

Mobile Probes

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ABSTRACT

This paper describes a new digital user study tool called Mobile Probes. Mobile Probes arose from a need to develop contextual and dynamic self-documenting tools for studying people's actions in mobile contexts. The technology used in the pilot study was based on dual band mobile phones with GPRS connections and an external accessory digital camera. A system was also developed for sharing and sorting the data. The system was implemented with Java software to enable the device to send and receive data, and PHP scripting to send and edit the questions and to view the answers through a dynamic web server. Another pilot study was conducted with a flexible platform that operates a spatio-temporal mobile log. The results of the studies show that Mobile Probes are a promising way to conduct user studies. Ideas for future development of the tool are discussed.

Author Keywords

User-centered concept design; User Studies; Mobile devices; Digital ethnography; Cultural Probes, Self-documenting; Shopping; Mobile work

ACM Classification Keywords

H.5.2. User interfaces, user-centered design

INTRODUCTION

The Cultural Probes study [7] has initiated a variety of ways to apply self-documentation in user studies for the design of interactive products and systems. Self-documenting tools and projective tasks have been used in design ethnography and in field studies of sociology and psychology. This paper first presents an introduction to the self-documenting tools including examples of probes studies. Secondly, two

user studies, in which digital mobile probes were used, are described. Finally, the experiences of these digital self-documenting pilots are presented and directions for future development are discussed.

Diaries

In diary studies the subjects are given diaries to document their feelings or activities during a certain period. De Longis et al. [6] state that when several events become documented, a more credible and solid description of the person can be attained than e.g. from only one observed situation. Diaries are also claimed to reduce the retrospective reflection and to gather more contextual data in comparison to interviews, where situations are mostly memorized. The richness of the data can be seen as an advantage of the diary method. The challenge, however, lies in motivating the users and in the analysis of the open and subjective entries [19].

Diaries are used in design ethnography to capture activities in context, to understand needs and motivations related to the use of technology and to gather user requirements for design [see 19]. Having to reflect and write into diaries can cause sensitization to the documented issues [6]. In design related diary studies this heightened sensitivity to specific actions and environments can be a positive effect. Diaries can help people to notice and to understand their everyday experiences and so become more prepared to discuss them in interviews and create ideas in participatory design workshops [20].

Self-photography

Similar to the diary method, self-photography has been used in various disciplines. In social sciences it is one possible technique for field observations. The subjects are given cameras and asked to take photographs either with or without specific assignments. In self-photography the observed has thus the control and "the understanding begins with the view through the eyes of the observed" [23].

In design ethnography self-photography can have several roles: first of all the photographs illustrate the users' perspective on their world. Secondly, they can be used as a tool to facilitate other approaches such as interviews and participatory workshops [2,10,23]. Thirdly, photographs are a rich and visual way to support communicating user study results to designers and other stake holders [1].

In a study reported by Brown et al [2] self-photography was used in a diary-like manner to document activities visually. The users were given digital cameras to photograph thoughts and activities related to information capture. The advantage of using this method was in gathering data during action. The photographs were also applied as props in the interview that followed the documenting period. The users found photographing easy and less laborious than writing notes in diaries.

Projective tools

Collages and other projective tools have their roots in psychology. In user studies projective tools aim at stimulating associations in order to discover users' needs, values, feelings and dreams for the starting points of design. Collages are often a collection of pictures and sometimes also words, both abstract and concrete, which aim to convey an expressive message. In user studies they are used to study issues that relate to e.g. senses or abstract experiences. The results are visualized associations that can aim to support design inspiration and understanding. [18,20,21]

Liz Sanders is one of the pioneers of using projective tools systematically in design studies. Make-tools aim at gathering data from people about issues that are not easy to verbalize. The tools support the users to express themselves and reveal sensitive and irrational but relevant thoughts by providing metaphors and associations [20].

Experience sampling method

Experience sampling method (ESM) is used to study the quality of subjective experience [5,19]. To conduct a study, users are given electronic paging devices. The device alarms randomly asking users to write down quickly what they are doing or how they feel based on the given questions or claims. In user-centered design ESM has been applied to identify and rank user needs and preferences of architectural redesign of home environments [11]. In the study, images or short videos were captured automatically when something was happening in the studied room. The users were able to browse and comment the images when it was convenient for them. The redesign of the home was guided by the samples of the real activities and also feedback in the actual context.

PROBES

The core of the probes approach is to give people (possible future users) tools to document, reflect on and express their thoughts on environments and actions. One of the aims of the approach is to create a communication link between the users and the designers, and to inform and inspire the design team.

The Cultural Probes and Domestic Probes [7,8,9] applied an artistic, inventive and aesthetically pleasing user study approach. The designer-researcher teams' purpose was to investigate aspects of people's lives and to create narratives which stimulate and inspire the concept design of provocative interactive devices and systems.

The Residential Probes study [4,9] emphasized design ethnographic orientation and information gathering rather than inspiration probing. They were used in "sensitive settings", such as in a hostel for former psychiatric patients, where other user study methods than probes were considered disturbing. The aim with these probes was to inform the researchers. They study complimented other design ethnography methods in a research project context. The probes thus facilitated understanding the needs of differently-abled people.

Technology probes [10] were technical applications which enabled being in contact with remote family members. The aims of the technology probes were divided into three different areas: a) to gather information about the users and the use of technology in a real context, b) to field test technology, and c) to inspire designers and users to think about new uses of technology and reflect about their everyday activities in new ways. The results gave insights into the practical needs and more playful desires but also provided real-life use descriptions.

At the University of Art and Design Helsinki several probes studies have been conducted in collaboration with companies. In these studies the main area of interest has been in gathering visual and narrative user material with a wide perspective for concept design. Creating an empathic dialogue between the study participants and the company designers has also been important. The focus of the studies has taken the use of the probes tools from the home to nurses' work context and further to mobile contexts such as exercising and free ride skiing. [12,13,17,18]

THE OBJECTIVE OF MOBILE PROBES

Masten and Plowman [16] vision digital ethnography as a new approach full of opportunities. The traditional design ethnography tools are updated with the possibilities of new technology. PDAs, emails, mobile phones, pagers, and digital cameras are used to gather user data and servers and computer systems to sort and share the data. Among the advantages are the possibilities to remotely and simultaneously observe several users, to automatize the sorting of the data and to create digital user databases for the stakeholders. Furthermore, users can become more active contributors instead of being only passive sources of data.

One of the challenges with probes studies has been to motivate people to complete the probes tasks in mobile contexts. This is necessary, because many of the interactive devices designed today are becoming mobile and their use is influenced by their changing contexts. According to our experience, the probes seem to work often in a retrospective mode, i.e. people tend to document their behavior only after the action is over and they are back at home. A retrospective component in probes studies is completely acceptable and worth recording. However, the fresh sense of context and action that might be captured with probes when applied real-time is obviously lost when this happens. Therefore, we

have been interested in developing more contextual interactive probing tools.

Another challenge with probes has been the interpretation and sharing of collected material in projects where companies are involved. The original rich and visual material often needs to be digitized afterwards for storing, sharing, and presentation purposes. This can require a considerable amount of work. To solve the problems of 1) variable context while recording and 2) flexibility in the probes analysis phase, we have experimented with digital mobile probes in two cases. This paper presents these two pilot studies using mobile interactive probes with case Shopping and case Mobile Work, and discusses the results as well as the possibilities for development.

CASE SHOPPING

The first mobile probes pilot study was part of a collaborative research and development project including two universities, several clothing industry companies and a department stores chain. The aim of the project was to create a new kind of sales point for clothing retailers. This aim was based on a vision of a sales point incorporating new technologies such as virtual mirrors, automatic body measurements and wall displays, which provided a wide range of possibilities for concept design. These kinds of solutions already exist in some form, for instance at Prada's flag ship store in New York [15].

A user study was conducted before the concept development phase to ensure a user-centered design perspective, which was a fresh view point to the companies involved. Two user segments were identified for the study from earlier quantitative market research: Frequent Shoppers and Efficient Shoppers. The companies knew their buying habits but the shopping and decision making behavior on an individual level was not clear or well known. Sales personnel were also seen as an essential user group for the success of the future sales point concept and they were included as a third group for the research. The mobile probes study was carried out with frequent buyers and sales personnel.

The probes approach was chosen as a method to cover a broad area of issues related to shopping, such as subjective preferences, social considerations and pleasure. The idea was to be able to document people's habits and thoughts related to shopping for clothes. Shopping behavior is mobile, as people tend to move around inside the shops and from one store to another to browse the alternatives. The challenge was to make people document their thoughts, feelings and actions while they are on the move.

Typically the basic probes packages include a theme diary and a disposable camera. The digital equipment included a mobile phone with digital accessory camera and a Java applet running on the terminal with tasks and questions for self-documentation.

Testing environment

The self-documenting started with an introduction meeting where the study was explained and users were instructed on how to use the mobile probes system on the device. The self-documenting period, which lasted for two weeks, was divided into two phases. First, the participants were asked to document their daily life as it related to clothes and shopping and to answer questions with text and images. The second week's tasks focused on the shopping experience and the participants were asked to answer the presented questions while shopping. The participants were encouraged to continue the first week's self-documentation during the second week as well. After the two-week period the participants were interviewed. In this semi-structured interview all the answers and images taken with the device were discussed.

With the sales personnel the self-documenting period lasted for one week. It also started with an introduction meeting. After this the personnel self-documented their daily work with the device. Also the shop personnel were interviewed after the self-documenting period.

During the self-documenting period the researchers, together with the companies involved, were able to see raw data accumulating onto the server's database via a web page.

Technology

The mobile terminal used for the shopping probes was Nokia 7210 dual band mobile phone, which supports GPRS data streams for fast internet connections and Java technology for third party software. It has a 128 by 128 pixel color display. The user can attach an external digital camera onto the device that will save captured pictures to the device's memory. There is enough memory for 50-100 images on the device, depending on the image quality. The mobile phone supports Java MIDP 1.0 programs with the maximum size of 64Kb. The size of the program limits the possibilities of software functionality. On a mobile network, there are different methods to connect into the Internet. The Mobile probes used the most recent one, a GPRS connection that provides a 48 Kbps data stream, which is sufficient for text and image data transferred between the mobile terminal and the server.

The phone ran a Java application, which probed the participants with questions and assignments, and sent the answers to the server. It was developed with Sun Microsystems Java 2.0ME (MIDP 1.0) [12]. The Java 2.0ME platform provides functionality to communicate with an internet connected web server through GSM/GPRS networks. Communication between the terminal and the server was based on the html method of GET/POST data communication.



Figure 1. Nokia 7210 phone and external digital camera

The backbone of the system was an online Linux server with PHP scripting language support [26]. PHP can be used to create dynamic web pages that are constructed on the server and then sent to the user's web browser. This way all data can be separated from its presentation. All the probes questions and user-submitted answers were stored in a SQL database. A basic user interface for formatting the questions and viewing the users' answers was developed with PHP. With the system, the researchers could edit the questions even during the on-going self-documenting period. Answers from the users were collected into the database from where they were presented to the researcher and other persons involved by a dynamic web page.

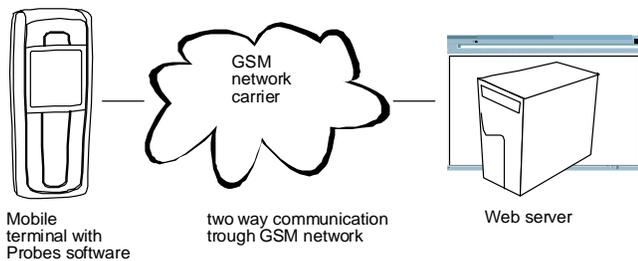


Figure 2. Technology Platform

User Interface

The Nokia 7210 device limits the size of the Java MIDlet to 64 Kb. Due to this limitation the user interface and communication with the back end cannot be very sophisticated. Early ideas included graphic intensive user interfaces and multiple question types with related images. This approach was hampered by the devices memory limitation and a practical approach of a hierarchical navigation structure was developed.

The structure of the user interface was divided into different categories depending on the studied subject:

For sales personnel it included categories

1. Daily diary with repeating question
2. Daily updated question
3. Instructions for picture taking tasks

Furthermore, for the shoppers

4. Questions to be answered while shopping

When the user selected one of these categories, the phone's software would make a connection to the server over the GSM network and fetch the corresponding question for the user. The user then had two options, either to return to the main menu or continue to the answering screen. In the answering screen the user could type in the answer and send it to the server.

In the image taking assignments menu the users could only see questions that would direct to the picture taking process. After this they were instructed to close the Java application and take the picture. Pictures were not sent but returned with the device after the research period because the java MIDP version 1.0 which runs on the Nokia 7210 doesn't support picture taking capabilities and the sending of files over GSM from Java applications. However, there are currently devices on the market that can do this.

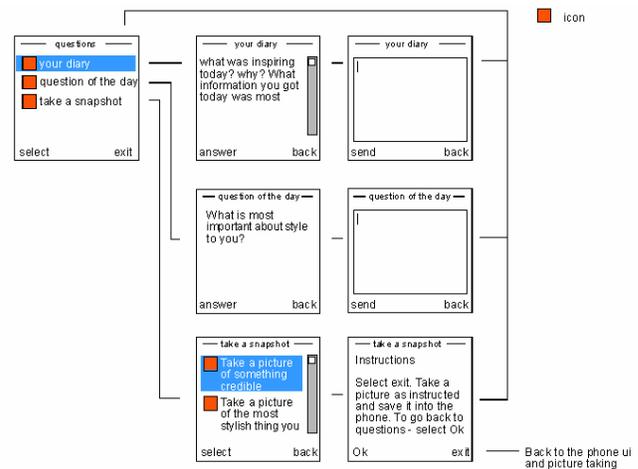


Figure 3. User interface

Results of the study

The first mobile probes pilot produced in total 101 images and 150 text replies from the 13 participants. The five shoppers provided 30 pictures and 101 text replies. The relatively low number of images can be explained by the fact that the use of the external camera is not very practical and the quality of pictures taken indoors is poor. Also, taking pictures inside shops is often forbidden.

Mobile probes proved to be complicated with the sales personnel who participated into the study. In sales work, the use of a mobile device can be seen as extremely rude by the customers. When interviewed the personnel gave this as the main reason for their low reply frequency. The shop personnel did not answer as many questions and the answers were mostly written before or after the working day as some of the personnel stated in their interviews. None of the images featured customers. This suggests that they were taken before or after working hours.

Thus, the context awareness of the system was not evident. Some of the answers were not related directly to shopping habits but did explain subjective values and opinions around clothing and shopping. Only some of the replies indicate by referring to the context that the answers were created in a mobile situation.

“Oh, now it’s so that I just came from the bar so stories are on that level. Observations: the present fashion of ‘sausage skin’ shirts and the modern women’s body structure with sausage on the waist line is not a good match”

Images included some pictures of shops but only from the outside. The pictures concentrated on the clothing itself as well as on the persons and their social situations.



Figure 4. The ‘best shop in town’ according to one shopper

Designers started to participate in the project during the analysis of the collected material. They stated that the mobile probes replies complemented with the data from the interviews helped to explain the social behavior surrounding shopping. For example shopping in groups was presumed to happen but its full implications were unfamiliar to the designers.

The interpreted material helped the concept creation process. According to the designers, the probes study would have been more useful if they had been involved in the probes study from the beginning. This way the collected material would have been easier to understand and its use would have been more efficient during the concept creation process. As a continuation, one of the designers conducted another probes study focusing on shopping experiences.

CASE MOBILE WORK

The Mobile Work case was a research project, which focused on enabling mobile work through developing mass customized products, services and applications with seven participating companies. The main research challenge of creating a model that enhances the productivity of work by supporting individual user needs in a sustainable way is still in progress.

The user study was divided into three phases. First, in each company a focus group interview was conducted to form an understanding of mobile work cultures in the companies and to identify the main themes related to mobile work. Secondly, a one-week self-documenting phase was carried out to gain understanding of mobile workers' individual experiences. The research questions were based on five main themes, which were identified in the focus groups. The third phase included participatory workshops where the gathered data was sorted and interpreted together with the users, researchers and company participants.

The self-documenting tool, which was developed for the project, was influenced by the mobile probes shopping case, and the Experience Sampling method [5]. The exploratory and open-ended probes approach was chosen, similarly to the mobile probes pilot, to cover the extensive area of mobile work, such as present physical, social, psychological and ideological issues, as well as visions for a better enabled mobile work and life style. The Experience sampling method's influence on pre-structured themes supported the aim to study patterns and intervals of activities and related experiences. The five tasks and questions which were sent to the users daily during one week were categorized according to the pre-structured themes.

Technology

The technology used in the mobile work case was different from the one used in the shopping case. Tasks and questions were sent as text messages (SMS) to the users' mobile phones. The users sent their answers with their mobile phones equipped with digital cameras to a dynamic web page. The web page was a mobile platform on the Internet that was originally developed for another project to communicate context-awareness, mobile experience, and its narrative potential [24]. Thus, the platform was applied here for the user study purposes. The user data consisted mainly of multimedia messages (MMS), but e-mail and text messages (SMS) were also submitted.

Interpretation and sharing of the data

After the data gathering phase, interpretation workshops were organized to analyze the material. Before the workshops, users and company participants were able to familiarize themselves with the 277 messages and 225 images in the web page. The messages were categorized by the users and by the questions

The web page system allowed messages to be printed out in a card-like format with a user, time and question tag (see Figure 5). In the workshop the users made a collage of their individual mobile work experience from the printouts. The individual collages were further interpreted in small groups to define the main components of mobile work experience. The collages and company-specific focus group reports were further elaborated to create mobile worker profiles and multi-level requirements to develop solutions for mobile work.



Figure 5. A context-related message sent by a user tells about typical mobile worker's everyday problems.



Figure 6. Multi-disciplinary team workshops were organized to create individual collages of the mobile work experience components.

Experiences from the study

The use of mobile phones with cameras was found to be natural, as presumed, in the study. Firstly, mobile phones are the primary working tools for site independent mobile workers today. Secondly, the participants were also active lead users of mobile phones.

The number of photos was better in this study than in the mobile probes pilot: 81% of messages included an image. The main reasons are related to the users, the more elaborated camera phones and multiple possibilities of sending messages. The experienced mobile phone users were also willing to try new gadgets. They were also accustomed to the technical problems with MMS and it was

easy for them to send messages by e-mail or SMS if something was not working or it was more convenient for them. The mobile phones had built-in cameras which made picture taking easier.

Despite the experienced users, some usability problems were encountered. For example it was not technically possible to reply with a MMS to a SMS message. The exact content of the question was sometimes hard to remember because the question was not visible or could not be easily checked while answering. The question tag was needed at the beginning of the reply message for the automatic categorizing in the web site, which complicated the answering task. Time-automated group-SMS-service was not used for sending the SMS questions and tasks. This created time-management pressures for the researcher who was conducting the study.

Because the study was conducted alongside work, the users were prompted to answer the question when it was convenient for them. Based on the message content and information from the users, the answers were both descriptive and predictive depending on the questions. The delay by the operator in transmitting the messages led to low reliability of time logging and so confirmation of context-awareness was needed.

The platform supported the user study in many ways.

- 1) It received messages and categorized them automatically.
- 2) On-line viewing of the answers reduced the uncertainty experienced in previous probes cases about the users' activity in task accomplishing and about the amount and the quality of the answers.
- 3) The platform enabled managing the content commenting on the data entries.
- 4) All the participants were able to familiarize themselves with the data prior to the workshops.
- 5) Printing the messages in pre-defined form was practical and effective. The messages were a powerful conversation tool in workshops. The interpreting of the material with the users and the company participants supported the step-by-step understanding of the complex phenomenon of mobile work.

LESSONS LEARNED

Our experience suggests that the mobile probes are suitable for user studies. In the interviews it became clear that the users had found the method of replying with the mobile device both natural and playful. The analogy of text messaging was accepted because most participants had used mobile devices and text messaging before. With one participant in the shopping case, however, usability issues with the device caused severe problems during the study. The person had never used a mobile device before, so the user interface was unfamiliar. Due to this problem she was

unable to answer the questions with the mobile device at the beginning of the study. Later on, she was motivated to learn to use the mobile device and started to provide replies to the questions.

A mobile phone is a natural object to carry and use in everyday life. People are able to communicate their experiences when ever they wish. The problem that the participants found in the shopping study, in addition to usability problems, was the fact that they had to carry two devices instead of one i.e. their own device, plus the one with which the study was carried out. In the mobile work case, the participants used their own phones. Nevertheless, usability problems were encountered with other issues.

Mobile probes can be developed into a context aware method. According to the users, the mobile device was carried with them during the study. However the context awareness of the answers is not always evident. In the Shopping case only a few of the replies are clearly impulsive and hint at the place and situation, most of them are opinions and short descriptions, which carry no clue of the context in which they were written. The pictures show that the camera was carried around, even on trips abroad. In the Mobile Work case the amount of pictures was higher and the content of the answers and pictures indicate both contextual and reflective data.

Mobile probes were found to be an effective way of conducting a probes study. All the data from the users was stored on one database in both of the cases and the answers were sorted by user and by question. This was a major change compared to tangible probes with separate items such as postcards and photo albums. Also, once the tangible probes are sent to the users to be filled in, the researchers can only hope they are completed and the users' interpretations of the questions and tasks have some relevance with the study aims. An improvement is the possibility of seeing the data appear on the server and observing the focus and motivation of the users.

Companies are looking for effective tools. The resources required for designing or customizing probes packages for each study can be a problem in the business context. The possibility to change and edit questions and tasks through the web system can be considered as an improvement. Also, the online view to the data allows interaction and possibility of adjusting the tasks in an iterative manner. In the shopping case, one company used the web interface to browse through the raw material collected from the probes study. In the mobile work case all the users and workshop participants browsed the raw data to deepen their understanding about the studied phenomenon.

In the shopping case, as the answers started to appear on the web page, the lack of pictures of both the context and the person was evident. Pictures make the persons and the activities seem more vivid. Furthermore, in our experience with probes, and according to the comments of the designers involved, the interpretation of photos without any

explanation is difficult and misleading. In that sense, as in the mobile work case, assisting the interpretation with users' notes about the content of the pictures streamlines the process.

DIRECTIONS FOR THE FUTURE

Device Development

The biggest impact on the use of mobile devices as a user study tool comes from the device hardware development. Most new mobile phones have a reasonably large color display and a built-in camera. These devices are capable of recording different media types like sound, images or videos. Current camera resolutions are reasonably low but future devices will include better optics and better image quality. With these devices it will be possible to take pictures or videos and save them on a MMC memory card. The limitations of memory and image quality will be reduced.

The Future of Java technology in Mobile Devices

Within a year there will be new mobile devices available with a newer version of the Java ME platform. This new MIDP 2.0 platform will provide new functionality and a more open view into the native software of the device. There will be the possibility to take images, videos and sound recordings through a Java application and send these media types over the GSM/GPRS network. These possibilities will enrich the information that people can provide. It will no longer be just text and images but a full scale multimedia that will illustrate people's lives more accurately for the parties involved.

With new specifications for network communication between Java applications and the backbone server, real-time communication would become possible. This enables the server operator and the Java application user to communicate between each other or between even larger groups. Media exchange is also possible in this way.

Flexibility

Developing the flexibility and compatibility of the digital system application and mobile phones could make the user study tool more usable. If the fast development and short lives of the mobile phones is considered, the commitment to a limited range of devices is not sufficient. The tool should support various modern technologies. The visions of the application possibilities are wide from design ethnography to collecting emerging trends and further. [see e.g. 16]

CONCLUSION

The users' motivation to participate, complete the tasks and document relevant issues is the key to successful self-documentation studies. In that sense the users' motivation should be one of the driving forces when developing the tools. We can identify four design drivers for the development of the mobile probes in the future:

1. Playfulness; game-like surprising tasks together with visual and open ended clues that enable associations and subjective interpretations.
2. Flexibility; allow customization for different user segments and purposes.
3. Easy to access; the user is able to complete different assignments smoothly with one device.
4. Collaborative Server; assignments, raw data and analysis can be shared with all parties.

There are vast possibilities for conducting research with mobile devices. The focus can be in documenting present activities and cultures. Or, the interest can be in probing new possibilities as users tend to create new practices and social innovations emerge with new technologies.

The material provided to the users can include inspiring images or videos. Researchers can prompt users to reply with visual and multi-modal messages and present context aware questions on-line. The navigation of the probes software could be more playful and include question related images, videos or sound clips. Also, user replies can vary from text to different media types. Experiences from other probes studies, where text messages (i.e. SMS) and multimedia messages (MMS) have been used support this idea [14,22].

One way to conduct mobile fuzzy front end [3] user studies, where the focus is often unclear, would be to provide an interactive dynamically changing system where user replies would direct the research focus. Researchers could make additional questions or provocative triggers on a particular subject if they find some answers important or inspiring. The raw data can be shared with company designers from the server through the web. This access enables direct questioning, inspiration and empathic insights, as well as multidisciplinary interpretations. The user data could even be displayed in the design teams' work space as an on-line user study channel.

ACKNOWLEDGMENTS

We thank the case participants and companies for collaboration and co-workers at the University of Art and Design for valuable feedback.

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