I looked at the user information that is available to designers. The projects showed variety at the studied consultancies. In addition to differences among consultancies, within each consultancy there were also differences in terms of available user information and the way this information was stored from project to project.

Some of the common objects that embed user information in consultancies were imagery (including printouts from the internet representing users, their context, etc.), market and user data available through competitive and comparative products, reports including user-related data transferred from the client, client's properties (all graphic, product, and organizational properties of the client), books, and magazines. The consultancies that had research department also included research presentations, research reports, video clips, post-it notes, and photographs. For some projects, the consultancies without research departments also had these research-based information as they had received it from the clients or their project-based research consultants. These objects served to store user

information about existing products, contextual information, constraints, best practices (e.g. ideal flow, ideal ergonomics), users' wants and needs. At Arch2, ID2, and IxD2, there were special project rooms/areas, which were devoted to these objects, while in other consultancies, these objects were distributed all around the office context.

While the readily available objects and the information they store shows variety from consultancy to consultancy and from project to project, a closer analysis of these objects showed that the information stored in these objects can be grouped based on two qualities: *nature* and *source*. These qualities were defined based on the characteristics of the user information. Each quality extends on a continuum. When these two continuums are overlapped, it forms a diagram with four quadrants to map the types of objects available to designers. The mapping on this diagram is based on the user information that is stored by each object. Figure 1 illustrates this diagram with some examples from the observed objects.
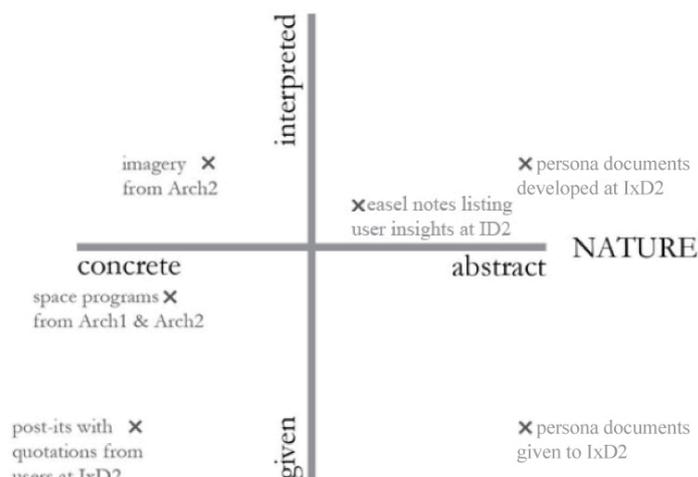

Figure 1: Mapping the objects that store user information within the studied design consultancies

The horizontal axis of the diagram communicates the nature quality. Based on the nature, the user information takes either *concrete* or *abstract* forms. Concrete user information is the information based on real users. On the other hand, the abstract side represents the information that is not attached to real users. For example, the post-it notes listing users' quotes on affinity diagrams observed at IxD2 fall into the concrete side. These post-it notes store the statements from user interviews in the concrete form as they do not include any interpretation of the designers or the design researchers. On the other hand, some of the projects in ID2 involved research intense processes. Not all the members of a project team had the chance to participate in the research phase because of the time and budget allocations. For those projects, the research team conducted the major part of the research process and shared their results with the designers in the form of insights available on easel notes at project rooms (and in research presentations and reports later in the process). These insights are abstract in nature since they represent an analysis of the collected user information instead the raw data.

Based on the source, user information is either *given* or *interpreted*. On the given end, the information is stored as it is. On the interpreted end, the information is analyzed from the perspective of the project. This interpretation is done by the design and/or research teams. For example, once again looking at the post-it notes of users' quotes on affinity diagrams observed at IxD2, this information is a given for designers as they involve statements from the users that were collected by the research team and shared with the design team. However, the insights from user involvement processes at ID2 are an

example for the interpreted user information. For projects in which designers do not participate in the semi-systematic or systematic user involvement processes, design researchers collect user information, analyze this information, develop insights from it, and share this information that is specific to each project based on user research. This type of user information is *interpreted* information, although it is not directly interpreted by designers.

Each type of user information stored in objects that are observed can be mapped at any point on this diagram based on its nature and source. Another example can be given from the space programs (the list of space requirements) in the architectural consultancies Arch1 and Arch2. Space programs represent the plan of the building/interior based on the allocation of square-footage to each space to be designed while keeping the whole square-footage of the space within a limit. These programs are developed in close contact with the client. Thus, they list concrete data (in the form of square-footage) for designers. The data in space programs are not fully interpreted because they do not provide definitive clues about the possible design solutions. For these reasons, space programs are located on the concrete-given quadrant, closer to the interpreted side (compared to the post-it notes with users' quotations at IxD2). In comparison to space programs, imagery (the print-outs/photographs representing the feel of the space to be designed) as utilized by designers at Arch2 is more interpreted in character. At Arch2, designers sat together with the client and users and discussed the feel of the space to be designed with the help of imagery. The final imagery that was selected after these discussions become the target for designers as they represent the feel/environment the client and the user wants and needs. Thus, that imagery was more than random selected space examples; instead they involved an interpretation. At the same time, they were photographs or printouts from already existing spaces. Thus, they represented concrete information. That is why the imagery from Arch2 is mapped on concrete-interpreted quadrant of Figure 1.

An example for the abstract-given quadrant is the personas given by the client to the designers of IxD2 at one of the projects. These personas represent the clients target in the form of fictional users. There was no real user that this information applied to directly and therefore they are abstract in nature. These personas were not developed specific for that project. Instead, the client handed them to the designers in order to communicate their brand identity. Thus, these represent given information as well. However, there were also projects at IxD2, which involved the development of personas and user journeys by the research team. For those projects, the research team conducted user research, analyzed the collected information, and developed personas as part of research findings. Thus, the personas were internally developed especially for that project to guide the designers for specific solutions. They still represent fictional characters. Therefore, the user information available through these persona documents can be mapped on abstract-interpreted quadrant.

Constructing the user

The diagram and the mapping that are explained in the previous section are helpful in terms of explaining what I observed in regards to how designers build user knowledge from user information at studied consultancies. While the objects storing user information were easily observed within the design consultancies, when designers were asked to explain the user of their products, their stories were not only based on the user information stored in these objects. Instead, the designers' user explanations were filled with more abstract information including references to other factors. The analysis into the sources and the construct of these statements/stories about users helped me further define the designers' user knowledge, thus designers' user models.

The construction of user models is mostly a mental process. Therefore, understanding how user information is processed into user knowledge was difficult. In order to develop such an understanding, I went back to literature and found constructivist learning theory as being helpful for providing some insight to analyze the user knowledge construction of designers.

According to constructivist learning theory, learning takes place with the construction of knowledge from information. This construction is individually processed (Duffy & Jonassen, 1992; Merrill, 1991; Resnick, 1989; Savery & Duffy, 1996). There are multiple factors effective in this knowledge construction process, for example, context, interaction with others, instructor, difficulties encountered, prior knowledge (Merrill, 1991; Resnick, 1989; Savery & Duffy, 1996). This constructed and internalized knowledge (not the recorded information) is associated with problem solving. This type of knowledge is congruent with the concept of tacit knowledge as described by Polanyi (1958). Tacit knowledge is not easy to articulate type of knowledge that internally guides human beings. Based on this description, tacit knowledge can be mapped in the abstract-interpreted quadrant of Figure 1.

My observations at studied consultancies were in line with the perspective provided by constructivist learning theory and the concept of tacit knowledge. Rather than only referring to readily available user information, designers were utilizing stories about some characters (which corresponds to what is described as user models in the literature (Pruitt & Adlin, 2006; Suchman, 2007)) in order to explain how their design solutions came to life. These characters included bits and pieces of several different factors; but overall they were abstract and interpreted. This observation helped me to posit that user information needed to be learned in order to be utilized tacitly in the design process. This learning is characterized with the processing of available user information into the abstract and interpreted quadrant as illustrated in Figure 2. Through this process, designers internalize the user information and built tacit user knowledge in the form of user models.
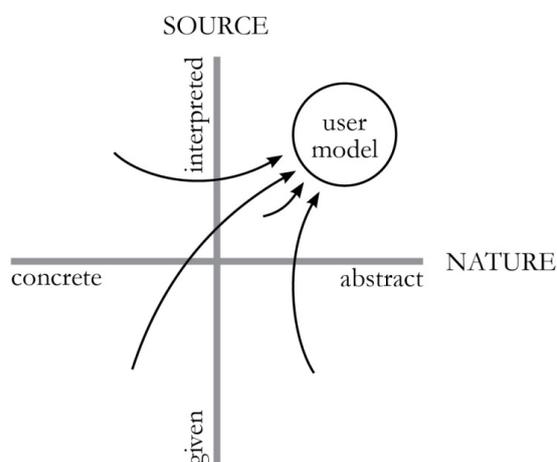

Figure 2: Illustration of the processing of user information into user knowledge.

After defining the processing of user information into user knowledge, I focused on defining the factors influencing this process. As I explained earlier, in several interviews and informal conversations with designers about the projects or products that they delivered, designers referenced some other phenomena in addition to the user information. These phenomena were observed independent of the existence of user involvement process in the project. It was possible to group these phenomenon under seven headings: designers' personal experiences as a user, their intuition, their professional knowledge (disciplinary knowledge), previous projects they had worked on,

their context (the office environment), and the input they receive from co-workers and the client. I have named these factors as *mediators* as they are influential in the development of user knowledge from user information. There are commonalities with some of these mediators and the effective factors in learning as defined by constructivist learning theory. For example, there are similarities between the prior knowledge as explained by constructivist learning theorists and mediators of professional knowledge and previous projects in design. As personal experience affects learning so does designers' intuition and experience as a user becomes a player in user-centered design process. The influence of environment on learning corresponds to the significance of context as a mediator in design. The role played by collaborators in learning is performed mostly by co-workers and client in design.

In contrast to user information (which is collected specifically for each project), the mediators are not necessarily project specific; they come from the designers' repository of knowledge. When the sources of these mediators are analyzed, it becomes clear that these mediators are either individually or organizationally (by the consultancy) defined. The mediators of context, client, and co-workers are organizationally defined. These are consultancy specific and the character and influence of these mediators are shared among the designers of a consultancy. On the other hand, the mediators that are labeled as previous projects, professional knowledge, experience as a user, and intuition are individually defined.

Independent from the source of the mediators (individual versus organizational), in several instances, the user information available through objects was blended with the information coming from mediators. For example, an architect from Arch2 gave the following explanation in order to define how they specifically design for their target user group: "Every project, you bring your own past with you. You do have your own filters of what you have done in the past, what you have seen, what you have learned from all of your clients. Then, it always affects how you filter the information you get the next time, the next time and the next time." Similarly, an industrial designer from ID2 mentioned the user information and the mediators to describe the design process of a consumer product. This designer first started his explanation with the information from their field studies in order to frame why the users needed the product. When explaining the requirements and specifications of the product, the designer gave examples from his own experiences as a user of this product. Through these, the designer defined the user experience that they targeted to design. While the designer was explaining the success of the design solution, he once again brought the information from user involvement process and compared the end user experiences with the design guidelines that were developed as a result of user research.

The evidence from the above and other interviews and observations helped me to analyze how designers construct their user knowledge in the form of user models. While the user information available at consultancy defines the baseline for the user models, it was blended with the mediators. Through this blending process, user knowledge is constructed. As explained earlier, the user knowledge can be mapped at the abstract-interpreted quadrant. While blending the user information with mediators, designers are restructuring their user knowledge and make it move into the abstract-interpreted quadrant. Figure 3 illustrates this user model construction process graphically. Even the information that is already located at the abstract-interpreted quadrant is built into the user model and relocated at a further point at this quadrant. The final user model is a holistic phenomenon (rather than disconnected user information and mediators). This holistic phenomenon was mostly in the form of stories and designers utilized these user stories while explaining their design solutions.
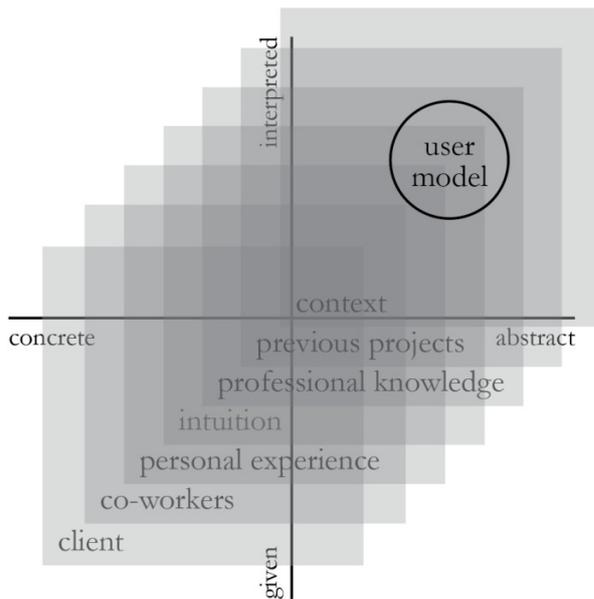
interpreted

user
model

context

concrete   previous projects   abstract

professional knowledge

intuition

personal experience

co-workers

client

given

Figure 3:The illustration of the processing of user information through mediators.

It was also observed that not every user story told by designers was equally coherent. This situation can be explained with the location of each designer's user models on Figure 3. While the user information is equally available to designers that are working at the same consultancy on the same project, the mediators are not, especially the individually defined mediators (i.e., previous projects, professional knowledge, experience as a user, and intuition). Because of these mediators, the user model of each designer is mapped on a different point in the abstract and interpreted quadrant. Also, some part of the organizational differences among consultancies in terms of user-centered design approaches and design process can be explained in reference to organizational mediators.

While it is not the main argument in this paper, it is also worth noting that with the active participation of designers within the research phase (as it was observed in Arch2, ID2, and IxD2) two additional mediators come into play. One is collaborative learning and the other one is contextual information. Also the project rooms in consultancies with research departments add to the significance of context as a mediator. The further information on how these mediators and the designers' active participation in user involvement processes affect the construction of user knowledge is discussed in another context (Oygur, 2012).

Conclusion

User, as a design factor, has a great significance on design professions. While some projects involved little or no user contact, they ended up being successful on the market because of developing pleasant user experiences. On the other hand, some projects with intense user involvement process failed on the market because of not meeting users' wants and needs (Cagan & Vogel, 2002; Cain, 1998; Veryzer & Borja de Mozota, 2005). These examples show us that user involvement by itself is not enough for developing pleasant user experiences. This study provides an explanation to the success and failure of projects through a deeper look into how designers construct user knowledge.

The case studies conducted six design consultancies from three design disciplines (i.e. architecture, industrial design, interaction design) revealed that the designers' user

models are not only depending on the user information that is available to the designers. Instead, the processing of this information with the help of mediators is crucial in the character of the user knowledge to be developed. With the help of mediators, initial user information gains more abstract and interpreted character. This abstract-interpreted character defines tacit user knowledge for designers to build upon while developing design solutions. These mediators are either individually or organizationally defined. Even in the absence of readily available user information, designers utilize these mediators in the process to develop their user models. Thus, the success and failure of projects regarding pleasant user experiences depend on user information as much as mediators.

While the effects of the user information and some of the mediators are individually studied by other scholars, how these all come into play while developing user knowledge has not been investigated. The findings from this study offer some insights for the practice of design. The design community has increasingly focused on better integration of user involvement and design processes. This study shows that the mediators in the process play a crucial role for better integration. However, current literature and research concentrate more on advancing user involvement methods and not giving enough attention to the mediators. As this study brings the mediators to further attention of the design practitioners, more research on the topic is needed to bring more clarity to the construction of user information by designers.

Acknowledgements

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Isil Oygur

Isil Oygur is an assistant professor of industrial design at Bahcesehir University, Turkey. She holds a PhD from Washington State University, USA and a Master of Science from Istanbul Technical University, Turkey. Her research interests include qualitative user research and user-centered design, with a specific focus on ethnography and contextual differences in the application of user research methods. Her journal publications include "User: Inspiration or Constraint?" (with Janetta M. McCoy, Journal of Interior Design, 2011) and "Design and the User Experience: The Turkish Context" (with Nancy Blossom, Design Issues, 2010).