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STUDY ON USABILITY METHODOLOGIES IN THE UNIVERSAL DESIGN PROCESS

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ABSTRACT:

Not only will tomorrow's populations be older, but they will be more demanding in how they choose to live and accommodate age, disabilities and illness. They will require products and services that are flexible, that can accommodate a wide range of different capabilities, yet which reflect diverse lifestyle aspirations, and enable active and healthy ageing (Foresight Ageing Population Panel 2000). Universal Design (UD) has been introduced as a tool to avoid a divergence between designers and users (Ingrid and Trnod 2005). Usability methodologies are concerning the different ways and techniques of interaction between designer and users in the design process. The present study aims to define and evaluate usability methodologies, showing where they could be used in the universal design process. It compares a theoretical prediction against practical examples from across the globe and theorizes on the differences between the two. According to the literature survey, we proposed a chart that could guide whether designers,

researchers, etc to use adequate usability methods through the design process cycle. We contacted some institutions and centers for universal design in the United States (the Center for Universal Design, North Carolina State University) and Europe (the Helen Hamlyn Centre, the Royal College of Art, UK), (the Institute for Integrated Design, Germany), (Lund Institute of Technology, Lund University, Sweden). Furthermore Japanese professionals in this area were contacted. The intention was to assess our proposal and assure of its appropriateness. The results of this study are the following: 1. the term of usability has two definitions based on the purpose; usability design and usability testing. The former one is concerning the users' requirements and problems. The latter definition is concerning the evaluation of the prototype and its performance. 2. The answers and opinions of the contact institutions, centers and Japanese professionals on our chart revealed that theory is a good indicator, but practical experience is somewhat different. Some of them agreed on the proposed chart, but others suggested and added more usability techniques. The differences in the answers of the contact institutions and centers can be due to many factors, such as, consumers, culture, context, environment, budgets, etc.

3. We need to test our proposal widely, for example by contacting industry (such as Toyota and TOTO) and consultative organizations (such as Steelcase and IDEO). The intention is to capture data across the spectrum of universal design experience so that it will be useful to see how to teach UD for students and what methods are most useful for industry. The present study will be interest for design practitioners, educators, students and decision makers and also to innovators or anyone involved in commissioning design.

Keywords: Usability Methodologies, Universal Design Process, Product Design

1. INTRODUCTION

Based on our previous study concerning the universal design process, the authors detected that interaction between designer and user is often required and beneficial at every stage of the design process (Elokla, Morita and Hirai 2006). Usability methods are often utilized during successive phases of product development, with the intention of making product use more efficient and attractive to customers (Burgstahler, Jirikowic, Kolko and Eliot 2004). The term usability was first popularized in the early 1980's as focus from programmer-computer interaction to user-computer interaction. There are many studies discussed the term of usability and its definitions (Oscar 2002, Turkka 1997, Donald 2004). The studies that discussed usability

assessment methodologies in the design process are limited. This study aims to evaluate usability methods and identify when they could be used in the universal design process cycle. It attempts to identify the best practices in the user research and presents the varied aspects in the international movement.

2. METHODS

This study was carried out as follows: first, a literature survey was done to clarify usability methods. Secondly, we evaluated each method based on the purpose. According to the literature survey, a chart was proposed so as to determine when each method could be used in the proposed design process. Thirdly, the proposal was assessed by four institutions in the United States and Europe. The intention was to know their opinions on this chart. Interviews were also carried out with UD professionals in Japan. We received the answers from the Center for Universal Design (USA) and the Helen Hamlyn Centre (UK), the Institute for Integrated Design (Germany), and Lund Institute of Technology (Sweden) both of which practice inclusive and universal design. Fourthly, a comparison was done between the theoretical prediction of authors and the practical examples of the contact institutions.

3. RESULTS

3.1 UNIVERSAL DESIGN PROCESS CYCLE

In the previous study, the authors proposed the cycle of universal design process as a guideline for people who work in this area, such as designer, researcher, student, etc. (Elokla, Morita and Hirai 2006). In the beginning of the project, a designer has to identify the design brief. For example, what is going to be designed? And what does the designer need to know? Then apply the following stages:

First stage “collect data”: in order to design a product that works and fits for the intended users, we have to learn about them, e.g. their abilities, aspiration and background. In addition, a designer has to consider the environmental context and the product environment and its market.

Second stage “identify the users’ needs/problems”: a designer has to assess the user/users’ needs, and define the difficulties they have and try to extract the problems.

Third stage “analyze users’ tasks and goals”: this stage of the design process is important because what users say they do and they actually do, are often different. People often cannot remember exactly how they use a product. Fourth stage “create/redesign”: It includes: idea generation, basic design and implementation design. Throughout each of them, a design is assessed and checked by user and designer in order to assure that it satisfies user’s requirements and legal standards. Idea generation is concerning a preliminary mental image of required product. The images are responding to the getting information from the users and a designer’s experience. Basic design is concerning the selected idea/s for drawing schematically (including plan, sections, elevations, and perspectives) so as to give user an idea of what the final product will be. The selected idea is usually the best one that fulfills the users’ needs. Implementation design is concerning a design that is selected for manufacturing. Fifth stage “test and evaluate for usability”: Once a prototype exists, a designer needs to test it, so as to know if it meets the users’ requirements or still needs particular modifications.

3.2 DEFINITION OF USABILITY

Usability is the extent to which a product can be used by specified users to achieve goals with effectiveness, efficiency and satisfaction in a specified context of use (ISO/IEC 1998). The meaning of usability is classified according to the purpose as follows:

a. Usability design: since first, second, third and fourth stages of the design process require collecting information and data about the user’s context, requirements, problems, and the product environment, we called these stages “input”. Usability design has three activities: A) Requirements gathering: understanding and specifying the context of use. B) Requirements specification: specifying the users’ needs. C) Design: producing designs and prototypes.

b. Usability testing: it aims to test and evaluate a prototype “output” throughout its life cycle. The life cycle of a prototype means for example, packing, instructions, set up, use, maintenance, and disposal. Usability testing is important to know how well a prototype satisfies the users’ needs.

3.3 USABILITY ASSESSEMENT METHODOLOGIES

According to the literature survey, this study evaluates 8 usability methods that are commonly used in the design process (Stephen 2005; Misugi, Kenji, Kanamori, Hitoshi, Koyama, Noboru, Atsumi and Bunji 2005).

A. Contextual Inquiry: It is a technique for examining and understanding users and their tasks, issues and preferences. It can be used to produce user needs' analysis and task analysis. It is more a discovery process than an evaluative process; more like learning than testing (Gaffney 1999). This technique follows many of the same process steps as field observations or interviews. The different is that interviewing during a contextual inquiry study usually does not include set, broadly worded questions. Instead, the partnership between the interviewer and interviewee is used to create a dialogue, one where the interviewer cannot only determine the user's opinion but also his or her motivation and context.

B. User Interview: This elicits information about user's experiences and preferences. An interview is formal, structured technique where one interviewer talks with usually one participant at a time for one hour (Centre for HCI Design 2004). It can be used at any stage of development, depending on the questions that are asked. More likely, though, it is employed early in the design process in order to gain a more detailed understanding of specific requirements (Hom 2003, Laurel 2003).

C. Focus Group: It is an informal technique that involves encouraging an invited group of actual users of product to share their thoughts, feelings, attitudes and ideas on a certain subject (European Commission 2005, Nielson 1997). It can be used at any stage of development, depending on the questions that are asked. More likely, though, it is held at very early stages of development, when the product requirements are still not firm (Hom 2003). Basically, it is used as an input to design (Fidgeon 2005). In the focus group, the designer brings together 6 to 12 users to discuss issues and concerns about the features of a user interface. The group typically lasts about two hours (Centre for HCI Design 2004, Laurel 2003).

D. Card Sorting: It aims to learn how users think about a product and how they would design it. Card sorting is a method for suggesting intuitive structures/ categories. A participant is presented with an unsorted pack of index cards. Each card has a statement written on it that relates to the design of the product. The participant is asked to sort these cards into groups and then to name these groups. The results of multiple individuals' sorts are then combined and analyzed statistically (Fig. 1). This technique is best used in the early stages of development (Nielson 1997). The reason is to assure that a design reflects the way users logically organize items, but can be done at any stage. The number of users needed is at least 10 but best with a minimum of 20 persons. The advantage of this method is showing a designer how users would organize and

name the information on a design. The disadvantage is that it is difficult to analyze the results with small number of users (Washington State University 2002).

Ask participants to group the cards in a way that makes sense to them

Next, ask them to name each group

Figure 1: Card Storing [13]

E. Field Study: It is carried out by observing the users as they do normal tasks (Washington State University 2001). This is done in their natural environment. This technique aims to view what users actually do in context and how interact with a product. Observer can take notes. Also audio and video recordings can be used. When conducting an observation, the observer should stay quiet most of time. The goal is to become virtually invisible to the users so that they will perform their tasks in the same way they normally do. It is often used in the early stages of the process (Nielson 1994). The number of users needed is from 3 to 5 persons (Washington State University 2001).

F. Questionnaire: A set of questions designed to collect responses and opinions from the users. Users are asked to fill out the questionnaire and return it to the designer. There are three basic types of questions: First, factual- type questionnaire which means that such questions ask about public, observable information that it would be tedious or inconvenient to get any other way. Second type is opinion-type questions. These ask the respondent what they think about something or someone. There's no right or wrong answer, all we have to do is give the strength of our feeling. Third type is Attitude questions. These focus the respondent's attention to inside themselves, to their internal response to events and situations in their lives. The questionnaire can be used at any stage of development, depending on the questions that are asked in the questionnaire. The number of users needed varies but it is good for large groups (Hom 2003).

G. Performance Testing: It examines a prototype by collecting data from people as they use it. A participant is invited to attend a session in which they perform a series of tasks while a designer

takes note of any difficulties they encounter. Participants are asked to “think out loud” about their thoughts, reactions and feelings (Laurel 2003, Fidgeon 2005). The designer collects data on how they are doing, for example, how long they take to perform the task, or how many errors they make (Hom 2003). This test aims to identify usability problems so that they can be solved prior to finalization of the product. The number of users needed is from 5 to 10. It could be conducted at any stage of the process to ensure that the design is staying on track (Centre for HCI Design 2004).

H. Heuristic Evaluation/ Expert Evaluation: Evaluators analyze and judge the design based on a set of usability principles. The intention is to find the usability problems (Hom 2003). In general, heuristic evaluation is difficult for a single individual to do because one person will never be able to find all usability problems. Basically different people find different usability problems. It is possible to improve the effectiveness of the method significantly by involving multiple evaluators. Three to five evaluators are required to carry out this technique. Each evaluator judges the design separately, then they are allowed to communicate and have their findings aggregated. This procedure is important in order to ensure independent and unbiased evaluations from each evaluator (Washington State University 2001).

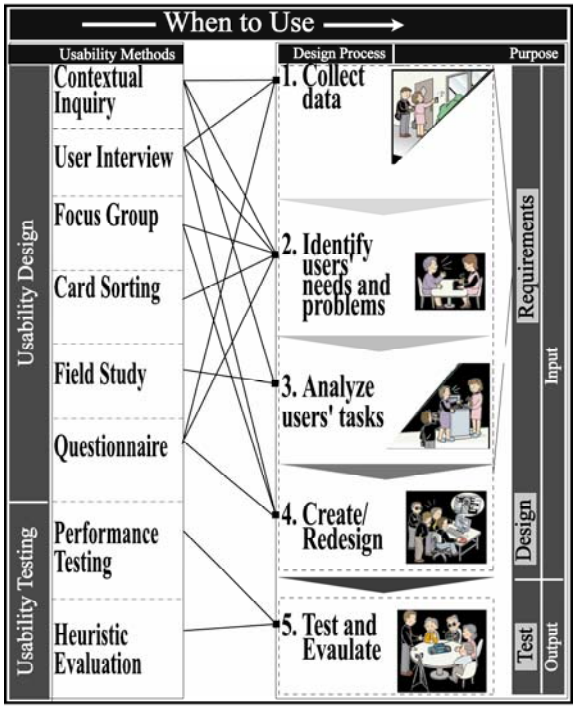

Figure 2: Authors’ Proposal

Based on the aim of each technique, we tried to identify when each usability method could be used in the design process (Fig. 2). Since the first stage of the proposed design process requires gathering information about the user’s context and the product environment, so contextual inquiry, user interview and questionnaire could be adequate. As for the second stage of the design process, contextual inquiry, user interview, focus group, card sorting and questionnaire could be used for identifying users’ needs and problems. In the third stage of the process, we could use the following techniques: contextual inquiry and field study. The fourth stage of the process, a designer could use user interview, focus group, and questionnaire. Performance testing and heuristic

evaluation could be adequate for evaluating a prototype.
Since the proposal is built on theoretical survey, therefore it is assessed by Japanese Professionals and the Center for Universal Design (CUD) and the Helen Hamlyn Centre (HHC), the Institute for Integrated Design (i/i/d) and Lund Institute of Technology (LIT). The judgment of each institution is useful and helpful for identifying the adequate usability methods which are required to carry out each stage of the universal design process.

One of the Japanese professionals accepts our proposal. And he thinks this chart can be seen as a guide rather than strict rules. There are some projects where we start breaking these rules.
The Center for Universal Design (CUD) agrees with our chart. But there are other schemes might be adopted depending on circumstances.

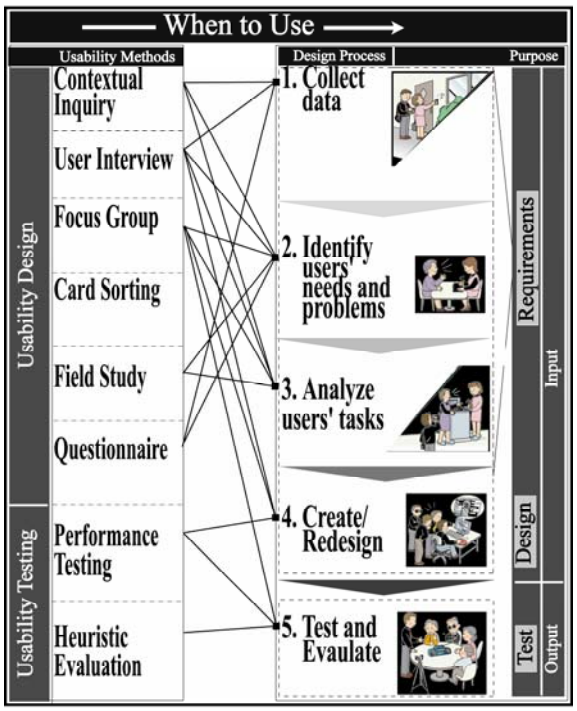

Figure 3: The Example of the HHC (UK)

The following examples of the HHC, the i/i/d and LIT are built on their practical experience (Fig. 3, 4 and 5).
The example that was suggested by the HHC recommends a designer to use contextual inquiry in the first, second and third stages of the design process. User interview is adequate to be used in the first, second, third and fourth stages of the design process. Focus group is effective to be used in the second, third, fourth and fifth stages of the design process. Field study is effective to be used in the second and third stages of the design process. Questionnaire is adequate to be used in the first and second stages of the design process. Performance testing is effective to be used in the fourth and fifth stages. And Heuristic evaluation is often used in the fifth stage of the design process.
In the HHC there are other usability methods, such as, user diaries which can be used in the first, second and third stages of the design process. This technique is carried out by asking a user to record what he/she feels, thinks and finds everyday, then give his/her notes to designer. On the other hand the example that was made by the i/i/d is as follows: contextual inquiry can be used in the first, second and third stages of the design process. User interview is adequate to be used in

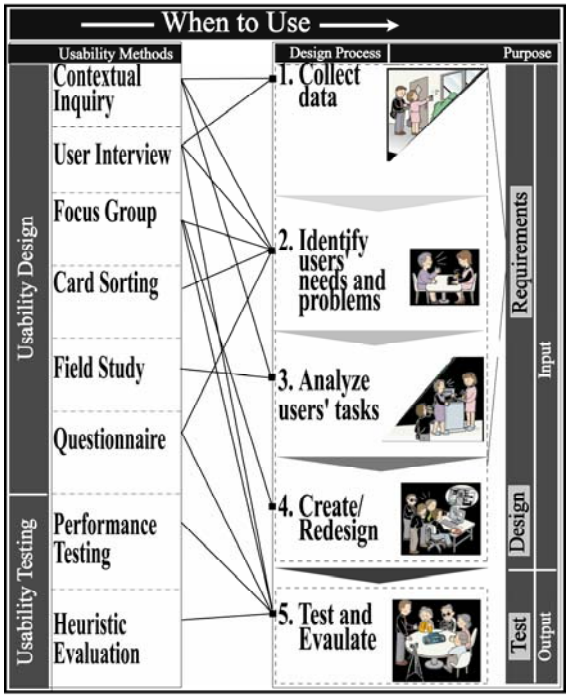

Figure 4: The Example of the i/i/d (Germany)

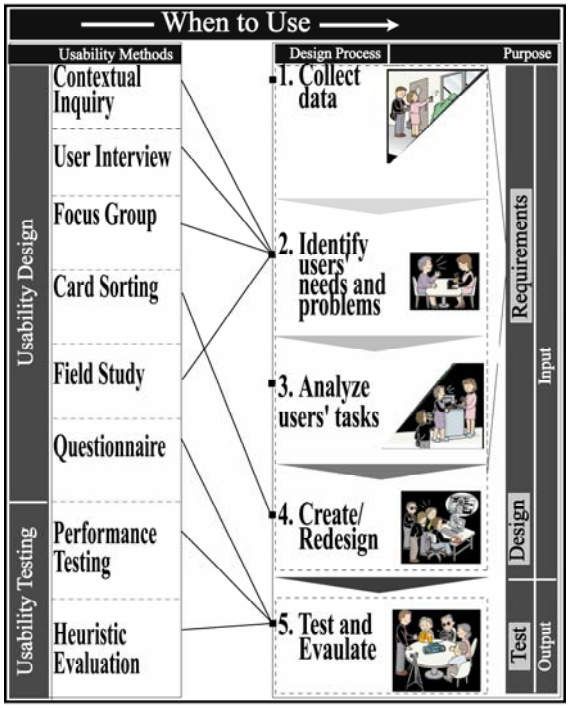

Figure 5: The Example of LIT (Sweden)

the first, second and fifth stages of the design process. Focus group is recommended to be used in the second, fourth and fifth stages. Card sorting can be used in the second stage of the design process. Field study can be used in the third stage. Questionnaire is adequate to be used in the second and fifth stages of the design process. Concerning performance testing and heuristic evaluation, the i/i/d recommends a designer to use them in the fifth stage of the design process. On the other hand, the i/i/d suggests other usability methods such as user scenario and expert interview. First method is recommended to be used in the second and third stages of the design process. User scenario is used for knowing where the problem is. Designer identifies the user's problem and tries to analyze why/how it was done. It is the creative imagination of a future scenario from viewpoint of user. Second method is effective to be used in the first, second and fifth stages of the process. Expert interview is used for solving users' problems by making interviews with the experts in the field of these problems.

As for LIT, it suggested that contextual inquiry can be used in the first stages of the design process. User interview can be used in the second stage of process. Focus group is effective to be used in the second stage of UD process. Card sorting can be used in the fourth stage of process. Field study is adequate to be used in the second stage of design process. Questionnaire can be used in the fifth stage of process. Performance testing can be used in the fifth stage of UD process. Heuristic

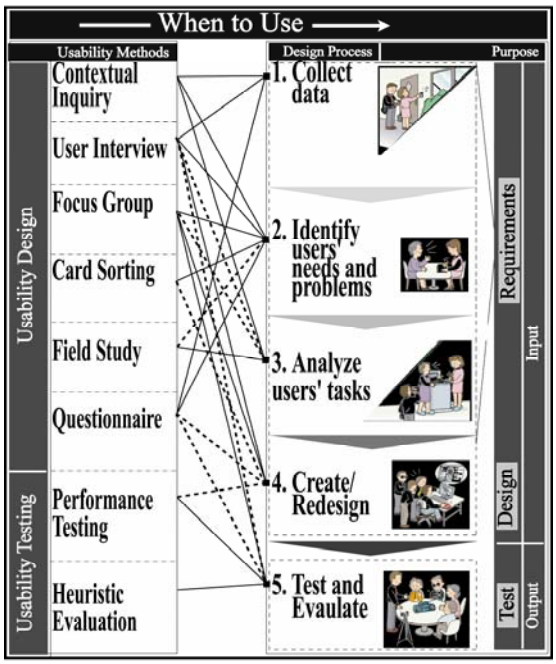

Figure 6: Combined Suggestion
| A method that can be used
¦ A method that might be used

evaluation is effective to be used in the fifth stage of design process.

The differences in the answers of the contact institutions are related to some factors such as consumers, culture, context, environment, budgets, time, etc. The answers of the CUD, the HHC, the i/i/d and LIT revealed that theoretical proposal could be used for developing UD product but practical experience is somewhat different.

We tried to combine our proposal with the examples that are suggested by the HHC, the i/i/d, and LIT so that it will be clear for researchers and designers to identify when each method can be used in the design process (Fig. 6). In the combined suggestion, contextual inquiry can be used in first, second, and third stages of the design process. User interview can be used in the first, second and fourth stages. Also it might be used in the third and fifth stages of the design process. Focus group can be used in the second, fourth and fifth stages. Also it might be used in the third stage of the design process. Card sorting can be used in the second stage and might be used in fourth stage of design process. Field study can be used in the third stage. Also it might be used in the second stage. Questionnaire can be used in the first and second stages. Also it might be used in fourth and fifth stages. Performance testing can be used in the fifth stage. Also it might be used in the fourth stage. Heuristic evaluation can be used in the fifth stage of the design process.

In the next stage of this work, our proposal will be assessed widely in order to identify the different and effective usability methods that can be used for developing UD product. The proposal will be judged by the manufacturers and consultative organizations which practice and use the concept of universal design, so that students and educators can know more about the concept of universal design and what methods are most useful for industry.

4. CONCLUSION

The present study tried to evaluate usability methods and identify when can be used in the universal design process. It identified the best practices in the user research and presented the

varied aspects in the international movement. Based on the literature survey, a proposal was made so as to clarify how to carry out each stage of the design process and which usability methods could be used. The proposal is assessed by the Center for Universal Design and the Helen Hamlyn Centre, the Institute for Integrated Design and Lund Institute of Technology in order to ensure of its performance and adequacy. Furthermore our proposal was judged by universal design professional in Japan. This study concluded the following: first, theoretical study could be good indicator for developing UD product but practical experience is somewhat different. The examples that were made by the contact centers revealed that practical experience is essential to identify which usability methods are most useful to be used in the universal/ inclusive design process. Secondly, our proposal needs to be tested more widely in order to obtain fundamental information about UD and its design process so that it will be valuable to see how to teach this concept to students and what usability methods are helpful for industry. In the next stage of this study, our proposal will be judged by UD manufacturers and consultative organizations.

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