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### CHAPTER III

#### USER-CENTERED DESIGN & USER RESEARCH

In Chapter Three, the selection of a specific method for describing user research is discussed. The definition and scope of user-centered design are introduced in Section 3.1. User research and its development are reviewed in Section 3.2. In Section 3.2, the selection of some models for describing user research investigation is described. And the selection of some research characteristics for describing user research application is discussed in Section 3.3.

#### 3.1 User-Centered Design

The importance of design with user needs in mind is not new. Since design has roots in craft, customized solutions by craftsman can be considered the first user-centered design. As early as 1937, formal methods for understanding users were taught in the ‘scientific subjects’ curriculum, which later became a fundamental course at Chicago’s New Bauhaus, under the direction of Moholy-Nagy. In the late 1960s, environmental-behavioral studies were introduced to the design field, in reaction to public dissatisfaction with modernist architecture (Mitchell, 1993). Methods of social and behavioral research are adapted to assess the quality of the built environment and develop a deep understanding of architectural spaces as they influence human behavior. While advocates of environmental-behavioral studies have only minimal impact within the architectural design community, their message and their research methods have met with greater appreciation by designers of all fields.

Today, with technology evolution, industry is moving increasingly from mass production and producer-centered approaches to flexible approaches that are more customer and user focused. More than ever, the needs of each particular individual are what is both being catered to and driving economy and culture (Heskett, 1997). Design teams must be able to incorporate users’ and stakeholders’ values in the design process in order to be successful.

While the term ‘user-centered design’ is widely used by design professionals and academics, its processes and objectives are often only vaguely defined. Some thoughtful definitions of user-centered design come from the software development community. In *A Guide to Usability*, Preece (1993) explains user-centered design as an approach whose principles include early and continuous focus on users throughout an iterative design process. John Karat (1996)<sup>1</sup> suggests user-centered design is characterized as ‘a process that sets users or user data as the criteria by which a design is evaluated or as a generative source of design ideas.’ In *Usability Maturity Model*, Jonathan Earthy (1999, p.11) refers to user-centered as ‘approaches which have as their primary intention or focus the consideration of the interests or needs of the

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<sup>1</sup> Karat, J., ‘User Centered Design: Quality or Quackery?’ *Interactions*, Vol.3, No.4, p.20, July/August 1996

individuals and/or groups which will work with or use the output from a system.’ And in his doctoral dissertation at the Institute of Design, Jay Melican (2000) defines user-centered design process as one that is informed by data from or about users, and in which that data is effectively applied.

For the purpose of this study, ‘user-centered’ is defined as an approach which has primary focus on users and effectively applied user data as a generative source, decision making support and evaluative criteria either early, during and/or late in design process.

### **3.2 User Research for Design**

In this study, user research refers to a process of understanding a design context in order to inform design directions both generatively and evaluatively. User research is employed not only to understand, credibly explain and perhaps predict human behavior in the pre-design process (Karat, 1997), but also to measure how people perceive, understand, remember, and learn in design evaluation process (Preece, 1993). Many methods employed in user research have their roots in cultural anthropology, social behavioral sciences and psychology (for example: experiments, questionnaires, interviews, observation), some have been adapted from marketing disciplines (e.g. focus group, workshops, telephone survey), while others have been developed specifically for user research and usability evaluation (e.g. cognitive walkthroughs, logging). Following are descriptions of the disciplines related to user research mentioned earlier, their aims and the limitations of their approaches.

3.2.1 Cultural Anthropology. The word *anthropology* comes from the Greek *anthropos* ("human") and *logia* ("study"). Anthropology is the study of humankind, from its beginnings millions of years ago to the present day. Anthropology seeks to uncover principles of behavior that apply to all human communities. In North America the discipline's largest branch, cultural anthropology, applies the comparative method and evolutionary perspective to human culture. Cultural anthropologists study humans through a descriptive lens called the ethnographic method, based on participant observation and face-to-face interviews. Ethnographers compare what they see and hear themselves with the observations and findings of studies conducted in other societies. Originally, anthropologists pieced together a complete way of life for a culture, viewed as a whole. Today, the more likely focus is on a narrower aspect of cultural life, such as economics, politics, religion or art. [<http://www.aaanet.org/anthbroc.htm>]

It is also important, however, to note that the goal of user research is different from social research. The goal of social research is to understand and describe current human behavior, while the goal of user research is to understand design context and to inform the process concerning what to design. User research for design seeks an understanding of change process, and investigates the claims of action research (Lewin, 1946; Kemmis and McTaggart, 1981) in promoting change. User research aims to identify goals to achieve, problems to eliminate, assets to preserve, and opportunities to exploit. In addition, it also provides an explicit basis for assessing design suitability.

3.2.2 Social and Behavioral Science. In the late 1960s, social and behavioral scientists began to have an impact on architectural design. A new social science specialization alternatively referred to as

environmental psychology, environmental sociology, or human ecology began to emerge (Conway, 1973). They generally chose to utilize research methods, techniques, and tools developed by social and behavioral scientists to study human attitudes and behavior—literature search and review, systematic observation, controlled interviewing, questionnaires, and surveys, sampling, and statistical analysis, with extensive research oriented to developing knowledge about the environmental needs of various user groups (Hershberger, 1999). From the late 1960s, environmental-behavioral studies have not only had impacts on the architectural design community, but also the designers of all fields.

3.2.3 Ergonomics. ‘Ergonomics (or human factors) is the scientific discipline concerned with understanding the interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimise human well-being and overall system performance.’ (International Ergonomics Association, July 2000)

Ergonomics is a relatively new branch of science which celebrated its 50th anniversary in 1999, but relies on research carried out in many other older, established scientific areas, such as engineering, physiology and psychology. Ergonomists use information about people, for example, their physical and cognitive abilities and limits, including their size (height, weight etc.), their ability to handle information and make decisions, their ability to see and hear and their ability to work in extremes of temperature. An ergonomist studies the way that these things vary in a group of people and determines the range of human abilities. With this information, the ergonomist, often working with designers and engineers, ensures that systems, products, places and processes will be able to be used comfortably, efficiently and safely (Lovesey, 2000).

3.2.4 Marketing Research. Marketing Research (as defined by the American Marketing Association) is the systematic and objective identification, collection, analysis and dissemination of information for the purpose of improving decision making related to the identification and solution of problems and opportunities in marketing. Market research can provide the market intelligence needed to encourage success, enhance competitiveness and maximize profits from discovering a gap in the market to ensuring customer satisfaction and planning effective marketing campaigns, whether they are looking to exploit a new commercial opportunity or grow their existing customer base. There are many market research techniques, used in line with the requirements of the business and the budget available. Face-to-face interviews, surveys by telephone, and by postal questionnaire are all used to gather quantitative data. Qualitative research by face-to-face interview with individuals or focus groups is conducted to providing insight into why people hold the views they do, and therefore yields greater understanding of customers (The Market Research Society, December 2001).

However, understanding a market is fundamentally different from understanding what to design and the data traditionally collected from marketing has limited usefulness for design. The goal of marketing research is to understand a market to sell products to it. Marketing research provides the understanding of what people will buy and how people make buying decisions, while user research for design seeks to understand what will help people live or perform better while fitting into their lives and matching their

culture. Because marketing and design have different goals, quantitative techniques useful for marketing tend not to be useful to design. Design needs to be built on qualitative data.

As already discussed, methods borrowed and adapted from each of the discipline approaches has certain strengths and certain limitations. To conduct user research, different approaches may be used in combination. Research methods and approaches are usually selected based on their appropriateness to research/project situation. One of the objectives of this study is to develop a better understanding and explain how user research is designed, conducted and applied in different project situations. A specific method for describing user research design will be described in 3.3 and the selection of some research characteristics for describing the conduction and application of user research will be discussed in section 3.4.

### **3.3 Research Design & Investigation Models**

A good user research design/plan saves time, energy, money and enables user information to be gathered efficiently and is available to the team at the right time in the design process. Research design begins with questions that researchers and the team want to answer about a particular problem, population, process, or project; or with topics they want to explore. Research questions may also come from the brainstorming of collaborative groups, or the specific interests and commitments of anyone involved in formulating the question. Once the broad research question/area is identified, it is then transformed into a series of quite concrete research designs regarding: the specific issues, and specific research questions related to the problem area, the rationale for focusing on the area, the place or site where the study can be conducted, the categories of people with whom the problem could best be studied, the time span needed to conduct the study, the way in which the information can be located and collected, and the individuals who can provide access to site, people, or sources for information needed to answer the question.

Decisions about the choice of research design are guided primarily by three main factors: research questions (what to investigate), research resources (time, trained personnel, and budget), and research constraints (characteristics of the research site/setting, subject, channel, etc.) (LeCompte & Schensul, 1999). Of all the three factors, the research question is the first and the most important one. Since question formulation is the starting point, it is critical to the success of user research design. The aim of this study is to provide a better understanding and explain how research questions are formulated in different research situations. In order to do so, it is important to develop some models for describing question formulations in a way that is meaningful to this study and useful in practice.

In social research and behavioral research in design, there have been some attempts to identify research elements to help in formulating research questions. For example, Spardley (1980) proposed nine research elements for social research including: place, actor and activity, object, act, event, time, goal and feeling. In the architectural field, Pena (1969) suggested a framework for information gathering under four considerations: function, form, economy and time. There are three elements to each consideration. Function

concerns people, activity and relationships. Form relates to site, environment and quality. Economy concerns initial budget, operating cost and life cycle cost. And Time has three classifications: past, present, and future. For innovation design and planning practice, Doblin Group has also developed the basic guides for user research, A.E.I.O.U., which stands for activity, environment, interaction, object and user.

These research elements are usually used as a guide for checking the thoroughness of question formulation. Research teams may start formulating descriptive research questions by selecting each of the research elements, for example, ‘what are the major types of environment?’ However, research questions usually tend to lead to the way in that two or more research elements are interrelated, for example ‘how environments alter user activity or influence where activity occurs, or how different activities require changes to the environment.

As research questions are usually formulated from the interrelationships among the research elements, there have also been some attempts to describe and guide question formulation through the key aspects revealing the relationship among research elements, and their relationship to the whole research context. For the purpose of this study the key aspects for data gathering are called ‘investigation models’.

Although not using the same term, investigation models have been developed and discussed as a research guideline in some previous approaches. For example, activity aspects were emphasized in Owen(1989)’s Structural Planning. Ergonomic aspects were discussed by Earthy (1998) in the *Usability Maturity Model*. And ‘Work Models’ were proposed by Beyer and Holtzblatt (1998) in understanding and modeling the work processes of individuals and organizations. The ‘Work Models’ consist of five investigation models including: flow model, artifact model, sequence model, cultural model and physical model.

As there are almost unlimited numbers of questions that can be formulated from the interrelationships among the research elements. Discussing research questions through each research element can be unmanageable and not very useful in practice. In this study ‘Investigation Models’ will be discussed. Investigation Models used in this study are developed based on Beyer and Holtzblatt’s (1998) ‘Work Model’, in combination with Owen’s (1989) and Earthy (1998) approaches. The seven investigation models used in this study are flow model, activity model, sequence model, ergonomics model, artifact model, physical model and cultural model. The description of each investigation model follows and the relationship between the investigation model to each research element in previous approaches can be drawn as shown on table 3.3.

Table 3.3 Investigation Model and Research Elements relations

Previous Guidelines		Investigation Models						
Research guidelines	Research Elements	Flow Model	Activity Model	Sequence Model	Ergonomics Model	Artifact Model	Physical Model	Cultural Model
Spradley's	Actor	X			X			X
	Event		X					
	Activity		X					
	Act			X				
	Space						X	
	Object				X	X		
	Time		X	X	X			
	Feeling				X	X	X	X
	Goal	X	X			X	X	X
Pena's	Function		X	X	X		X	
	Form				X	X	X	
	Economy	X						
	Time			X	X			
Doblin Group's.	Activity		X	X				
	Environment						X	
	Interaction	X		X	X			
	Object				X	X		
	User	X			X			X

3.3.1 Flow Model. Flow model reveals who the stakeholders are, what they do, and how they interact with each other. It reveals the communication patterns that underlie the way people perform their activities/tasks. It shows what part of the activity is currently of concern and how the concern could be expanded to support more tasks and/or people. Flow model also reveals a common structure of stakeholders' roles based on their responsibilities, needs, and goals.

3.3.2 Activity Model. Activity model reveals recognizable patterns of activities people do in everyday life and/or around the design system. Activity is a set of purposeful actions taken by users and system in an environmental setting.

3.3.3 Sequence Model. Sequence model reveals the pattern of task in activities, and the intents achieved in doing the task. It reveals the common structure of a task across user groups, showing how people accomplish a task in different situations. It reveals what needs to be done, the order and strategy for doing it, and all the motivations driving specific actions. The investigation of sequence model shows the detail

structure of tasks that need to be supported, suppressed or replaced. It shows the over all structure of task, which may be mirrored or simplified by design.

3.3.4 Ergonomics Model. Ergonomics model takes into account the physical, cognitive, social, organizational, environmental, and other relevant factors, and makes them compatible with the needs, abilities, and limitations of people. In Usability Maturity Model (Earthy, 1998), the ergonomics is referred to as the study of human capabilities and limitations, human interaction with technologies and environments, and the application of this knowledge to products, processes and environments.

3.3.5 Artifact Model. Artifact model shows how people select, organize and structure objects they used. It helps better understand how people create, use, and modify objects for their purposes. The investigation of artifact model opens a window into the mind of the users, showing how they think about what they do practically and symbolically. It also helps identify hidden intents that might be undetected and unsupported previously in the existing system.

3.3.6 Physical Model. The investigation of physical model helps better understand the physical context of the potential user and the product or service. Physical model shows the common issues imposed by the physical environment. It shows the kind of access and movement allowed by the physical environment, and the constraints that effect all user groups. Physical model also shows how people and objects move through the environment and shows the common strategies in how people structure their environment to support their activities. This structure provides clues to how people think about and organize their activities.

3.3.7 Cultural Model. Cultural model shows the common aspects of culture that pertain within and across user groups. It reveals what people care about, how they think about themselves and what they do, and what constraints and policy they are under. The investigation of cultural model helps define expectations, desires, values, and the whole approach people take in their context. It provides an in-depth understanding of potential user groups and the way to communicate to them.

### **3.4 Research Characteristics**

There have been attempts to classify and describe the way user research is conducted and applied. Within the history of behavioral research in design, user-research has been classified and described according to information resources, human senses (Rubin & Elder, 1980), research applicability (Aldersey-Williams, Bound, and Coleman, 1999), data gathering methods and analysis techniques (Liz Sanders, 1992). And in 2000, Jay Melican, in his doctoral dissertation at the Institute of Design, proposed dimensions of user research classification including: analytical approach (conceptual vs. procedural), degree of abstraction (raw vs. abstract), degree of generalization (individual, social/organization, cultural), model of collection (observing, listening/discussing, participating), media of delivery (verbal, visual, tactile), and position of privilege (privileges the subject, privileges the researcher).

The dimensions of user research characteristics used in this study are developed based mainly on Melican's work. Four classifications (analytical approach, degree of generalization, model of collection, and media of delivery) were borrowed and adjusted from his classification. Besides the four classifications,

another three classifications including phase of application, research aim, and research structure were also developed based on literature, expert interview and direct experience.

3.4.1 Phase of Application (pre-design, during, post-design). Phase of application referred to the period in a project that user research is conducted and applied in generating design goal. A distinction can be made based on user research application from pre-design to during design and to post-design phases.

Pre-design research devotes to exploration and determining project mission, project definition, and/or design brief at the strategic level. The critical objective of pre-design research is to uncover unarticulated or emerging user needs in order to identify opportunities for matching the unarticulated needs of users with technological possibilities. In addition, it seeks the holistic understanding of the users in the market to help inform the way to support and communicate to them.

During-design user research involves the process that Sless (1990)<sup>2</sup> calls ‘iterative design’. Iterative design is a design process in a situation where design solution are implemented and constantly evaluated and modified. In iterative design process, researching, evaluating and designing activities need to be done in recurring loop. Thus, a strong interaction is built between the three activities.

Post-design research involves a systematic re-examination of design once it has been completed and occupied or used for a reasonable length of time. Its primary purpose is to identify what might be termed ‘the problems and assets of the design.’ Problems are those features of the design which through oversight or error do not meet the needs of its users and consequently should be modified. Assets are those features of the design which work especially well and are highly valued by users. These features are worthy of preservation efforts (Sims, 1997).

3.4.2 Research Aim (Generative, Evaluative). An important distinction of user-research can be made in its approaches: generative and evaluative. The aim of generative research is to gather user information as input for the idea generating process. Information-processing theories of design problem solving assert the process of design can be described as a sequence of knowledge states through which the design team moves in their search for an optimal design solution. Each new knowledge state is the end result of a cognitive operation or ‘generative process’ that has taken a previous state as its starting point or ‘input’ (Rowe, 1987).

Evaluative research can be defined according to a number of different parameters and its assessment varies significantly with the type of system under development. For example, the primary aim of usability testing in the area of computer software is to measure how people perceive, understand, remember, and learn the elements of software interface (Preece, 1993). Other forms of evaluative research include preference testing, concept validation, and ergonomics analysis.

3.4.3 Research Structure (structured, semi-structured, unstructured). A commonly made distinction is based on the degree of structure of the research from fully structured to semi-structured and to unstructured. The fully structured research is at one extreme, with predetermined set of questions asked, and the

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<sup>2</sup> Sless D. and Fisher P., ‘Information design methods and productivity in the insurance industry’, *Information Design Journal*, n.6, 1990

responses recorded on a standardized schedule. The semi-structured research is in the middle, where the research team has worked out a set of questions in advance, but is free to modify their order based upon their perceptions of what seems most appropriate in the research context. They can change the wording, give explanations, leave out particular questions which seem inappropriate or include additional ones. The unstructured research is at the other end, where the researcher has a general area of interest and concern, but lets the conversation/ observation develop within the area (Robinson, 1993).

3.4.4 Analytic Perspective (conceptual-procedural). An important distinction of user-research can be made in the analytic perspective. The analysis perspective can be conceptual or procedural. Conceptual analytic perspective reveals user's beliefs about, and attitudes toward a product, service or situation. It also uncovers the motivations and expectations behind behaviors that users display. Procedural perspective aims toward an understanding of the user's physical, cognitive limitations, and capabilities, and may come to understand how setting, tool, or other artifact can be best constructed to adapt to those capabilities.

3.4.5 Degree of Generalization. Degree of generalization was defined by Melican (2000) primarily by the scope of the research or its sample size, between the particular and the general. The degree of generalization has also been equated with the level of the analysis. On the individual level, user's behaviors and interactions may be analyzed in the interpretative framework of that individual's situation; on the social/organizational level, user's behaviors are understood as influenced by interpretative communities to which that user may belong; and on the cultural level of generalization, user's behaviors are seen as reflecting cultural structures (Robinson, 1993).

3.4.6 Mode of collection (immerse, observe, listen, participate). Mode of collection is a direct result of the chosen research techniques. Recently, many similar research techniques are adapted and named variously by a number of design and research firms (for example: 'physical trails', 'guerrilla ethnography', 'beeper studies', 'shadowing', and 'cultural inventories'). Discussing each research technique (by name) may not be very useful. However, many specific techniques can be grouped by the predominant mode of data collection. Three modes of collection that were used in Melican's (2000) work are observing, listening and discussing, and participating. In this study, the fourth mode of collection, immersing, is added to describe the situation where the researcher becomes completely involved as a part of the user group.

3.4.7 Media of delivery (experience, tactile, visual, verbal). The media of delivery refers to the form in which data are presented, and it is likely to reflect the mode in which data were collected. There are three categories of delivery media discussed in Melican's (2000) work: verbal, visual, and tactile. According to Melican (2000), user data is commonly presented verbally or in diagrammatic formats. More richly visual delivery can be in the form of video or photographic imagery, or impressions captured in a researcher's sketchbook. Tactile presentation involves the use of prototypes constructed by subjects (Sanders, 1992), or deliverables enhanced with the inclusion of artifacts collected in the research process. Researchers may collect artifacts that users buy or create to facilitate a task or work process (Beyer and Holtzblatt, 1998), for example, their personal calendars, notebooks, or standard forms they use. In this study, another form of delivery, 'direct experience', is also added to describe the situation where client and the team member were

engaged in the field study and user information is delivered to them directly through direct experience in the research field.