Studying Users for Developing Usable and Useful Products

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ABSTRACT

This article presents a framework for studying users in order to support designers in constructing usable and useful consumer products. The framework is aimed at designing consumer products for which users cannot be specified in advance, long lasting observations of users are difficult or impossible to arrange, and the time frames available are short. We discuss what kind of end user information is needed, how to gather it, and how to transfer the results to designers. We applied the developed framework in a case study and found that it is capable of providing a reasonable depth of knowledge in a short time frame with low costs. Comments from designers indicate that the methods give concrete input to design work, such as the necessary feature composition users need. Finally, we draw out a number of lessons learned.

Keywords

User-centred design, user study methods, user requirements, consumer products

1. INTRODUCTION

The most influential step in improving the usability of an artefact to be designed is to take its intended users into account in the early stages of the development. Early focus on users transforms the design process from trial and error to an informed activity resulting in fewer iterations. While designers agree that it would be important to know the intended users, they find that the methods used to gather information about users should be improved (Bekker & Vermeeren, 1996). There is a need to build a bridge between users and designers to help designers to connect the structure of the user interface to the structure of use (cf. Constantine, 1995).

The aim of our research is to develop a framework for studying users. The framework can be applied in real-life consumer product development projects characterised by scarce personnel, tight schedules, and uncertainty. Consumer products like mobile phones have a large number of potential users, and users cannot be specified in advance. A major factor in determining competitiveness is how quickly a product is delivered and the frequent releases of consumer products create the time pressure. Under such less-than-perfect circumstances, designers often find

involving users too time consuming and expensive to be practical.

As Curtis et al. (1999) point out, qualitative user -centred design processes such as contextual inquiry can generate huge amounts of data to be organised, analysed, and represented. All this requires time and may be too demanding to product development time scales. Curtis et al. (1999), for example, spent 50 engineer months and $65,000 gathering and analysing data.

The "discount usability engineering" approach (Nielsen, 1994) is aimed at saving time. It is based on the use of scenarios, simplified thinking aloud in testing, and heuristic evaluation. Nielsen recommend "simple visits to customer locations", but in other respects the early stages of product development are dismissed. However, usability engineering is expected to be most effective if brought in at the very beginning of the product development cycle.

Furthermore, the results of Heinbokel et al. (1996) suggest that user involvement disturbs the process of software development. In their longitudinal field study, projects with high user participation showed lower overall success, fewer innovations, a lower degree of flexibility, and lower quality of team interaction. A solution may be that designers control user involvement by performing short user studies instead of user participation. Users can, for example, be observed at work or they can be interviewed in order to gather user needs.

A holistic and systematic framework for studying users is needed. The framework should spell out clearly what kind of information is needed, how to gather it, how to describe it. The well-known contextual inquiry offers a way to gain information about the work of users (Holtzblatt and Beyer, 1996; Beyer and Holtzblatt, 1998). Our work has adapted many ideas of contextual inquiry and design while focusing on consumer products and short time frames.

The longer-term objective of our work is to unify different views from human-computer interaction, cognitive psychology, and ethnography to synthesise design methods applicable for designing a variety of consumer products. The following sections discuss what types of user information are most critical during the early stages of design, how these can be collected, and how the results are presented. We also apply the developed method in a case study and discuss its usefulness on the basis of our experience.

2. USER STUDIES

2.1 What kind of information do we need?

To be useful and usable at all, the design of any product must adhere to intrinsic limits of human information processing capabilities. An essential part of this is to know what kind of knowledge and skills the users already have. Ericsson and Kintsch (1995) have collected evidence that persons can acquire domain-specific memory skills that allow them to extend their capacity of working memory for a particular activity. Adelson and Soloway (1985), for example, showed that expert programmers could produce good and bug-free designs when they were given program specifications, but not in the case of unfamiliar domain.

Also, the users are able to stretch their limited information processing capabilities if they can use their domain specific knowledge in understanding the new system. Thus the Ericsson and Kintsch (1995) evidence implies that considering the quality of present knowledge we can design more complicated systems without causing excessive cognitive load to users.

What kind of knowledge is essential in using new products? It is proposed that giving individuals a conceptual model of a system before instruction enhances user learning (see Staggers & Norcio, 1993). Turning this argument around, if one could gather information on how users currently perceive their tasks, one should be able to utilise users' existing models in designing a system intended for these tasks. There are suggestions on how to do this kind of metaphorical design (see Madsen, 1994; Rubin, 1996; Tepper, 1993), but to get these models directly from users would give them much more validity and applicability.

What kinds of conceptual models do users have before any product exists? Johnson et al. (1988) suggest that the most important aspect of the model is task-related knowledge and that its basic structural components would be goals, operations, methods and selection rules. It is intuitively clear that designers should know the goals of the users in order to support them and it is also vital to know how the users achieve these goals currently. By identifying user goals, it is also possible to discover the problems and needs users have. Users do something and they achieve some goals, but they may actually want something else.

The ability of users to use a system depends on how well the system matches their goals and way of action, and how well the users can realise their expectations and utilise their knowledge of tasks and procedures. Figure 1 illustrates the layers of user characteristics concerning the use of products.

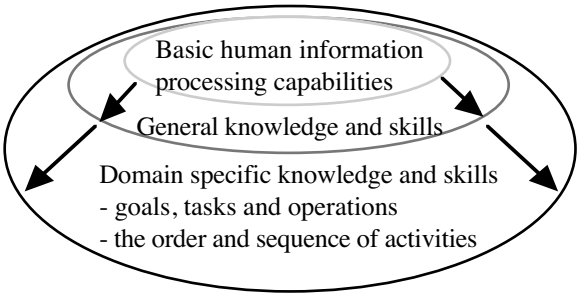

Figure 1. A model of the user characteristics concerning the use of products.

The core of the characteristics is the basic human information processing capabilities, which are rather constant. General knowledge and skills widen the basic information capacity. Then the domain specific knowledge and skills widen the capacity even more.

2.2 How to gather information?

The first step in gathering information about users is to decide on the target users to be contacted. The users chosen should be representative users, in order to understand the essential group of users. Users differ in their interactions with a product because of their specific personal characteristics, interests, needs, and skills. It is not possible to contact all the possible users, but you can select typical users from the main sets of users.

Ulrich and Eppinger (1995) find it useful to contact a class of users called lead users. Lead users may reveal more needs because they have had to struggle with the inadequacies of existing products and they may have already invented solutions to meet their needs. Sometimes it may be difficult to discover what the underlying needs behind these solutions really are.

Further, not all users are equally motivated and they will use the product less frequently than lead users. Thus, it would be most useful to contact both kinds of users: lead users to find advanced needs and usual users to pinpoint the problems they struggle with.

The second step is to decide on the best techniques for gathering user information. We suggest three specific techniques, along with specific know-how on their use. The aim was that the techniques should be easy and simple, yet reveal a variety of topics.

As a starting point, we selected the usual technique, interviewing, as we find it a quick and efficient way to gather information. Observing users was considered to be too time-consuming. In refining our interviewing technique, we took into account some of the inherent limitations of conventional interviewing methods. First, the questions must be well thought out, in order to get relevant information, and second, users are not good at answering questions - they forget details or things that are obvious in their opinion.

Two other techniques were included to augment interviewing. The interactive feature conceptualisation technique was selected to aid conversation and documenting. The think-aloud technique was selected to uncover skills and information that cannot be gathered just by asking. The interaction of the techniques is presented in Figure 2.

A user is first interviewed in order to create a comfortable atmosphere and gather the basic information. Secondly, the interactive feature conceptualisation technique is used. In this technique, after the interview, the user is asked to classify items that had been mentioned and written down on sticky notes during the interview.

Thus, the interviewer and user draw an overall picture of the results together. Thirdly, detailed information is gathered through the think-aloud method. A brief description of each technique is presented below.

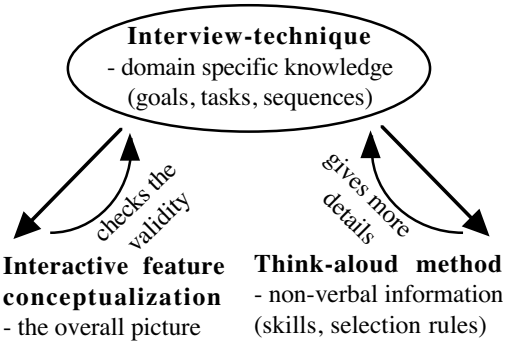

Figure 2. The focus of each technique used and the interaction between them.

2.2.1 *Technique I: Semi-stuctured Interview*

The interview technique is influenced by earlier work of Bauersfeld & Halgren (1996), Beyer & Holzblatt (1996), and Wood (1997). The interviews are carried out in the natural settings of potential users, using their own task-related language. The idea is to gain deeper understanding and help the user to remember details by seeing and maybe trying the tools and artefacts being discussed. The users are encouraged to show artefacts and give demonstrations.

The interviewer prepares questions. The questions are not followed strictly, but they are used as a checklist. The interviewer tries to understand the user rather than just to get a list of questions answered. Typically, first some open questions are asked about their activity in general, then the user is asked to demonstrate the activities being studied, while more detailed information is gathered by further questions. A video camera is used to capture the process.

Possible topics of interview and questions include:

• BACKGROUND INFORMATION

The goal of gathering background information is to help the analyst to interpret the results and classify the users. The typical questions are about age, profession, technical orientation, previous computer experience, work experience, and educational level.

• GOALS AND PREFERENCES

The aim of these topics is to understand what users want to achieve and how an intended application can support their tasks and allow better ways to achieve the goals.

Examples of such questions:

What is most important in your work? Why did you buy this tool?

• USER'S KNOWLEDGE, SKILLS, AND EXPERIENCES

The aim of these topics is to understand what users can do, how they employ objects in accomplishing their goals, and what kind of work-related processes they have.

Examples of such questions:

What kinds of tools and equipment do you use? How about the usual ones like paper and pencil? Can you describe your most typical tasks? What is the order of action steps?

• CONTEXT OF USING AN INTENDED APPLICATION

A design team should understand the context in which their application will be used in order to be able to support the user tasks in an optimal way. What kind of tasks does the user have? What is the combination of tools used by the user? In what kind of an environment does the user act? How are other people involved?

Examples of such questions:

Where do you use your tools? Which kinds of tools do you carry with you? Who do you meet during the working day?

• PROS AND CONS OF THE CURRENT TOOLS AND ACTIONS

The current tools and actions may have advantages which users are unwilling to give up. On the other hand, tools and actions may be suboptimal. An intended system should include most of the good sides and solve the problems. The pros and cons should pay attention to when a user is telling about his/her actions and tools. Sometimes the analyst may need to ask clarifying questions in order to understand the pros and cons.

Examples of such questions:

What is the meaning of this procedure? Why do you find this useful?

• PROBLEMS WHICH USERS HAVE

While users are explaining how they do things, they rather spontaneously report problems and frustrations they have had. The interviewer can ask about them too, but users often find it difficult to remember all problems they have. All kinds of materials (tools, documents, and samples) may help the user to remember. The interviewer should also recognise if users do something in a complicated way in order to solve their problems.

Examples of such questions:

What is most troublesome in your work/task? Which kinds of important things are you unable to do? What is the reason for all these actions?

• SYSTEM BASED QUESTIONS, PREFERENCES AND REQUIREMENTS OF USERS

A designer needs to know details of users' working styles concerning the future system. Users may spontaneously state preferences and opinions and the selections they have made tell about their preferences.

Examples of such questions:

What kinds of notes do you have in your diary? What kinds of functions do you need to help you?

2.2.2 Technique II: Interactive feature conceptualisation

The aim of this part is to form an overall picture of the user and his context and to get a classification of tools, persons, places, properties, and concepts. The technique is adopted from Baursfeld and Halgren (1996) and simplified and developed further.

During the interview, tools, processes, places, persons, etc., that the user mentions are recorded on sticky notes. At the end of the interview, all sticky notes are placed on a large sheet of paper. The user is asked to rearrange the items into categories that make sense to them in their context. Alternatively, the interviewer places sticky notes containing places (e.g. home, car) on a sheet of paper and asks the user to place other notes according to them. As the notes are grouped, the interviewer tries to understand the overall picture. For instance, to capture communication patterns between people, he can ask clarifying questions about communication and draw arrows representing connections between people or flows of information.

2.2.3 Technique III: Think-aloud method

The aim of the think-aloud method is to find out procedural knowledge such as how users use their present tools and what beliefs, theories, skills, etc. delineate the use. Procedural knowledge is a representation of one's ability to perform a skill (Mitchell and Chi, 1985). As Mitchell and

Chi (1985) point out, questioning is a good first step in measuring procedural knowledge, but one should not rely entirely on this method. When tasks become automated, little attention is required to execute the task and skills become difficult to articulate. A better procedure for measuring procedural knowledge is to give the subject a series of problems to solve, and have him think out loud while solving these problems (Mitchell and Chi, 1985).

As it is difficult to apply think-aloud protocol analysis directly, we created a somewhat modified version of it. The user is asked to tell how he uses a tool by thinking aloud during the imagined use. The user has the tool in hand, imagines his/her typical use situations, and tells how he would use the tool in the situation. For example, a user is asked to describe how he uses his calendar during a day. The idea is to gather more detailed information about ways of use, values, skills, and selection rules, in this way. The interviewer asks clarifying questions when needed.

2.3 How to describe results?

Holtzblatt and Beyer (1993) give some fine diagram types intended to describe the results of a user study. Using these diagrams as a baseline, we tried to find a way of describing the results of user studies that is simple and easy but still useful so that the descriptions are not left unfinished and the designers can effectively use them.

We developed the descriptions as a result of a case study. Holtzblatt and Beyer's (1993) context and physical models were found to be inessential, because the products addressed by our research are for consumers and not for any certain organisational context. In our experience, the most essential aspect to be modelled is the way users use the product. This should be described as detailed and systematically as possible.

In order to keep the creating of figures easy, only two diagrams were included. The first diagram describes the overall results based on the interactive feature conceptualisation-picture (see Figure 3). The overall diagram resembles the flow model of Holzblatt and Beyer (1993), but it also includes information that they included in their physical model. The diagram includes the relevant individuals, groups, communication flows and ways, tools, artefacts, and places. The expressed user needs and problems are included in the diagram.

The second diagram is a concrete interpretation of the results in order to support design work. It gives an interpretation of the results and describes solutions that the results suggest (see Figure 4). The developed diagram is near the task model of Johnson et al. (1995) containing the goals of the user, but it is done from the point of view of using the future system. Therefore, it contains use situations, places of use, procedures, and user roles. Thus, the diagram helps to generate realistic scenarios of use (cf. Scenario-based design (Carroll, 1995)).

3. CASE STUDY: DEVELOPING A PDA

3.1 Study overview

The case study was conducted for TeamWARE Group, a Finnish subsidiary of Fujitsu Corporation that is mainly active in CSCW, office automation, internet solutions, and knowledge management products.

The aim of the case study was to test our techniques in a realistic setting of designing a personal digital assistant (PDA) application. In particular, we wanted to find out what kinds of information can (and cannot) be effectively gathered from intended users of the product, and how the information can be used by designers in their work. The PDA application in question was designed to be a personal organiser with calendar and notebook. The designers had already created their first interface prototype of the PDA software, and they were interested in gathering more information about target users to support their design work.

3.2 User studies

Three users participated in the study. They did not use any PDA at that time, and they had different occupations and interests. Each of the studies took about an hour and a half. One researcher conducted each study, videotaped its progress, and made notes. The permission to use a video camera was asked in advance. One study was not videotaped because the user found it disturbing.

The interview questions were decided together with an interaction designer. The users were interviewed about their work tasks and goals, tools, communication tools, information flows, and contacts. They were asked how they organised their time and to-do lists. A think-aloud method was applied to the use of calendar, address book, memos, and electronic mail.

The main results of each subject were first described in two written tables under predefined headings. The headings were: background information, goals, tasks, tools, use descriptions in thinking-aloud sessions, needs in work, and other needs. Then diagrams were drawn, as described earlier (Figure 3 and 4). Figure 3, based on the interactive feature conceptualisation technique, includes the categorisation of objects and naming of categories that the user made. The arrows describe information flow. The discovered needs were later added using a lighter colour.

3.3 Evaluating the results

To assess the usefulness of the results, the tables and diagrams constructed were shown to an interaction designer and a usability specialist. They commented on the findings and the presentation style of the documents.

The interaction designer found the sequence-pictures useful in understanding the goal structure of users. The use sequences in Figure 4 provide a systematic way to assess user behaviour and document decision-making arguments. The usability specialist thought that the overall figure of the results helped to understand the context of use and to generate scenarios of use for usability tests. They both found the overall results useful and at least one idea suggested by the diagrams was adopted in their next prototype. In particular, identified user roles and situations were new findings.

Apart from directly suggesting potential features to be included in the design, the diagrams helped to straighten out hidden (and erroneous) assumptions of the designer. For instance, the designer seemed to have a different model of using a calendar from actual users. The designer thought that deadlines are important aspects of the diary. In contrast, interviewees spent considerable effort organising information and classifying to-do items while giving deadlines far less attention.

The results of only three users already constituted some kind of structure. In sequence pictures, there seemed to be a group of common functions, some optional and complementary functions and some conflicting functions. Different users had some different needs and different personal preferences.

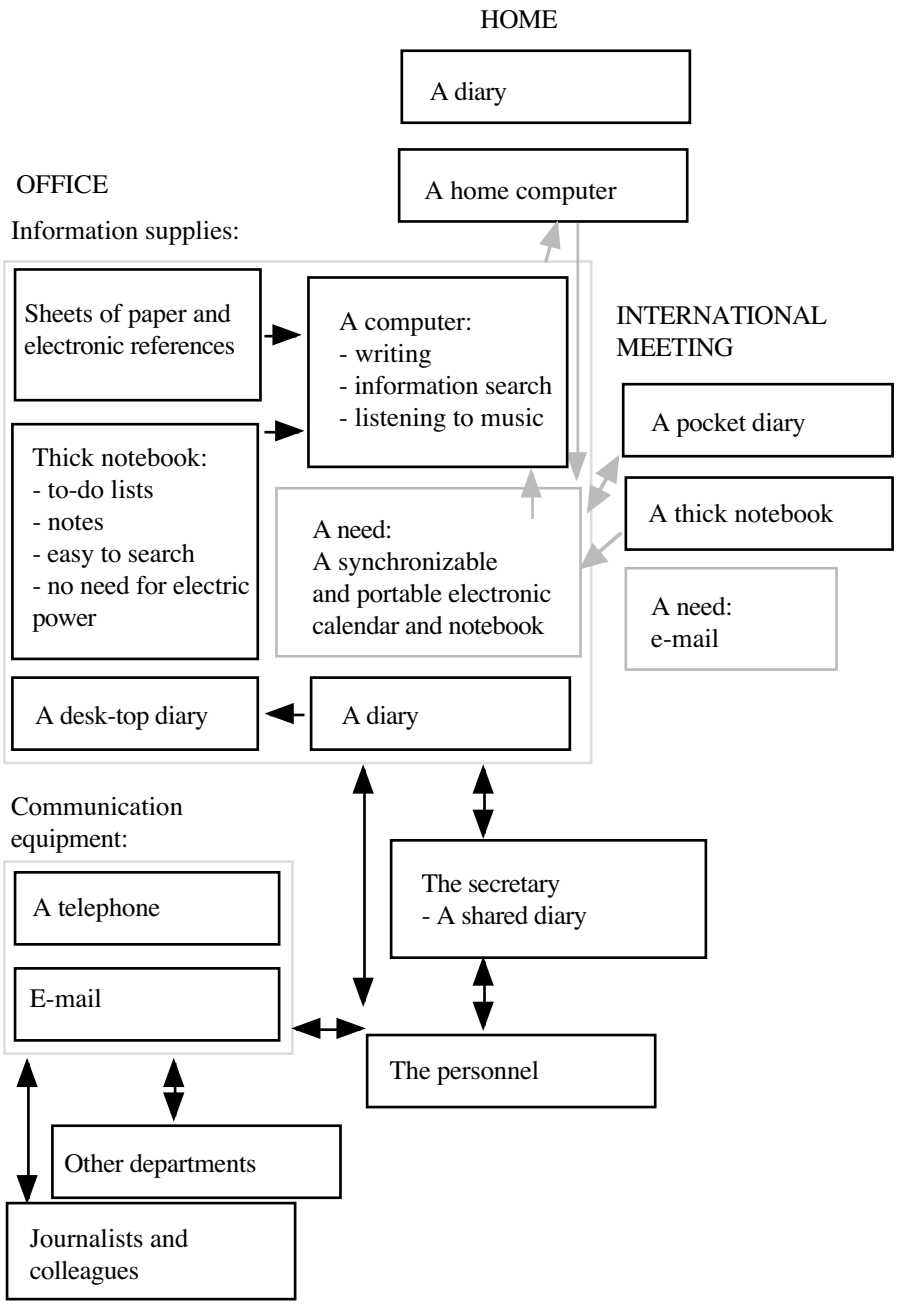

Figure 3. The overall figure of a user.

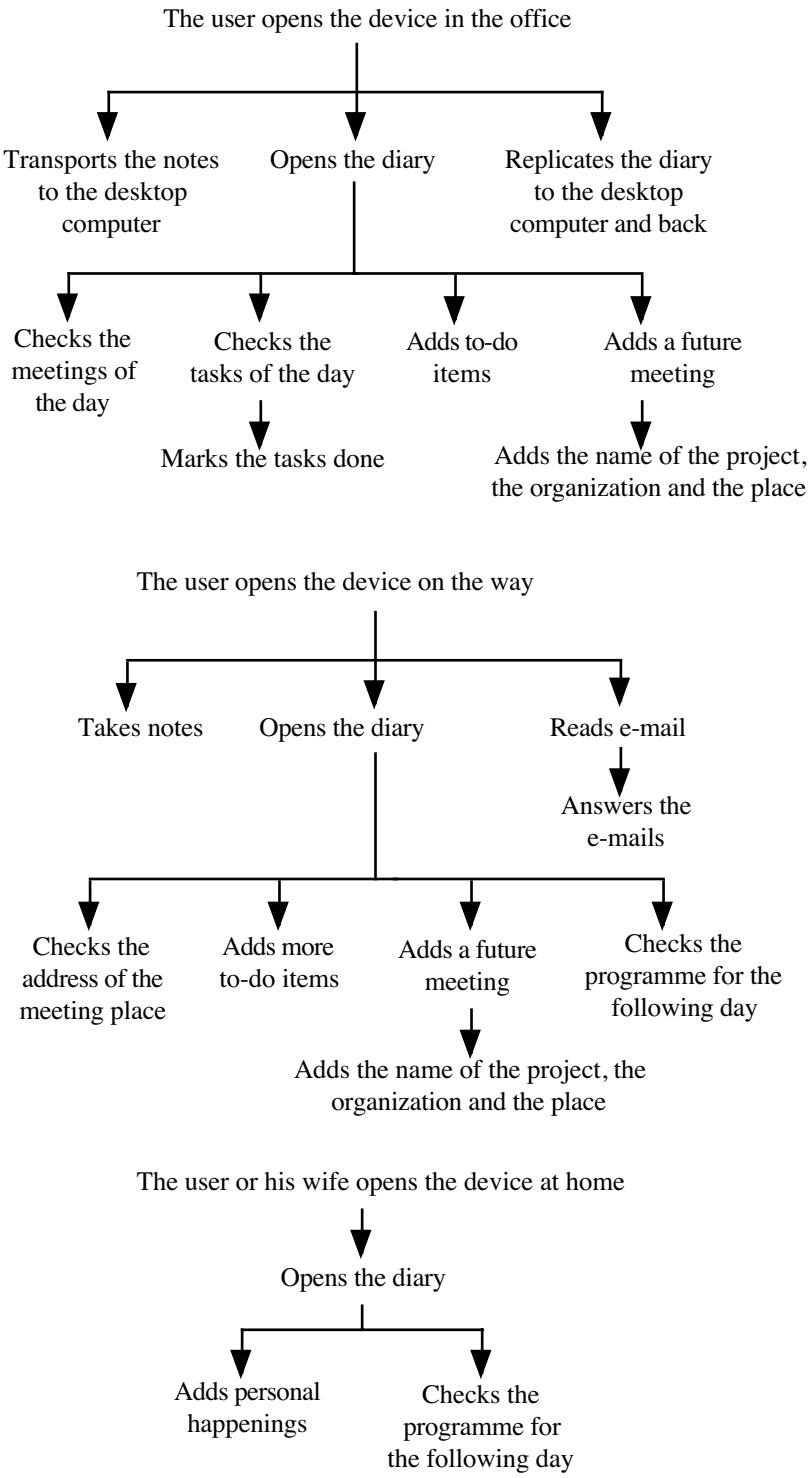

Figure 4. The use sequences of one user.

3.3.1 Person hours spent

Table 1 accounts for the total time spent on the case. Most of the time was spent drawing pictures.

It would have been possible to save some time, if the overall pictures had not been drawn for all users separately.

The phase of the study	Hours
Preparing	2
User visits and travels	7
Documenting the results	18
Total	27

Table 1. Estimate of the total number of person-hours spent on the case including three users.

3.4 Lessons learned

The case study permitted us to learn some useful lessons on our framework:

• *Allow more time* for user visits if possible. In one-and-half hours, a lot of information was gathered in an intensive way and sometimes it was difficult to find time to gather all types of information. On the other hand, it was easier to get users to participate for a short time: they were all busy professionals.

• *Take good notes* if the user has time to wait. If you have good notes, you will need less time to describe your results. If you have very limited time to spend with the user, it is wiser not to take notes and instead watch the videotape afterwards. In any case, try to describe the results briefly after an each user visit.

• *Find out user's priorities*. The users sometimes openly stated necessary requirements for the application, but even more information on their priorities would be useful.

• *Recognise the values of users*. Find out the good aspects of their present tools and processes. Sometimes they are unwilling to give up these things. For instance, in the PDA case some of the users thought it is vital that the new diary would be synchronisable with their computer diary.

• *Recognise the differences of users*. Different users may need a different studying approach. Not everybody is willing to be videotaped. Some users find modelling their work with sticky notes interesting, but some of them prefer telling the same things.

• *Summarise the results*. Even the results of three studies were difficult to keep in mind and consider. In order to support decision making the designer would like to have results described compactly. It is important to find and describe a synthesis of the results. The arguments for the synthesis should be visible details of the results. It is possible to make user and requirements classifications and to summarise the common contents of sequence pictures in one final picture.

• *Visualise the results*. Describe the synthesis of the results with examples and scenarios. This makes the results more understandable, real, and convincing.

4. CONCLUSION

In summary, our framework is capable of providing a reasonable depth of knowledge in a short time frame with relatively low costs (Table 1). Its results seem to be useful to verify assumptions on users and their preferences, decrease risks, and help in making design decisions. Comments from designers indicate that our method can give concrete input to design work, such as the necessary feature composition users need, the nature of some realisations of the features, and an estimate of their usage. The results give a rough but informed basis for design work.

The results indicate that the three techniques complement each other. A user did not mention any problems with time management or his calendar in the interview, but when thinking-aloud method was used he told how he has to use sticky notes in order to manage with his calendar. He did not experience any problems until he faced the details of using the calendar.

Our other case study reported elsewhere supports the results (Kujala and Mäntylä, 2000). A psychologist, rather than a designer, interviewed six users using the user study framework and developed new design propositions. The results were compared with a baseline design process with usability tests of 33 users. The results show that the user study was useful although the investment of 46 person hours was modest. The design propositions based on the user study results made the product more usable and desirable for the users.

In addition, three baseline designers were interviewed, and it was found out that the user study provided them new information. The designers had identified most of the user needs, but they found it difficult to distinguish the essential ones. The designers found the results of the

user study to be useful for understanding the priorities of the users, their use contexts, and their specific ways of use.

In summary, the advantages of the user study framework are:

- The techniques provide general description of persons, their work, tasks, knowledge and preferences. The descriptions can be gathered and re-used in designing further systems directed to the same target group.
- The developed descriptions allow for defining the necessary feature composition from the user's point of view.
- The results supplied some concrete ideas about the appearance of the interface. (For example, the calendar should have more space for notes than the traditional ones).
- The results allow for connecting the structure of the user interface to the structure of use. In sequence pictures it is possible to see how a single way of use relates to broader contexts of use. In addition, user roles and places can be identified.
- The structure of the system can be compared with the current structure of use including tasks, goals, procedures and appearances in order to discover the divergent points and to develop design strategies to help users manage the differences.
- By anticipating different ways to use a system it is possible to expose potential error situations.
- Use sequences aid in generating scenarios for usability tests. This way scenarios and tasks would be more realistic than the scenarios and tasks the designer has thought and the usability testing would be more appropriate.

Use sequences can be used to improve expert reviewing as they provide realistic tasks and goals to cognitive walkthroughs.

5. FURTHER WORK

Despite the advantages of the method, all the gained information needs processing and understanding. There is still the challenge of conveying the information to development work. This takes a lot of effort but it should improve and advance development process. Further work should raise techniques to create summaries and join user studies to development process.

ACKNOWLEDGEMENTS

This research has been supported by the Academy of Finland through the project "Smart Products in an Information Society", and Technology Development Center (TEKES). We gratefully acknowledge the help of Pirkko Jokela, Kalle Saarinen and Mika Koski of TeamWARE Group in setting up and executing the case study part of our research. The authors wish to acknowledge the helpful comments provided by Marjo Kauppinen.

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