Good to See You Again: Engaging Users in Design

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ABSTRACT
Designers and researchers have been involving users as part of their design processes for some time now. However, there are limited examples of user-driven innovation processes that are conducted and studied in an industrial context. In this paper we present and provide a detailed account of the design process for the *Social and Spatial Interactions (SSI)* platform. This research project was conducted by systematically involving end users from the very start of and throughout the design process. Some activities conducted as part of this project include a probes study, co-design workshops, and evaluations of prototypes. We describe and illustrate the individual steps of the process, as well as reflect on the overall impact and challenges of introducing and applying user-driven innovation in an industrial research context. In particular, we discuss aspects such as shifting attitudes in different phases of the user engagement, overcoming skepticism in a multidisciplinary research team, and the role and the competence of the facilitator.

Categories and Subject Descriptors
H.5.2: User interfaces, User-centered design.

General Terms
Design, Experimentation, Human Factors.

Keywords
Design Methods, Co-Design, Workshop, Innovation, Ideation.

1. INTRODUCTION
Industry is engaging users into their innovation processes with varying methods, mindsets and processes. User-driven innovation and co-creation are manifested in business books as ways to succeed [5] and user-centered design has been acknowledged for a decade as a common practice in companies. Today companies are engaging users directly into their product development processes. More and more often digital media is used as a platform for gathering insights and feedback from customers. Companies might even establish long-term partnerships with *lead users* [5] to be able to incorporate their expertise and experiences in the product development and to test new ideas, e.g. in sports-related equipment [9]. Depending on the company, these efforts can be discussed using different terms such as user-involvement, co-creation, user-centered design or user-driven innovation.

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Academic design researchers have studied and experimented with various kinds of research methods and processes for user involvement. The research questions can concern fine-tuning particular methods (e.g., observing embodied interaction in workshops), or studying paradigm shifts (e.g., from usability to experiences). Many of the approaches studied in academic context are useful and applicable in industry and have even been developed in collaboration with industrial partners. However, the academic design research approaches are applied in industry with different research questions. There are practical needs (e.g., efficiency) and strategic concerns (e.g., openness), as well as increased interaction and communication between different stakeholders with different expertise.

In this paper we present the design process of the *Social and Spatial Interactions (SSI)* platform. We provide a detailed account of a research project conducted in an industrial context in which a user-driven innovation approach was applied by involving end users throughout the design process. The main objective for this project was to find opportunities for novel ways of interacting with handheld devices by observing people's daily interactions with current mobile technologies (i.e., laptops, tablets, mobile phones, MP3 players). We describe and illustrate the individual steps of the process, as well as reflect on the overall impact and challenges of introducing and applying user-driven innovation in an industrial research context. In particular, we discuss aspects such as shifting attitudes in different phases of the user engagement, overcoming skepticism inside a multidisciplinary research team, and the role and the competence of the facilitator.

The rest of this paper is structured as follows. First, we provide background information on both the *SSI* project and user-driven innovation. Then, we present three user study phases (i.e., probes, co-design workshops and prototype evaluations) that form the core of our *SSI* user-driven innovation process. Finally, we reflect upon the implications of applying user-driven innovation in industry, followed by conclusions.

2. BACKGROUND
The *Social and Spatial Interactions (SSI)* project described in this paper was developed by a group of researchers from the User Experience and Design (UXD) team at Nokia Research Center in Tampere, Finland. The project was conducted using a user-driven innovation approach where end users were actively engaged in the design process. The first author led the project by planning, facilitating and/or participating in the different stages of the project and thus was the driving force behind involving end-user participants in the project. Both the first and second authors have vast experience in studying, experimenting and developing design and research methods in an academic context. This paper however reflects upon an industrial case where such methods were applied 'for real'. In the remainder of this paper, we will use 'we' to refer to the authors of this paper, as opposed to *SSI* project team members.

Figure 1. The Social and Spatial Interactions *(SSI)* platform. People involved in shared collocated interactions.

2.1 Social and Spatial Interactions (SSI)

Mobile phones were originally conceived and have traditionally been utilized for personal use. The improvement in sensor and short-range communication technologies offers possibilities to explore shared use of mobile phones. In this paradigm shift, collocated users engage in collaborative activities using their devices, thus going from *personal-individual* towards *shared-multiuser* experiences and interactions. The *Social and Spatial Interactions (SSI)* platform [12] extends the current individual use of these devices to support shared collocated interactions with mobile phones (Figure 1). The platform supports shared collocated interactions, using the mobile phone as a physical interface and a sensor network built in the phone to track the position of the phones on a flat surface. The question the platform addresses is if people are willing to share their devices and engage in collaborative interactions.

2.2 SSI Principles

In this exploration for new ways of using mobile phones, from a *personal-individual* to a *shared-multiuser* use, the research team has defined the main principles of *Social and Spatial Interactions:*

2.2.1 Social

The platform supports joint multiuser interactions by encouraging people to share their devices to create an experience or reach a given common goal. The *SSI* team has been looking into various physical and social contexts of use, such as teamwork at the office [13], sharing media content at home [14], or outdoor games.

2.2.2 Spatial

The platform supports interactions that depend on knowing the relative position between phones on a flat surface without requiring a dedicated infrastructure (i.e., fixed lab setting) or external equipment (e.g., infrared tower or camera) to track the devices in 3D. The platform provides a 3D tracking solution that is built in the phone and that allows detecting where phones are with respect to each other. The sensors embedded in the mobile phones allow knowing how people are arranged (i.e., seated or standing) around the table. As no extra hardware is needed besides the enhanced phones, the platform can support activities and interactions that take place in different indoor (e.g., office or café) and outdoor (e.g., park or forest) contexts. Siftables [19], a group of compact display devices that communicate wirelessly and form a sensor network, have inspired the *SSI* work.

2.2.3 Tangible

The *SSI* platform relies on people's ability to handle physical objects. The phones are used like Lego blocks to interact with digital information by performing simple actions (e.g., move, sort, group, join, spin, stack, etc.). Tangible user interfaces (TUIs) allow people to interact with digital information by manipulating physical objects where the data is coupled with the object [7]. Bricks [2] introduce the notion of 'physical handles' to manipulate virtual objects. Several TUIs systems require complex projection displays to couple the information onto the object. In this work the use of a mobile phone as a physical interface to manipulate data is explored.

2.2.4 Multimodal

The platform uses touch (i.e., touchscreen) and device gestures (i.e., gestures performed while holding a device in one's hand) as the two main user input modes. Multimodal feedback is provided during the interaction, not only through visuals, but also haptics and sound. When people start using their phones to interact with digital data, there are some situations where the device's screen is no longer visible, such as when spinning the device or flipping it upside down. In these situations, people get feedback through other modalities. Accelerometer data is used to detect different device gestures. Using the hard table surface as a reference point, the platform can detect a horizontal or vertical tilt of the device by performing a quick upward movement on either side of the device and bringing it back to a rest on the table [1]. Individual mobile devices can also be combined together into a larger canvas by bumping, pinching or knocking devices together, thus forming a larger display [4].

3. USER-DRIVEN INNOVATION

Doing user studies and engaging users for and in design can be conducted with different methods and mindsets. Sanders and Stappers [20] have suggested that human-centered design research as practiced in the design and development of products and services could be characterized with the dimensions *led by design* versus *led by research*. Furthermore according to their view, the other two dimensions are *user as a subject* versus *user as a partner*. The *research-led* view can consist of gathering insights from users' needs through observations and interviews and interpreting them for product development. The *design-led* process on the other hand could involve inviting potential users to express their needs in co-design sessions [20].

We called the process described in this paper *user-driven innovation,* as both *research-led* (i.e., prototype evaluations) and *design-led* (i.e., probes [3] and co-design workshops) types of activities were included. The *SSI* team decided from the very start of the project to systematically involve users throughout the design process. Users were thus considered partners in the process rather than subjects that were objectively observed but left out of the generative interaction. As such, potential end users were contacted to help define the scope of the project at an early stage and help inform all the subsequent phases of the project. As a clear example of the users' influence on the process, the final (and focused) project objective as described in Section 2 was identified once the probes study had ended. Initially, the main project objective was generically defined as *finding opportunities for novel ways of interacting with handheld devices.* The *SSI* team's first activity was to conduct a probes [3] study and observe people's daily interactions with current mobile technologies (i.e., laptops, tablets, mobile phones, MP3 players). Only after this first study the team was able to identify, together with end users, an interesting opportunity to explore shared collocated interactions that require people to share their devices. The user involvement

and design team engagement was organized through an iterative process, where the objective was to support both the research team in understanding users and to facilitate the users to co-create. Workshops became meeting points where researchers and potential end users shared insights based on the project progress.

In this user-driven innovation project, potential end users have been involved in creating novel artifacts and interactions for the *SSI* platform. The *SSI* team has conducted a probes study, co-design workshops, and prototype evaluations. Taking these different steps has 1) allowed the team to gain a better understanding of how people might use the *SSI* technologies and 2) enabled the users to look at their practices, reflect about *SSI* in relation to them, and innovate on potential situations and uses for the future technologies.

4. PROBES STUDY

In the first stage of this user-driven innovation process, the *SSI* team conducted a probes study [3] where people's pervasive use of (mobile) technologies was observed. The probes study was conducted between April and June 2009, in Tampere, Finland. The purpose of the study was finding inspiration for ideas that were rooted on the real needs of a specific user group. The main research question for this study was *how could novel ways of interacting with mobile technologies provide support for users' daily tasks, dreams and aspirations?*

Design probes [16][17] are based on self-documenting: the users are given probes kits including tasks such as diaries and open questions, for documenting, communicating and reflecting their experiences. According to Mattelmäki's studies [16] there are four main reasons for applying probes in companies: to get inspiration for the design process, to allow users to participate in the design exploration, and to support the dialogue within the design team and with the users. In addition, probes can be applied to: 1) support creative thinking, to explore novel or unconventional perspectives and to inspire designers and other stakeholders; 2) engage and empower various participants in an exploratory design process, to reflect and create new ideas based on their experiences and insights; 3) ease the social collaboration in multidisciplinary teams and with users; 4) involve collaborative people and organizations in human-centered design dialogues. These dialogues are part of developing the understanding of the users, making sense of the design space and its opportunities and supporting the exchange of information and learning in collaborative teams; and 5) enter the individual zones of the people that are studied. Probes aim to foster subjective and empathic insights into the other participants as well, be they designers or other collaborative experts [17].

As mentioned, the probes approach is a tool for collecting user data, but also a tool and a process for collaborative exploration [17]. One of the reasons for using probes is involving organizations and stakeholders into discussion to co-explore, share interpretations and to create new understandings early in the design process [16]. Probing then aims at getting an understanding of the subjective elements of users' contexts such as emotions, lifestyle, routines, motivations and values. The outcomes of such studies are often user representations that can be utilized as inspiration and to raise the awareness of user perspective and findings and ideas that influence and inspire the design solutions. Furthermore, the probing process (i.e., self-reporting and reflection) sensitizes users to the co-designing phase [21]. More intangible outcomes relate to design empathy and collaborative learning among the various participants.

4.1 Participants

The probes study was conducted with 14 mixed-nationality students from the Tampere University of Technology (TUT) and the University of Tampere (UTA). The participants were chosen to represent a young generation of mobile phone owners who would *a priori* be more familiar with and open towards novel interaction techniques and applications. A mix of Finnish and international students who had very different needs in terms of socializing and communications (e.g., keeping in touch with families and friends who are in another country) participated in the study. The participants varied in gender (10 male, 4 female), age (between 20 and 28), nationality (7 countries from Europe, Africa and Asia), and study subject (8 technical, 6 non-technical). All participants owned a mobile phone, different from the one used in this study.

4.2 Method

In the following, the probe kit is described. First, the kit (Figure 2) contained a design-studio diary including: 1) a timeline to probe the daily thoughts and activities of the participants, 2) closed questions covering different aspects of routines, collaboration, and use of technology, 3) open questions to make people tell stories and express their opinions, 4) a sociogram plotting the participants' structure of interpersonal relationships to allow self-expression, and 5) a drawing exercise (i.e., *ideal mobile device*) to probe the dreams and aspirations of the participants. In the sociogram exercise (Figure 2), participants were asked to cluster their contacts according to categories (i.e., family, friends and other) and the frequency of the contacts (i.e., daily, weekly, monthly). In the *ideal mobile device* drawing exercise, participants were asked to think about an aspect of their life that a new piece of technology could make easier for them.

Second, the kit included a Nokia 6210 cameraphone to illustrate some of the experiences they had while working on the probes. Besides taking pictures, participants could also: 1) take pictures with sounds, 2) capture sound only, 3) record short videos, or 4) write microblog entries. The *SSI* team suggested to them taking pictures with sound to comment their pictures and thus save time later making handwritten annotations. The cameraphone was running ImageSpace [10] that automatically uploaded the content captured by the participants with the cameraphone to a Web interface. On the Web, the photos were contextualized and placed on a map using the GPS data from the photo. This allowed the *SSI* researchers to have access to the data as soon as it was captured.

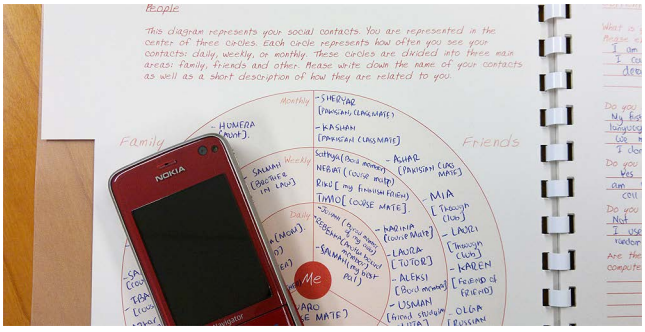

Figure 2. The design probes kit. The diary on the sociogram page and the Nokia 6210 cameraphone.

Figure 3. Probes data pre-analysis or interpretation. Selecting relevant snippets of information.

To increase motivation, all participants were given the probe kit during a personal meeting that took place either at TUT or UTA. Participants worked on the probes at the University and in their homes for a period of one week (i.e., seven consecutive days) and they could freely choose the starting day. After one week, a second individual meeting was held in which the probe kits and cameraphones were collected. Interviews (30-60 min.) were conducted based on the contents created by the participants in the diary and through ImageSpace. Participants were then given one movie ticket each to compensate them for their time.

4.3 Analysis

Once the probes kits were collected, the data was processed for interpretation. The analysis was done in two parts: 1) the two researchers who prepared and conducted the probes study did a pre-analysis, and 2) the results from this pre-analysis were shared to a larger group of researchers in an analysis workshop. This approach resulted from the need to communicate the exploratory field data inside the research team, and make sense of the information together.

4.3.1 Pre-Analysis (Interpretation)

Based on Sleeswijk Visser's work [21], two researchers did a pre-analysis or interpretation of the data (Figure 3). The general idea was to go through the data and make selections that would be later presented to other researchers who had not been involved in the probes study. There was a need to find the right balance between raw and interpreted materials so that the researchers would be able to make their own interpretations. To support this process, the material had to be made accessible and provide ways for them to make notes on the material. Thus, the decision was to create four boards that would summarize the study findings.

The data from the diaries was transcribed and coded. A total of 1299 photos (93 photos per participant on average), 101 microblog entries, 92 sounds, and 34 videos were collected. The two researchers selected snippets of information from the original material (e.g., transcripts, photos, pages from the diaries), and made open-ended suggestions for the interpretations by pointing some key issues and their relations. As a result, the following four general topics were identified: *"a day in the life of"*, *"technology is personal"*, *"breaking the distance"*, and *"what technology could do for me"*. Each of these topics was documented on four boards with information from different participants (Figure 4). These boards do not produce a shortcut to a final result, but rather a map showing possible directions or paths, risks and opportunities to support the researcher's interpretation and orientation. The remaining photos, transcripts, photocopies from the diaries that did not make the final boards, and the original diaries, were put into four folders for consultation.

4.3.2 Analysis Workshop

The second part of the analysis consisted of an analysis workshop. The analysis workshop took place on June 18, 2009 in Tampere, Finland. Three researchers were invited to the workshops, for a total of five persons as part of the analysis team (including the two probes researchers). The analysis workshop consisted of four different steps: 1) Sensitizing, 2) Immersing the data and topics, 3) Creating themes, and 4) Insights and idea generation.

Figure 4. One of the four resulting boards from the pre-analysis: "Technology is personal". Analysis-workshop participants directly added their notes using Post-it notes.

First, one day before the analysis workshop, a sensitizing task was given to the three researchers joining the analysis. Each of them received one folder with the remaining data that had not made it into the final four boards. The researchers had to explore the folder contents and make personal notes as they went through the data. This sensitizing activity allowed them to become familiar with three or four users each, and thus also with the type of data that was collected. Post-it notes and quick-tabs were included in the folder to prevent them from writing directly on the diaries, as other workshop participants would be looking at them the next day. The researchers were also asked to write down one paragraph describing how they perceived each of the three or four probe study participants.

Figure 5. The analysis workshop. Different materials were available: pre-analysis boards, folders with raw data, photos and projected videos.

Second, the analysis workshop began by introducing the four pre-analysis boards (2 hours). All five participants went through the boards and made personal annotations on Post-it notes, which were added directly to each board (Figure 4). The idea was for the researchers to make new discoveries, find anecdotes or topics that surprised them, as well as identify potential new ideas. Besides the boards, participants (i.e., researchers) also had access to the

folders containing raw data, a laptop containing all the participants' photos, and participants' videos that were projected on the wall. Third, participants began to create themes collectively (2 hours) (Figure 5). The researchers first discussed a small number of major themes; they identified data elements that were relevant to those themes; and they engaged in the process of sense making of each theme. Finally, the researchers were involved in idea generation (2 hours). The ideas originated from the main topics that were identified in the previous step.

4.4 Findings

Six main themes were identified during the collective part of the analysis workshop. These themes later derived into more specific ideas around these six themes. We will now briefly present one of those themes.

4.4.1 The computer as a hub for life

The probes study allowed the entire team to realize how much technology was embedded in people's lives. Most of the international student participants had recently arrived in Finland and were trying to both stay in touch with their loved ones back at home and meet new friends locally. As a result, the computer mediated many of their interactions. Their (laptop) computers were used for Skype video conversations, to watch movies, to do their homework, to read the news, and maintain their social interactions. Participants reported things like checking Facebook or their email as the first thing they do in the morning (before brushing their teeth or taking a shower). They would literally use their computers everywhere, including in bed. (Figure 6)

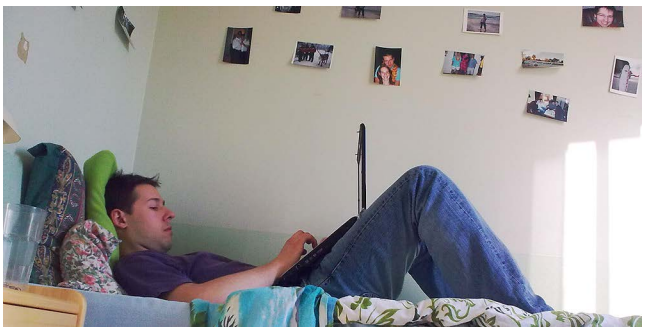

Figure 6. A probes participant checking his email in bed.

Figure 7. A probes participant captured two friends in his home sharing the same table using two computers.

Based on these findings, the *SSI* team began thinking of new ways in which technology could better support the needs of the participants. The team started to rethink how mobile phones could be used. For instance, another participant took a long sequence of pictures showing how three friends shared a common space (i.e., table) for different activities (Figure 7). In this sequence, participants were depicted sharing the table to have lunch, or using their laptops to watch funny videos, reading their email, watching TV, constantly switching and transitioning between an individual and a social situation. This shared and flexible use of space and technology to support a social situation made the *SSI* team think about the following: could we use our mobile phones to create a network of displays that can augment larger surfaces? Maybe this network of personal devices could be used to support social and spatial interactions between collocated users. Looking back, these two pictures (Figures 6 and 7) heavily inspired the *Social and Spatial Interaction* platform.

5. CO-DESIGN WORKSHOPS

The second stage of this user-driven innovation process consisted of organizing co-design workshops. There were three main reasons for conducting these workshops. First, the *SSI* team wanted to discuss the probes study results with the participants. Second, the participants witnessed two simple demonstrators showing the possibilities behind *SSI*. Third, the research team's intention was to co-design applications for *SSI* that would include playful interaction techniques. The workshops took place in September 2009, in Tampere, Finland.

5.1 Participants

Five participants from the probes study joined the co-design workshops. Additionally, three researchers who were familiar with the ongoing *SSI* work joined the co-design sessions. These three researchers had also previously participated in the analysis workshop (Section 4.3.2). This was the first time for two of them to meet the probes' participants. The main challenge in organizing these sessions was to find a common design language that would allow both the probes' participants and the researchers to co-design in equal terms. All sessions were recorded on video.

Figure 8. Idea generation in pairs using the PLEX Cards during the co-design workshops.

5.2 Method

The co-design workshops consisted of five parts. First, each session started by presenting the general findings from the probes study to the participants for discussion. This allowed checking the reliability of the interpretation thus validating the probes' findings. Second, a simple demo showing the possibilities of *SSI* was presented. In the "Together Status" demo, a network of connected mobile devices with different form factors and underlying technologies share different interaction states (e.g., a key press on one device was displayed on all the devices in the network). Third, after the demo the five participants and the three researchers engaged in idea generation sessions. Participants split in pairs and used the PLEX Cards [11] as a source of inspiration

to think about playfulness when designing (Figure 8). The task was: *based on the technology demos create playful interactions for SSI that support your daily tasks, needs or dreams*. Fourth, participants saw a second demo (Figure 9). "Kapteeni" is a distributed memory game in which the objective is to repeat a random sequence of button presses that keeps increasing in length. Finally, participants worked as one group using the PLEX Cards and the demo as active ingredients of the exploration.

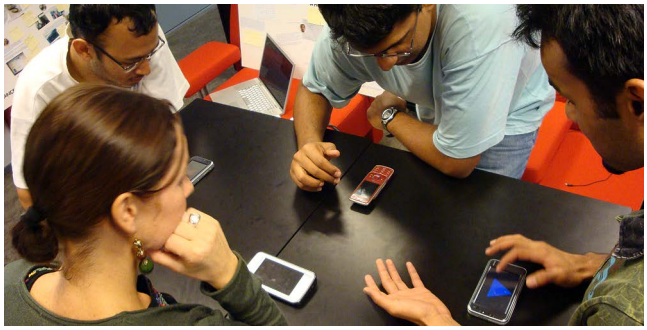

Figure 9. Discussing ideas as a group while playing Kapteeni during the co-design workshops.

5.3 Analysis

The creators of the ideas initially documented the ideas on Post-it notes during the sessions. Later on, the first author analyzed the videos and the notes and compiled a set of possible ideas for *SSI*.

5.4 Findings

After presenting the probes study results, participants validated or confirmed the probes findings by commenting things such as: *"I couldn't have described my life here in Finland in a better way."*

The demos allowed introducing technological aspects without directly leading the participants to a final solution. In that respect, the technology demos served the purpose of showing possibilities instead of dictating solutions or restricting the design space.

The co-design sessions were successful in generating ideas that combine the needs of the users, the intentions of the researchers, and the possibilities offered by technology. The end-user participants and the researchers were able to work as a team. The PLEX cards provided a tool to look for an additional source of inspiration whenever it was needed. The co-design workshops work resulted in 20 possible application areas for *SSI*. Out of these 20, two have already been implemented as prototypes while a third one is currently being developed.

6. PROTOTYPE EVALUATIONS

For the third stage of this user-driven innovation process, the *SSI* team took one of the 20 *SSI* applications and implemented it to demonstrate the potential of the *SSI platform* and some of its principles. The MindMap prototype [13] is a brainstorming tool that allows a workgroup to create, edit, and view virtual notes on any table, not requiring hanging Post-it notes to a board or wall. The MindMap evaluations took place in December 2009, in Tampere, Finland.

The purpose of the evaluations of this first prototype was to complete a first design iteration in the user-driven innovation process. The team was also interested in informing the overall process behind the *SSI* platform by checking if the MindMap prototype is a relevant application for users in the context of *SSI*. Finally, the team wanted to test some of the proposed interaction techniques in terms of naturalness, ease of learning and use and identify potential improvements for the prototype. Further design and implementation details can be found elsewhere [13].

6.1 Participants

The evaluation was conducted with nine participants, mostly international students who had previously participated in the probes study and co-design sessions. The participants varied in gender (8 male, 1 female), age (between 22 and 47), and background (6 technical, 3 non-technical). The evaluations were conducted in three groups of three participants. All sessions were recorded on video.

6.2 Method

The evaluations consisted of three parts: introduction, task, and semi-structured interview. In the first part of the study (30 min.), the MindMap prototype and its interaction techniques were briefly explained. Each participant was provided with one device running the prototype. Participants were then allowed to freely explore the available functionality and get acquainted with the application. In the second part of the study (30 min.), all three participants collaboratively created a mind map containing at least 10 notes. Some discussion topics that had emerged in the co-design sessions (e.g., planning a night out, organizing a party) were proposed. Otherwise, they could freely think of a new topic that they would agree on. In the final part of the study (60 min.), a consistent set of open-ended questions were asked to each group during semi-structured interviews, prompting participants to walk the evaluation team through some of their experiences while creating the mind map. The team was also interested in obtaining feedback on the general principles behind the *SSI* platform.

Figure 10. The MindMap prototype evaluations. Three participants from the probes and co-design workshops interacting with the devices on the table.

The three sessions were conducted in an open meeting room area with modern and colorful furniture (Figure 10). The three devices were set on a small and tall round table (60cm diameter x 130cm tall), and participants stood around the table. All sessions including the semi-structured interviews were recorded on video and transcribed. Participants were given one movie ticket each to compensate them for their time.

6.3 Analysis

The data collected consisted of video recordings and photos captured during the interaction, as well as the three resulting mind maps. An affinity diagram [6] was built to analyze the data from both the observations of use and the semi-structured interviews. Two researchers independently made notes as they watched the videos for each of the three sessions. The same two researchers

analyzed the qualitative data through several interpretation rounds. Affinity diagramming allowed creating categories and visualizing the main themes emerging from the data.

6.4 Findings

As mentioned earlier, detailed results of how the prototype supports the creation of mind maps, and on the naturalness of the proposed interaction techniques can be found elsewhere [13]. We will now concentrate on the findings regarding the *SSI* platform.

Participants saw the potential of the *SSI* platform for collaboration, teamwork and gaming. All participants liked the idea of engaging in social co-located interactions. *"It sounds very tempting if you could have your devices connected with each other," [P1] "it's great, it could be used for multiplayer games," [P6]* and *"(It could be used) for any type of collaborative work." [P4]* Regarding the main research question, participants said they would be willing to share their devices.

Regarding the tangible aspects of the platform, most participants said the combination of physical interaction together with the device gestures was a strong aspect of the platform as it used simple gestures participants were already familiar with (e.g., flipping the device upside down to delete a note): *"I really like that with this physical stuff you don't need to do anything, that's cool." [P2]* A few participants expressed their concerns of using their mobile phones physically as it may get scratched.

Based on these findings, the team decided to continue the *SSI* work by bringing more device gestures into the interaction [14].

7. DISCUSSION

7.1 User-Driven Innovation

As mentioned earlier, Sanders and Stappers [20] suggest that human-centered design research is practiced with particular mindsets and (with a provocative interpretation) that by selecting certain methods the mindset is selected as well. Probes for example according to this outline is *design-led* and considers users as subjects, not as design partners as would be the case in participatory design. Our observations based on the case described here are that probes: 1) supported the process of involving users as partners in the design phases of the project, 2) facilitated the designers and other stakeholders to accept the users as design partners. The probing phase was mainly the responsibility of the researcher who also conducted the pre-analysis phase in collaboration with another researcher. Thus, the application of a so-called *design-led* method can include phases that are more or less *research-led*. We also witnessed that professional people who have strong expertise in their domain found some of the users' ideas slightly trivial as design solutions at first, but when looked at through a more reflective lens, they were able to identify themes that were meaningful. One could summarize that in industrial context a user-driven innovation process such as this one has phases in which the mindset and emphasis changes. Users are considered both as subjects and partners, the process is led by design at some stages but in order to be structured it also needs some research-driven stages. In the following we will further reflect on some critical phases of the process.

7.2 Overcoming Research Team Skepticism

As was stated earlier, this project was conducted in the context of a research project in industry. However, we are unable to generalize and state that the process described here is common practice in Nokia Research Center. For example, from the multidisciplinary research team that participated in the analysis workshop (designer, psychologist, computer scientist, software architect, and games researcher) (Section 4.3.2), only the designer/facilitator was familiar with user-driven innovation and its methods. Therefore, the project was very much related to teaching the methods to the rest of the research team and applying them in practice.

When the research team received the folders containing pictures, transcripts and diaries from the participants, they were unsure what they would get out of them. However, as they started going through the data their attitude evolved from being skeptical to appropriating the method:

- *"(When) I started looking at this person from the folder it was a bit like 'why is this?' It helped to start with the diary and get a sense of who this person is first. (The sensitizing phase) we did yesterday was quite important (to get) into the right frame of mind before coming here."* [R2, Programmer]
- *"Of course I formed some picture of them but probably it is incorrect in many ways as it is based on a few small details. I don't know how much it is the purpose to get a realistic picture of a person or more like inspiration."* [R3, Software Architect]
- *"The boards made the material much richer because then you get input from other people not just (the probes participants). Seeing the pictures helped connect with what was happening. Also the discussions with the two facilitators because I got more information about how the people really are, well, your interpretation of them."* [R1, Games Researcher]

We noticed there were slight differences in how designers and researchers perceive the interpretation of probes material:

- *"This raw data was good in the sense that you can draw your own conclusions and then you know how the conclusions are derived."* [R3, Software Architect]
- *"Getting this input (regarding) how these people think is opening up new ways of looking at these (research) issues. I also think that the main purpose for this whole day is to use this as a basis or as input for further reflection and not so much on the output that we get from here."* [R1, Games Researcher]

These comments are in line with Mattelmäki's findings [16] in academic-led projects with companies. Such exploratory projects aim at finding unconventional views through engaging various participants to reflect their experiences and create ideas based on the insights triggered by e.g. the probes materials. One of the aims is also to ease the social collaboration in multidisciplinary teams and with users. These dialogues are part of developing the understanding of the users, making sense of the design space and its opportunities and supporting the exchange of information and learning in collaborative teams [16].

7.3 The Facilitator Role

The lead researcher of this project has vast experience and a strong belief in user-driven innovation methods and approaches. This experience is a key factor in the relationships with both the participants and the research team. The facilitator needs to gain the trust of both users and researchers to involve them in the process and create a commitment to the project. The facilitator then needs to feel confident and at ease with the methods they are applying so the stakeholders can concentrate on the topic of the session instead of how people are being led methodologically. If

the stakeholders feel confident about the facilitator's work, then the facilitators can dive into the activities and discover the methods for themselves. These observations support Keinonen's [8] reflection on the challenges of evaluating design research methods. A method is not just an instrument but its application can be built upon a particular personal competence. And furthermore, certain methods and their applications can be part of an agenda, a mindset that is rather challenging to measure such as advocating the user-driven mindset in an organization.

7.4 Specific Process Observations

In the following we will list other important observations regarding the process. First, becoming familiar with the participants is the basis for the dialogue and fruitful collaboration between researchers and with the end users. People are in general curious about other people and probes studies allow peeking into the lives of the users [17]. Those who conduct the user studies (e.g., facilitators) have a close view of or even have a familiar relationship with the users and thus, it is important for them to keep an open mind about the fresh views brought in by the other researchers in order to contrast them with their own. Second, building collaborative interpretations is the most effective way to make sense of the fragmented data that results from probes studies. Trusting the findings of the pre-analysis phase and becoming engaged in building new insights is easier when one can participate in building the interpretations. Third, creating a space (i.e., time and place) to become sensitive to user-driven innovation helps the process. The participants valued *"using this day as an input for further reflection"*, i.e., gathering information and making interpretations to identify (research) questions for further studies. The physical setting and the available materials also allowed diving into the data. The combination of outlines, raw data and posters was well received. The materials complemented each other and helped in seeing beyond the limited number of users each of the participants was able to go through in the sensitizing phase.

8. CONCLUSIONS

There are various examples of academic design researchers who apply, experiment and study user-driven innovation and its methods. However, there are limited examples of user-driven innovation processes that are conducted and studied in an industrial context. The *Social and Spatial Interactions (SSI)* project provides a concrete example of user-driven innovation by systematically involving potential end users throughout the design process. Through a series of user studies (i.e., probes, co-design workshops and prototype evaluations) we have reflected on the overall impact and challenges of introducing and applying user-driven innovation in an industrial research context, including overcoming skepticism in a multidisciplinary research team, and the role of the facilitator. Additionally, we identified specific issues that play a role in the process, such as the importance of contrasting different views, building the interpretation together, and creating a space for a successful sensitizing phase.

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