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Applying probes – from inspirational notes to collaborative insights

TUULI MATTELMÄKI*

University of Art and Design Helsinki, Hämeentie 135 C, FIN-00560 Helsinki

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In user-centered design, attention has shifted from improving usability and addressing ergonomic problems to wider perspectives such as experiences in everyday life. This shift has forced user-centered practitioners to evaluate and develop tools for finding new means of understanding user experience for design. Visual, playful and open-ended probes have raised fresh interest in the design community. In order to create a deeper understanding of this approach, this paper presents the fundamental qualities of probes and, based on empirical data and literature, describes four reasons for applying them in the product development and concept design context: for inspiration, for information, for participation and for dialogue.

Keywords: probes, user-centred design, user experiences, concept design

1. The probes approach

The probes approach has stimulated much fresh interest in the design community (Fulton Suri 2003a, Gaver *et al*. 1999; Hemmings *et al*. 2002, Mattelmäki & Battarbee 2002, Wensveen1999, Westerlund *et al*. 2003). Probes are design-oriented user research toolkits that are based on self-documentation (see examples of kits in figure 1). They do not aim primarily at documenting but purposefully invite or provoke users to reflect on and verbalize their experiences, feelings and attitudes, and to visualize their actions and contexts. They address the challenge of studying users in their own settings, which are mainly personal. They can also be used to create interaction among groups of people, i.e. designers, researchers and users, who are often previously unfamiliar to one another (Gaver 2001, Hemmings *et al*. 2002).

This paper has two aims. The first aim is to deepen our understanding of probes; the second is to study how exploratory probes can be applied in product development and design companies. What are probes useful for, in a company context?

This paper first introduces how the probes were first used, and describes examples of how the probes approach has since been applied. Secondly, the qualities of probes are

*Corresponding author. Email tuuli.mattelmaki@uiah.fi

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defined, and four reasons reported in the literature for applying probes are summarized. Thirdly, an empirical study on the experiences of applying probes in company contexts is presented. This review study was done because there is scant understanding of the feasibility of applying probes from the design practitioners', companies' and users' points of view. Finally, the findings are discussed in relation to user-centred concept design activities in a company context.

1.1 *Four examples of how probes have been applied*

Probes have been used for several purposes with varying aims and in different contexts. In this section, as an introduction, Cultural Probes (Gaver *et al*. 1999) and three other studies are presented to show the range of ways in which the probes approach has been applied.

The approach was first introduced as **Cultural probes** in an EU funded research project. This project focused on three communities of elderly people: one in the small town of Peccioli, Italy, another in Oslo, Norway and the third in Bijlmer, a suburb near Amsterdam, the Netherlands. (Gaver *et al*. 1999, Gaver 2001)

The Cultural probes study was conducted by an artist-designer-researcher team whose objective was to investigate the cultural and personal aspects of people's lives. After collecting background information (i.e. literature and having people fill in questionnaires) the researchers felt that in order to design for these people statistical facts were not enough. The need for empathic understanding and the open design brief gave rise to the approach in which the aim was to eliminate stereotypes and to create a sensitivity for listening to users.

Cultural probes were aesthetically well-designed packages containing tasks such as photographing and answering questions on illustrated postcards. These tasks were given to the users who completed and returned the documented probes to the researchers. The tasks were open ended and ambiguous in purpose, to elicit ideas about new possibilities and to avoid ''focusing on needs or desires they already understood'' (Gaver *et al*. 1999). What if Bijlmer was a body? Where would its eyes, ears or heart be? These tasks were influenced by projective methods used in psychology and contemporary art philosophies were supported by maps and stickers for the elderly to think about.

The Cultural probes study was described as an artistic, playful, aesthetically pleasing and provoking process by the developers (e.g. Gaver 1999). In contrast to the traditional requirement of scientific objectivity, they wanted to empower the designers' imagination in combination with the needs of future users (Gaver 2001).

Among the aims of the Cultural probes was to create an interaction between designers and users (Gaver *et al*. 1999). Furthermore, as pointed out by Thackara (2000), the project revealed new ways of thinking about the design process: ''we're beginning to understand what it means to design *with* people rather than *for* people.'' Although these aims and results seem to share the qualities of participatory design philosophy, the process appears designer driven. As Gaver *et al*. (1999) observes: ''Just as many influences went into designing the probes, so have they been one of many influences on our design process.'' This initial probes approach emphasizes a design inspiration focus and aims at provocative future design proposals.

Probes were developed in a new direction in the **Informational probes** study (Crabtree *et al*. 2003; Hemmings *et al*. 2002), in which the approach was applied to information gathering instead of inspiration probing. These probes were used in sensitive contexts, such as in a hostel for former psychiatric patients, where the use of alternative user study methods was thought to be problematic. The probes thus provided ways of gathering

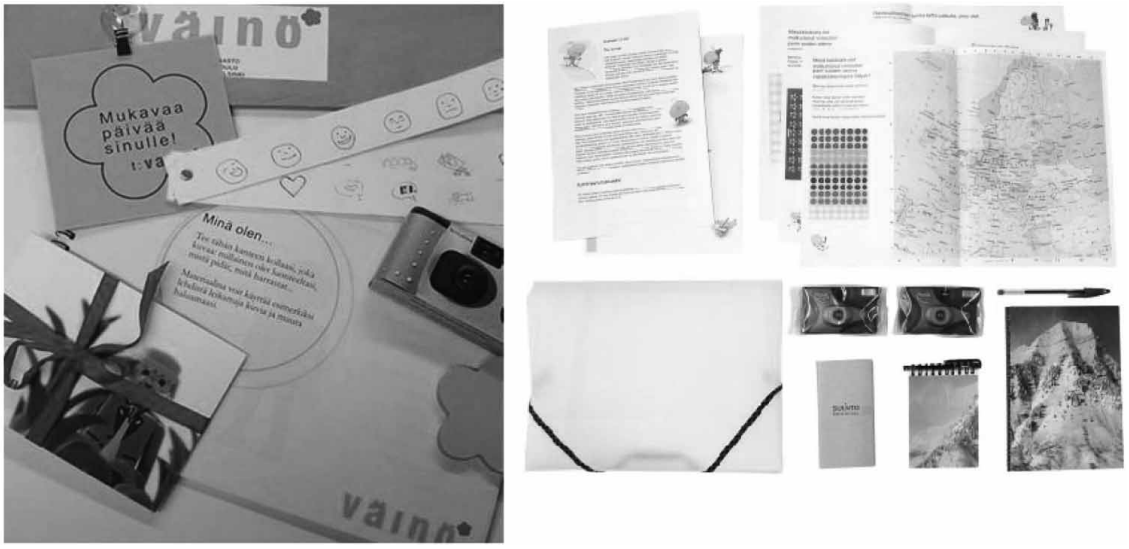

Figure 1. Examples of probes kits and artifacts. On the left: Väinö probes kit including workbook with diary, open questions and drawing and collage-making tasks, a selection of stickers, a camera with picture taking assignments and illustrated cards with open questions. Most of the illustrations were created with little dolls which simulated elderly people and their life situations. On the right: Suunto probes kit, including mapping tasks, two cameras, a diary booklet with daily questions, two pens and a note pad. The theme of the probes kit was invented around a sympathetic novice skier, whose pictures illustrated the introduction letter and the assignments.

data and facilitating the understanding of the needs of differently-abled people in their present life. The probes were used to inform the researchers and also to establish a conversation between the users and the researchers for the next research phases.

Another approach was taken in the **Technology probes** (Hutchinson *et al.* 2003) study. Here the probes were not self-documenting kits but technological applications, such as a writable LCD tablet with a bulletin board-like interface, which enabled the users to be in contact with remote family members. The aims of these probes were to gather information about the users and the use of technology in the real context, to field test the technology, and to inspire designers and the users to think about new uses of the technology, and to reflect on their everyday activities in new ways. The results provided real-life use scenarios which were later used in participatory design workshops.

Influenced by the Cultural probes several **empathy probes** cases have been conducted at the University of Art and Design Helsinki in collaboration with companies (Mattelmäki & Battarbee 2002, Mattelmäki 2003 a, b, Jääskö *et al.* 2003. Jääskö and Mattelmäki 2003). The main interest has been in gathering versatile, experimental and subjective user data with an open brief for concept design. Typically these probes studies have included individual interviews with the users after self-documentation to discuss interpretations of the data, to address more focused themes and thus to enhance the user understanding.

Figure 2 shows the typical empathy probes process, one aim of which has been to project reflections of the users into the companies, supporting the engagement with user data and facilitating design empathy. Communication throughout the process proved to be crucial because not all members of the design team engaged in a project can be directly engaged in the user study. The meaningful sharing of the gathered data and the interpreted results with company representatives has also been an emphasis. For example,

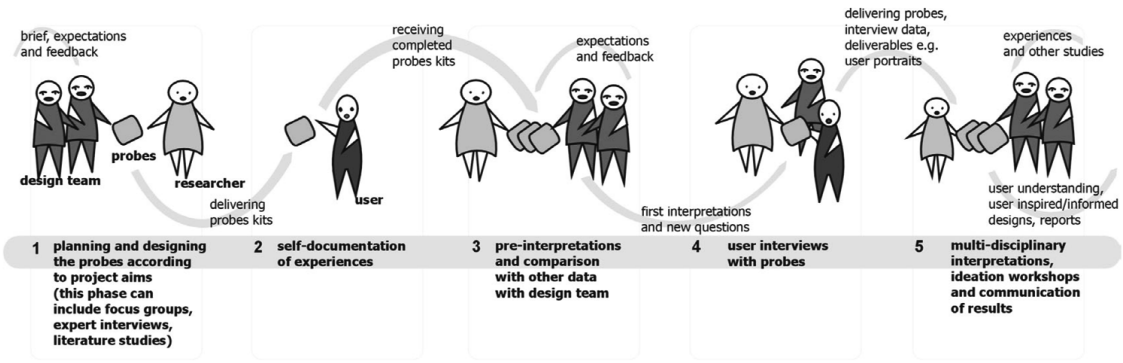

Figure 2. Empathy probes process.

the raw user data in the probes kits is interpreted into narratives and user portraits in multidisciplinary workshops.

1.2 *Probes' fundamental qualities*

Since the Cultural probes study was published in the late 1990's there has been great interest in creating new innovative approaches for user-centred design and especially for the early fuzzy front end phase of design. Some of these approaches have much in common with probes, i.e. their playfulness (e.g. Shedroff 2003), innovativeness (e.g. Hanington 2003) and projective nature (e.g. Sanders and William 2001), although Cultural probes are not cited as an inspiration. Among the new approaches there are those that acknowledge Cultural probes as their forerunner. These approaches have developed in two directions: in the first self-documenting is applied to gather signals, e.g. Cultural probes and Informational probes. The second direction experiments with "experience prototypes" (Buchenau and Fulton Suri 2000) to reveal new opportunities for technology and to empower users to take part in the experimenting, e.g. Technology probes and Urban probes (Paulos and Jenkins 2005). To make a distinction between what we will call probes and other innovative user-centred design approaches, three fundamental qualities can be employed. The two first qualities link probes to applied ethnography as defined by Sanders (2002). The third stresses the fact that the users have an active role in recording signals.

First, probes are **design oriented** and have an **exploratory goal.** They are used for exploring new opportunities rather than for solving known problems. This quality links probes to concept design activities, where the goal is often not known, fuzzy and adjusted through an iterative process. Like the probes sent into deep oceans or into space, the probing instruments are developed to gather data to help in answering research questions about domains that are difficult to access or even imagine. In user studies, the probes are tuned to selected aims but also include a wish and a risk of unexpected results. They empower both users' and designers' interpretations and creativity. Furthermore, the open ended probes can be descriptive, documenting the present, and/or predictive, looking ahead to possible futures.

Secondly, probes concern the **users' subjective world.** They ask users to experiment and to make interpretations and explanations of their experiences. Thus, they offer users' individual points of view as bases for enhancing design.

Thirdly, the probes are based on **self-documentation.** Thus, the recording of the data is done by potential users, who are considered as active participants in the design process. The probes are collections of tasks given to users to encourage them to interpret, document and express their experiences and ideas. The probes' tasks aim at focusing the

users' attention to noting and recording their everyday life, their values, needs, and social and emotional engagements. The probing is done with **probes kits,** which include various **probes artifacts** and **tasks**.

Physically the kits can include artifacts such as disposable cameras, albums, illustrated cards, and pens. The tasks often include, but are not limited to, taking pictures, filling in diaries and open-ended questions, drawing maps, making picture collages and recording sounds. The probes philosophy encourages creativity in planning the tasks and designing the probes artifacts. Thus, the probes kits tend to and should be different for each project.

The choice of the probes tasks is influenced by the goal of the study, the users, the context and the experience under investigation. One possible goal can be to create descriptions of individual users. The probes tasks are then specifically designed to capture users' attitudes, lifestyles and emotional issues. The media used can vary from paper and stickers (e.g. Gaver *et al*. 1999) to an audio recorder (e.g. Wensveen 1999). Mobile phones or other interactive devices can also be used to gather user data (SMS and MMS messages) (Sejer Iversen and Nielsen 2003; Hulkko *et al*. 2004) or to provide instructions for the probes tasks (Jönsson *et al*. 2002). The self-documenting can be carried out by using digital probes: for example, diary entries and photographs taken with web cams and digital cameras can be exchanged via the Internet (Virtanen *et al*. 2004).

1.3 *Reasons for applying probes*

As the previous examples illustrate, probes have been applied with various aims and attitudes. In each case the probes have been developed and applied to support the aims, contexts and designers involved. These aims, attitudes and reasons are discussed in the literature, within which four reasons for applying probes can be identified.

Two of the reasons, to enhance design inspiration and to gather information, have been mentioned in several studies, e.g. Hutchinson *et al*. (2003), Jönsson *et al*. (2002), and Wensveen (2000). *Gaver et al*. (1999) applied probes to support designers' inspiration, to start interactions between designers and users, and to provoke the users to participate in the design process. Informational probes (Hemmings 2002) were designed to gather subjective information and to open dialogues with users. The reason for applying probes in participatory design, i.e. taking users as design partners, has been discussed by Hemmings *et al*. (2002), Hutchinson *et al*. (2003), Paulos and Jenkins (2005) and Westerlund *et al*. (2003). In the following section these four reasons, **inspiration, information, participation and dialogue**, and their characteristics are summarized.

1.3.1 Inspiration. The aim of design is to create new solutions. Inspiration probes aim at providing new insights for designers' creative thinking. The open and aesthetic probes tasks leave space for interpretation and inspiration both for the users and the designers. Probes studies that aim at inspiration are presented and shared by showing the raw data, completed individual tasks, probes artifacts, and the design ideas (see e.g. Gaver 2001). The results are interpreted in a designerly way, i.e., looking for patterns and exceptions, creating semi-factual stories or capturing appealing design ideas. Requirements of objectivity can be left aside (Gaver *et al*. 2001).

1.3.2 Information. The goal of information oriented probes is to find information about users, their experiences and needs. The tasks for probing information are primarily descriptive and leave less space for interpretation than the probes for inspiration. Probes in their information-gaining role deal with subjective points of view and the early phases

of design, where a general overview or an active rapport with individual users should first be established before focusing on gaining a more detailed understanding using other ethnographic approaches. The users in such probes studies are ''transformed as active enquirers into their everyday lives, rather than passive subjects of our research'' (Crabtree *et al*. 2003). According to Hemmings *et al*. (2002), the artistic design of the information probes artifacts is less important.

1.3.3 Participation. The participatory design attitude accepts users as creative people who can participate directly in the design process when given the appropriate tools and encouragement. In probes, users are given tools to experiment, observe and potentially also record their own experiences. They are provoked to use their imagination, or to act and interact with technology, prototypes or imaginative smart systems. For example, technology probes were used to give the users new ways of thinking about the possibilities of remote interaction (Hutchinson *et al*. 2003). Urban probes (Paulos and Jenkins 2005) were used to make interventions, experiment with technological prototypes and empower user experimentation.

1.3.4 Dialogue. One of the aims of user-centered design is to build a dialogue between users and designers. Cultural probes create a direct interaction between users and designers. Crabtree *et al*. (2003) have also reported their experiences of using probes to develop and support dialogue. Through the probes process the involved people become familiar with each other; the process encourages ''continuous conversations'' and promotes collaboration (Crabtree *et al*. 2003).

2. Examining probes as a concept design approach

Keinonen *et al*. (2003) argue that defining products for the fast-paced phase of developing and manufacturing is only one of the objectives of concept design activities in companies. Through concept design companies can also, in the long term, learn about and concretize alternative future opportunities, test and prepare markets for future products and furthermore, exercise individual and organizational creativity and learning. These activities can include technical, design and user studies focusing on phenomena which are not yet known but are envisioned as opportunities for future products.

Cultural probes (Gaver *et al*.1999) and most of the reported probes studies were carried out in exploratory design and research project contexts. The experiences of the use of probes in these studies have been reported based on the authors' own experiences. However, there is a lack of knowledge of their feasibility as an approach from other stakeholders', i.e. design practitioners', companies' and users', points of view. Thus, to explore whether a probes approach might be applied in concept design activities in companies, the following study was conducted.

2.1 *Data and method*

Seven probes cases were studied. These seven cases were conducted in collaboration with companies and as part of design research activities at the University of Art and Design Helsinki. This industrial and academic collaboration allows experimenting with new ways to approach user studies for design and supports developing user-centred design practices in companies. In all the cases probes were applied to gather user data for concept design. In most of the cases the data was used for looking beyond current

products and for understanding user experiences for design. The combination of companies involved, of probes tasks and of other approaches applied together with probes in these cases is described below.

The **Well-being and exercising study** (Mattelmäki and Battarbee 2002) was the first of the probes cases conducted. The study aimed at understanding the relationship of well-being and exercising in the life of non-athletes. The probes kit followed the example of Cultural probes (Gaver *et al*. 1999) and included a camera, a diary and open questions on illustrated postcards. Each user was interviewed as part of the study. This was followed by the **Weight management probes** case (Auno 2003) with a more focused theme. The aim of this study was to understand people with weight management needs and to design an interactive concept to support them. The probes kit included a key holder. The users were asked to imagine that the key holder was their smart exercise mate and they were asked to use their imagination and to record interactive features and situations with it. This encouraged the users to describe everyday situations in which their weight management goals could be supported, e.g. giving advice at the grocery store. Both cases above were done in collaboration with Polar Electro, a Finnish manufacturer of heart rate monitors.

The nurses and transportation study (Jääskö and Mattelmäki 2003) widened the use of the probes from home and leisure to professional work. The probes study aimed at providing a personal picture of nurses: their attitudes, motivations, and the social and technical aspects of their work. The specific focus was on patient transportation situations. The study was done in collaboration with Instrumentarium Corp. Datex-Ohmeda Division, a manufacturer of patient monitoring equipment, and the Finnish design consultancy ED-Design. A collection of the probes artifacts used in this study is shown in figure 3. Figure 4 illustrates the use of probes data in the interview, in which the contents of the photos are explained to the design team by the nurse who took the pictures.

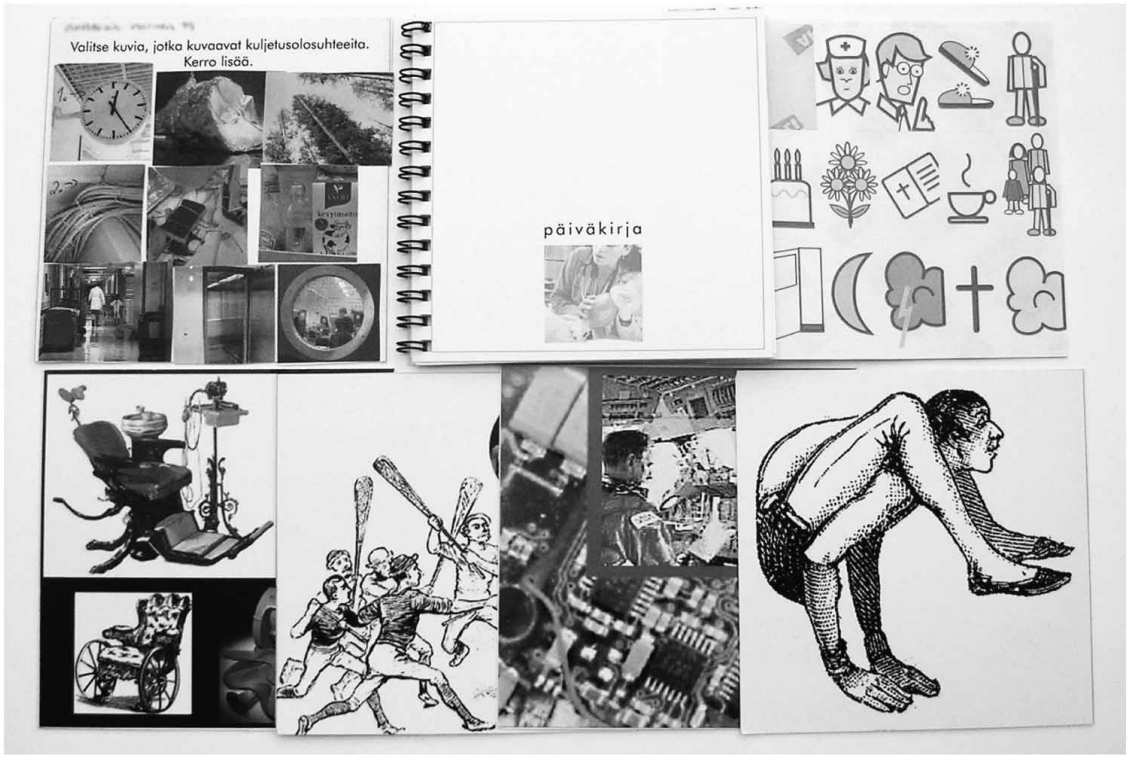

Figure 3. Nurses and transportation probes kit enclosed images for collage making, a diary with stickers and several illustrated cards with open questions.

Figure 4. A nurse is explaining and interpreting the probes to the design team in an interview.

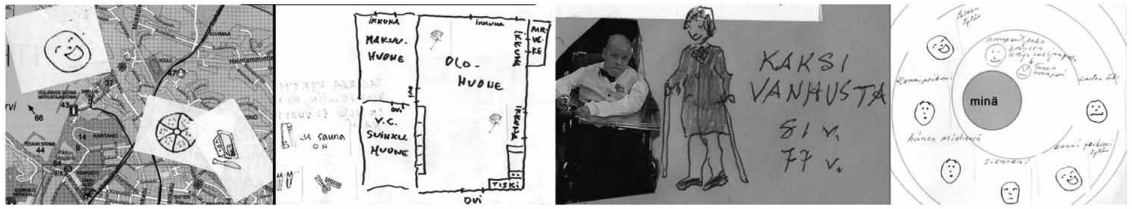

Figure 5. Examples of Väinö probes tasks: my town; my home; who we are; my contacts.

In **the free-ride skiing case** (Jääskö *et al*. 2003) the probes were designed to collect data about an extreme sports culture. The probes kit, which included a workbook, was built around the character of a sympathetic novice skier who asked questions and made comments. The results were used to focus participatory observations. The case was part of a project with Suunto, a Finnish manufacturer of sports instruments.

In **the tele-work study** (Virtanen *et al*. 2004) the aim was to gather data on the different aspects of working at home and the use of home office furniture. The probes supported other user study approaches such as participatory design sessions. In this case the diaries and open illustrated tasks were sent and received through the Internet. The case was conducted in collaboration with Lundia, a Finnish manufacturer of modular furniture, Sato-Rakennuttajat, a construction company and the Studio Salovaarat design consultancy.

In the **Väinö study** (Mattelmäki 2003b) the aim was to study elderly people's home environment, attitudes and feelings related to ageing and independent coping at home. The project had various participating stakeholders, ranging from community welfare to telecommunications organizations. The probes kit is illustrated in figure 1 on the left, and some of its tasks are presented in figure 5.

The **YleX** case probed material for a radio channel design for YLE, the Finnish broadcasting company. The probes kit included, among other artifacts, a radio and tasks in which users were asked to record sounds with their mobile phones (Niemi 2003).

In all of the examined cases comments and experiences were gathered throughout the study and all the users were asked to comment and give feedback on the approach. Furthermore, company participants were interviewed in four of the case studies: Väinö, nurses and transportation, free rider skiers, and tele-work. Table 1 presents the role of the

Table 1. The role of those interviewed and method of interview method in the four probes cases.

Case	Theme interviews	Telephone interviews	Email interview	Total
Väinö	1 in-house architect		1 architect 1 project manager	3
Nurses and transportation	1 in-house designer 2 senior usability specialists 1 design consultant	1 program manager	1 design consultant 2 users	8
Free-rider skiers	1 interaction designer 1 product manager			2
Tele-work	1 in-house designer 2 design consultants 1 manager 1 marketing manager 1 senior researcher	1 manager	6 users	10
Total	12	2	11	25

interviewed and the method of interview. These semi-structured interviews explored questions such as the following: were the goals of the project met; what were the strengths and weaknesses of the process and how should the approach be improved; was the project useful to the company, and to the interviewee professionally and personally; and what meaning and value was gained from the different phases and tasks of the probes process. The data consists of transcribed interviews, personal correspondence and notes from discussions and case meetings. The author participated in all the cases, in the role of researcher, adviser and/or tutor.

The data was sorted with reference to the four reasons for probing described earlier, i.e., does the data indicate that the probes were 1) inspirational and 2) informative to the early phases of concept design. Furthermore, that probes 3) support user participation and 4) foster dialogue between users and designers. Comments and descriptions of how designers work and how the approach could fit into company practice were also studied. Understanding of the application of the probes approach by other researchers, the companies and the case contexts, and knowledge which accumulated during participation, informed the interpretation of the data. In the following sections the findings are presented.

2.2 *Probes support design teams' inspiration*

The phase of making the probes kits was described as inspiring by professional industrial designers who designed some of the probes artifacts and different from the ways they had normally approached user studies, i.e. probes focused on individual users' experiences instead of on the use of a product. The design of the probes kits expressed the designers' personal styles and skills. One designer, for example, stated that if the probes kit were designed by him it would have had a different look. Furthermore, choosing, drawing and editing the probes also made the designers imagine the way the users would use and interpret them.

Personally I was really exited about this. I liked to think about it and search for good pictures, and to make these. For me it was natural... And they [the nurses] can see that we have put in effort, that we respect the person. It has to be done well to make them understand that we are serious about this. If you just gave them a pen and a plain leaflet - here you are... there should be a trigger, to make them want to get familiar with the stuff. [In-house designer/Nurses and transportation]

In the examined cases the probes were used to gather subjective views of users' experiences. The designers stated that they prefer to see the big picture of the role of the product or system to be designed in the users' context. They want to understand how products are used, who the people who use them are, and what their goals and motives are. Thus, in the early phases of design, designers want not only device-specific information but need a more holistic picture of the users as people and their context.

Moreover, the interviewed designers were willing to get involved, to make personal connections and to be able to make their own interpretations of the users' worlds. The probes process and data can support this process because its nature allows versatile interpretations.

I like to marinate myself in all kinds of material. It is a personal way, maybe an architect's way. To gather a lot and sleep over it. Through whose interpretation do I get the results? Others want a ready made package; I want to have time with it myself. [Architect/Väinö]

Visually oriented professionals point out that they need concrete visual material with which to work. The interviewed designers do not find that reading research reports is useful for ideation. The data need to be presented such that it can be quickly "scanned" for framing the design brief or creating ideas for solving the current design problem. A design consultant said that in a design consultancy the design task can vary from a paper mill to a detail of a user interface. One designer can be involved in several projects at once. One needs to quickly adapt to the style and feeling of the environments, the future users and the use situations for which the designs are meant. Probes data were seen to serve that need. Selected photographs and short quotes from probes studies trigger the imagination but link it to everyday reality and authentic situations.

On the other hand, one of the designers warned that detailed descriptions of the current physical environment do not help when designing future concepts. Designer's work is about asking "what if " questions (Schön 1983). User studies should help exploration and provide insights and facts for more focused design evaluations or research.

Dramatic material is strong because it facilitates the empathizing... An [industrial] designer's work is research: to make a hypothesis, to focus and to evaluate. The (user) research supports this evaluation, provides facts for more detailed evaluation...This kind of user data works first as an inspirational broad sweep. When the design is at a certain level, one should go back to the user data and evaluate which elements have been realized. One can't pay attention to all. It is the designer's skill to choose the targets and forget about the less interesting ones.... The format of the data is important. [Senior design consultant/Tele-work]

2.3 *Probes provide useful information on users' needs and context*

In concept design the aim typically is to specify a product idea without using the specification directly for production (Keinonen *et al*. 2003). Flexibility and openness play a major role as innovations are not pushed but are to be fueled. This also creates special needs for information gathering and sharing. In early concept design, the challenge is to frame what information is needed. The explorative nature of probes can support this framing. For example, a naïve question about the dangers of down hill skiing provoked the freeride skiers to write strong statements about their safety attitudes which provided the product manager, also a skier, with new insights:

> *In a way the wrong questions were the right questions. If the question was posed stupidly we started to really be able to discuss and find the core of what it was about. [Product manager/Free-ride]*

Yet the openness and exploratory nature of probes can lead to unexpected directions. For example, when the case focused on exercising, the photographs taken by a user illustrated his wife's blooming flowers. When users are given open questions and projective tasks the focus and the quality of the results are uncertain. One user, for instance, recorded daily activities in her diary, while another did not fill in the diary at all, except for sending summer greetings to the researchers. A product manager stated humorously that at the point the probes are sent to the users, one can only cross one's fingers and hope for the best.

> *The gathered data is not as such [as required] for everyday product development work... I expected to get more concrete issues... But it was a surprise how subjective and personal the presented issues were. [Usability manager/Nurse and transportation]*

Although probes are typically aimed at future concepts, their application can also reveal faults with current products. During the probes cases some users commented on products they had used and also expressed how they would like to have them improved, although that was not the main objective of the probes studies. When the users are given time and tools, they are able to experience and to consider their problems, needs and dreams. In a company context this means that even though a study is done to innovate new concepts, it can result in improvements to the ongoing product development and even to existent products.

> *Self-documenting reveals the weaknesses and problems of a product. The users have time to think about the issues and they don't have to rudely say them to our face. [Design consultant/Tele-work]*

When using probes, attitudes, moods, as well as activities, are documented over time, but the contextuality of the actions often remains general. For example, in the freeride case the situation in which the diary entries were written was not recorded. Freeride skiers do not take probes kits to the mountains to document their experiences while skiing. Nurses are not able to take pictures when they are transporting a patient from an operation. Later in the evening, they might recall their days' activities. In this kind of self documenting notes about actions are often reflective rather than contextual observations of dynamic experiences.

There can be contradictory expectations of probes results with respect to long and short term product development. The companies and collaborative designers have concrete problems they need to solve in the short term and thus require concrete answers to these immediate questions. For this the probes tasks are often too unfocused, subjective and emotional. In the case studies some hidden information expectations were not met by the probes data. These expectations were related to ongoing product development. However, some of the probes study findings were noted as being useful to short term product development, i.e. they raised the importance of some already known problems and affected design decisions.

> *We did not get deeper than the surface of the patient transportation situations. There were attributes, such as how the devices should be: weight, battery life... Most of these things had been found in previous studies. It is difficult to say whether we found anything new.... This was a reminder about the problems...About the contexts we gained knowledge that could not be achieved in other ways. This was related to personal relationships, stress factors, positive issues, what keeps them going and the importance of a strict separation of work and free time. Such things are not really available through observation. In interviews, depending on the situation, people rarely start to say that their boss is terrible, or those smells,.. not really... [Senior usability specialist/Nurses and transportation]*

And

> *There is always the problem: When you prepare enough you get the [probes] packages sent. Then you receive a massive amount of data. Then it is the analyses and filtering and what it means specifically to us. Not only that it is nice to know more about the sports... We would not do any of this if our clear goal was not in getting more turnover and better bonuses... The data we have gathered gives answers to "what and why". But no products are created before we have the "how". Those have to go side by side. [Product manager/Freeride]*

The strengths of the probes lie in the subjectivity of the information gained. The weakness is, unfortunately, the same. The data, comprising photos, texts, and tasks produced in multifaceted ways, is, even where possible, complex to interpret in a way that produces reliable information. The fragmented pieces of information, subjectivity and the broad focus were mentioned as negative aspects in some interviews.

> *The strength is in the vivid knowledge about the concrete tele-work environment...A good method to gather data, the analysis needs developing. [Senior researcher/Tele-work]*

In the case studies the probes were used in conjunction with other approaches such as focus groups, expert interviews and observations. This was done to gain a more holistic picture of user experiences with different points of view (e.g. Sanders 1999). The approaches supported each other. In the free rider skiers' case the understanding created from the probes material was used to support participant observations. In the tele-work case the probes were applied in parallel with other activities such as participatory design meetings. Researchers and the company representatives were able to dive quickly into the users' way of life.

2.4 *Probes allow users to express their needs and ideas and to participate in design*

Probes' success or failure lies in their ability to motivate users who are considered active participants – to provide inspiration, information, or to co-create ideas for design. Thus, the users were asked to describe their experiences with using probes.

The aesthetics and the surprising character of the probes in the examined studies was highly appreciated and mentioned as engaging by many of the users. Some of the users in the nurses and transportation case stated that they were willing to participate because the approach and the focus of the study was novel. Some of the users commented that the approach was "a bit odd", and practical issues such as picture taking with a manual flash sometimes negatively affected users' motivation.

The possibility for expressing oneself in different ways and thinking over issues from various angles was found to be interesting, creative and motivating. Nevertheless, accomplishing the probes tasks, writing diaries, taking pictures and answering the open-ended questions was found to be not easy, requiring some effort and reflection. This was time-consuming but also pleasing for most people. Some of the nurses, for example, reported that they became more conscious of their environment, devices and work. Furthermore, even after the study they continued to observe their environment. And finally, they also felt that participating in the study taught them to think more creatively and to visualize issues in a new way.

> *When I started to write I realized how personal (the issues were) - although writing to a strange person. This is more personal than e.g. a telephone interview. This is my profile! [User/YleX]*

Those probes tasks which were not simply documenting but asking users to frame an opinion or a feeling required thought and deliberation. The openness of the probes made the users reflect on what the researcher might mean by certain questions and how to frame an answer. Thus, the tasks sometimes created a feeling of uncertainty. Some of the users gave the completed probes back with comments such as "I hope I did it in a way that you expected" or "I don't know what you will make of this, but here you are."

> *First I thought, what on earth, what are they looking for? [User/YleX]*

2.5 *Probes create a dialogue between users and designers*

Gould and Lewis (1985) have described the key principles of user-centered design. They emphasize the necessity of creating a dialogue with the users early and often. Prior to system design the designers should have direct contact with the potential users in order to understand them, e.g., who they are, what their activities are, their attitudes, even their emotional and cognitive characteristics. Both objective and subjective approaches can be used by design teams to discover what matters to the users (Fulton Suri 2003a). Tools that allow designers to make personal connections and relate to the users' situation are also needed.

> *Basically the strength is that there is a method with which you can get close to the user... User-centered design aims at making the design team engaged actively, to visit the use context, to see the users or the (probes) material to have a personal touch.*

Instead of getting a cold readymade product specification. [Senior design consultant/ Nurses and transportation]

This study brought different kinds of information, experiential, empathic. It is interesting to get under the user's skin. They (the persona representations) were the central part, the rest was general. This brought subjectivity. [In-house architect/ Väinö]

In general, the possibility to engage with users and in the user study activities was the factor that motivated and created insights for designers and other stakeholders. Meeting the users face to face during the probes study, as in figure 4, or being able to interpret the raw user data was considered motivating. The possibility to participate in the study personally increased the commitment to the results and the motivation to use and share them in the company. Those engaged directly in the probes process found the process to be a valuable tool for learning and understanding as well as for gaining personal insights:

The hospital world has been quite strange to me and I have never been especially interested in it. The material that was gathered in the tasks and the interviews opened to me their world a bit. And the best is that it made me become interested. [Design consultant/Nurses and transportation]

And

The clips from the diaries, what they [the users] have been doing, their thoughts and pictures. One starts to get to know the people [In-house designer/Tele-work]

Subjective, narrative and visual user material can be used for "in-house marketing". Even the blank probes kits were passed around in the companies for co-workers and other stakeholders to comment upon. The probes artifacts and the philosophy of the tasks often raised positive emotional responses.

User profiles based on probes data and subjective descriptions deepen the understanding of the studied phenomena. In the nurses and transportation case, the users were depicted in posters which described the nurse as an individual instead of focusing on the technology developed in the company. The posters were found to be an interesting and not overly serious way to spread the idea of the users being something other than a stereotype. Describing situations where the company's products played a secondary part was found to provide a fresh point of view. The posters activated discussion in the company, creating a more holistic perspective on usability.

...to make them remember that the users are ordinary people with emotions and feelings. Everything cannot be explained with logic and reasoning. [Usability manager/Nurses and transportation]

The meaning of the empathic (probes) study: the (designed) concepts are based on them and that is the link to reality. [Design consultant/Väinö]

On the one hand the nature of probes leaves space for interpretation, and to avoid one-sided and overly subjective conclusions, the interpretation should be done in multi-disciplinary teams. On the other hand collaborative activities in companies need

facilitation to establish a common understanding. The probes, the raw user data and outline presentations were used in workshops as means to familiarize team members with the users or the design theme. The user representations gave starting points for narrative telling, role-playing scenarios and brainstorming ideas. These sessions allowed participants with different backgrounds and levels of expertise to share their knowledge, insights and associations. They provided possibilities for new collaboration practices inside the companies and with other partners.

> *The workshop was good, the material was looked through and some product ideas were created... brainstorming. We could think that before starting new product development, we could have this, send packages to the use context the product is meant for, and we would have a kind of brainstorming session, where the material is discussed through and interpreted. [Senior usability specialist/Nurses and transportation]*

3. Discussion

One of the objectives of this paper is to examine the ways in which probes can function in design and product development companies. The results of the study above and the four reasons for using probes and their characteristics presented earlier in this paper are discussed and summarized below.

Probes support design inspiration and allow personal interpretation. Conducting a probes study is a designerly activity. Designers put their professional artistic skills and subjective insights into the probes design. In this phase, they may already start to generate preliminary solution hypotheses and experiment in reframing the design space, which according to e.g. Schön (1983) belongs to the designerly way of thinking.

Making the probes kits is a natural and motivating task for designers and orients their thoughts towards the users' worlds. Visual aesthetics are a natural component of designers' self expression; hence to inspire designers and to approach the users in an appealing way, effort is put into the aesthetic design of the probes kits. Designing probes resembles designing a product rather than planning research. This may be one of the reasons industrial design students and designers find this approach appealing. The size of the package, the usability of the diary, and the outlook of the tasks have to be designed.

Open and interpretative data as well as probes tasks and illustrations with metaphors trigger the designers' associations. Wide perspectives and flexible access to different sources of information and disciplines are necessary for creative thinking (Ahola 1978; Lawson 1980; Schön 1983). The openness and broad brush character of probes leave space for imagination, which is still grounded in the users' world. In companies there is a need for research and design approaches that support creativity to explore new fields of human life and to innovate in new product and technology development (e.g. Bødker *et al*. 2000, Cagan and Vogel, 2002, Fulton Suri 2003a).

Probes data provides information on users. However, in the studied cases feedback on the usefulness of the information for company use is contradictory. On the one hand, the probes data opens fresh and holistic perspectives and vivid information on individuals and their contexts. On the other hand, the data may be too ambiguous and fragmented with too broad a focus to be used for concrete design decision-making in companies. For the purpose of information gathering, probes should not be used alone. Sanders uses workbooks, which she calls primes, to make users become more aware of their experiences related to the theme of the study (Sanders and William 2001, Sanders 2002). Primes are similar to probes in their open-endedness. However primes are used primarily

for preparing the users to express their creativity in later participatory sessions. Probes can function in the same way. Probes can be used as an introduction to the design theme and the users. With the help of this introduction, both the users and the other participants are better prepared to discuss interpretations, share information and even co-create design ideas. When applied as one approach among others probes can e.g. make interviews more effective by providing a means to familiarize oneself with the people and phenomena in focus, and complement observations by bringing up subjective issues and longer term reflections. The comparison of probes and other user-centred methods cannot be done within the scope of this paper but is a subject for future research.

Probes allow users to express needs and design ideas. There were individual differences in how the probes were considered by the users. The approach was enjoyable for most of them but also created feelings of uncertainty and confusion. However, reflecting and expressing was found to be pleasurable and interesting. The feedback also brought up feelings of frustration and confusion about the openness and ambiguity of tasks, and the purpose and goals of the studies. How much the participant wants to and can adapt a playful attitude to the expression of their ideas in e.g. drawing or writing and imagining possible futures depends on the individual (also discussed by Sarpiello 2002).

Users' expertise and creativity can be harnessed to support and provoke the design process (e.g. Sanders 2001). To encourage motivation, probes need to be fitted to the specific users. This fit may include characteristics such as practical task-related issues, aesthetics and the visual and textual language. The tasks should be both meaningful and playfully surprising. Furthermore, the probes should enable various ways for people to explore the issues studied, and to participate and express themselves.

Probes were able to create a dialogue. Probes support the user-centered dialogue on three levels: The interpretative dialogue within the design team, the direct dialogue between the users and the designers, and an inner dialogue, in which user experiences and designers' insights become linked. This inner dialogue is about design empathy as described by e.g. Fulton Suri (2003b). The strength of the probes approach is the ability to get close to the user.

For the user, the dialogue is opened with the designers' expressions and design ideas. For the designer the dialogue can start by ideating the study aims and designing the probes tasks for the users. The dialogue continues either in face-to-face meetings with the users or through representations of the users: the probes material, user portraits and authentic descriptions of situations.

In addition to the interaction between the users and the designers, user-centred dialogue takes place in companies and in design teams. Multidisciplinary interpretations, workshops and communicating of the probes study results can enhance this dialogue. The subjective probes material represented the users' perspectives and environments, which created a feeling of the users' presence within the design team. The process also offered possibilities for sharing interpretations and ideas. Engagement increases the importance given to the user data and to transferring insights to and across the organization.

Probes kits signify respect for users and can be seen as gifts to them, a sociable way to start a relationship or dialogue. Although the company participants commented on how beautiful and funny the probes kits were, in a company context, there is pressure for simple, reduced and effective processes, and the cost of custom designing a probes kit for each study can be seen as an obstacle in the long run. One possibility to solve the problem of resources for designing probes is to develop ''scaffolds'' (Sanders 2001) or frameworks for the creation of probes that support but do not constrict their uniqueness and

creativity. If the designing of the kits becomes too routine a procedure, it can negatively influence the designers' engagement and hinder the fresh development of the tool for each purpose and context.

The human-centred design process as described in ISO 13407 (1999) proposes that the user studies and their deliverables are done prior to the solution design. In companies this means that often user studies are conducted by user specialists, who filter the data on behalf of the designers. Design oriented probes are not a method for gathering information at one end of the design process, i.e., the starting point of the user centered process, or for supporting inspiration at one end of the process. Rather, the design and user studies should go hand-in-hand and iteratively. In the company setting, such iterative and multidisciplinary collaboration needs facilitation, and tools and practices for establishing and maintaining dialogues for common ground (Brandt 2004). The aim of using probes can be to bridge the user need identification phase and the concept design phase. Figure 6 summarizes the four reasons for using the probes approach in human centered design and their typical characteristics when applied in concept design.

To conclude, the data obtained through seven cases suggests that the four reasons for applying probes are also relevant to user-centred concept design in design and development companies. The probes data, and process, has been seen to fuel design inspiration. They enable a user-centered dialogue between the users and the designers and within the design team. Probes help to familiarize the design team with the users and the research theme and to focus the research questions. Because the probes results are often too subjective and fragmented to be used for product development decision-making, they should be complemented with other approaches. Some users find the open and thought provoking probes tasks inspiring, while others can find them irritating. Thus, the quality of probes results is dependent on the probes tasks and users' motivation, and of course, on the design team's skills and resources.

Some of the challenges of probes, i.e. uncertainty of the motivation and contextuality, might be avoided by a more interactive dialogue. There are already systems being piloted that use new personal technology for self-documenting (e.g. Palen and Salzman 2003, Masten and Plowman 2003, Hulkko *et al*. 2004). These ''mobile digital probes'' systems can support more interactive probing and the possibility of interpreting and sharing the data during the self-documenting period. Furthermore, the digital systems can provide possibilities to categorize and communicate the data in more systematic ways.

Objectivity or systematic analyses are not key words in the early design context. Fuzzy front end user studies aim at finding user values, needs, desires and fantasies (Cagan and Vogel 2002). Probes allow interpretation, inspiration, creativity in data gathering and ideation. Gaver, one of the pioneers of using the probes, says that he is skeptical about framing probes as a formal methodology. He feels that by so doing the approach would become heartless and superficial (Gaver 2001). When methods are written into handbooks or definitions the innovative use of the tools can be frozen. Freshness can be maintained by avoiding routine procedure (Buur and Bagger 1999). Approaches should be applied with a creative attitude and developed for each purpose. In that sense probes have flexible and useful qualities also for business purposes.

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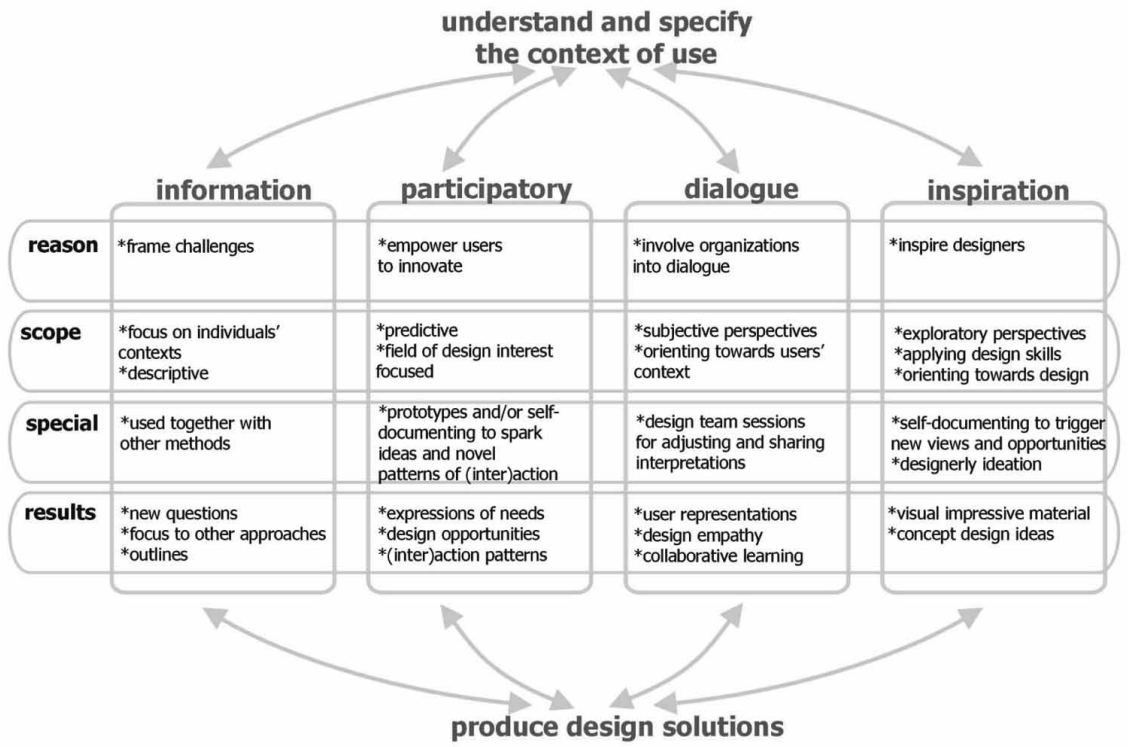

Figure 6. Four reasons for using the probes approach in reference to ISO 13407 human-centred design process (ISO 13407, 1999).

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