Tools for Participation: *Intergenerational Technology Design for the Home*

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In this paper we propose an interwoven set of shared artefacts for stakeholder participation in designing domestic technologies. Our toolkit includes technology probes, associated fieldwork and conceptual goal models. Three technology probes facilitated playful communication between grandparents and their grandchildren. This communication was mediated via pictures and messages between the generations. We used high-level goal models, derived from Agent-Oriented Software Engineering (AOSE), as a template to analyse rich field data collected via the technology probes and interviews. As an integrated approach the AOSE goal models, combined with technology probes and field data, provided a uniquely inclusive toolkit for the participation of multiple stakeholders (users of technologies, field researchers and software engineers) in the design process. The integrated tools served as a lens to investigate the use of domestic technology by grandparents and their grandchildren. The tools helped design participants from different, and sometimes conflicting, perspectives, to come to a shared understanding of patterns of interaction between grandparents and grandchildren and to come to a common view about the design of appropriate technology.

Keywords – Stakeholder Participation, Shared Artefacts, Domestic Technology Design, Agent-Oriented Modelling, Technology Probes.

Relevance to Design Practice – The proposed approach highlights the importance that shared artefacts play in enabling active participation of different stakeholders in the design process. We demonstrate how to combine participatory tools so that designers can reach an understanding of how to develop truly satisfying and fun domestic technologies for users at home.

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Introduction

Stakeholder Involvement

The Participatory Design (PD) community widely acknowledges that participatory techniques such as workshops, storytelling, performance techniques, games and human-centred iterative prototyping, improve understanding and communication between stakeholders in technology development (e.g. Brandt & Grunnet, 2000; Brandt, 2006; Esnault, Daele, Zeiliger, & Charlier, 2009; Muller, 2007; Sanders, 2000). However, the effective exchange of the results of these participatory techniques is often problematic due to the lack of a shared 'language' among multiple stakeholder groups (Markus & Mao, 2004; Pekkola, Kaarilahti, & Pohjola, 2006; Robertson & Simonsen, 2012). At the same time, the priorities and values of each group can make effective communication difficult. This is further exacerbated when designing technology for stakeholders whose communication skills do not facilitate direct participation in design, such as children. Additionally, participatory techniques involving the end user do not typically address the problem of transferring the results of field studies to those responsible for technological development (dePaula, 2004; Pekkola et al.; 2006; Blomberg & Karasti, 2012). The role of software engineers and other technology designers as participants in the design process is not clearly represented by traditional PD approaches, therefore, we suggest tying insights about technology use closer to the development process overseen by software engineers using these tools.

It is commonly accepted that design is a social process that involves communication and negotiation (Brandt, 2006). Yet the design of technology often involves jargon and terminology that is not always shared and well understood across different stakeholders (Muller, 2007). Differences not only exist between technical and non-technical stakeholders but also exist between different technical disciplines involved in the development process; such as between Human-Computer Interaction (HCI) field researchers and software engineers. In order to communicate effectively design participants need a shared language which is sensitive to their specific needs (Dearden & Rizvi, 2008; Miller, Pedell, Vetere, Sterling, & Howard, 2012).

We propose a toolkit with three artefacts: technology probes, associated fieldwork and conceptual goal models. We argue that the combination of these three artefacts will help to mediate effective communication between participant stakeholders and will contribute to innovative designs. We illustrate our proposed toolkit with examples of technologies used by intergenerational families.

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Domestic Technology Development

Designing domestic technology (i.e., technology for the home) is particularly challenging (e.g. Howard, Kjeldskov, & Skov, 2006; Hagen & Robertson, 2009). Domestic technology is generally successful if it satisfies both functional and non-functional needs (Sandweg, Hassenzahl, & Kuhn, 2000; Hassenzahl, Platz, Burmester, & Lehner, 2000). For domestic technologies that support intergenerational interactions it is also important that every member of the family from the very young to the very old is capable of operating and enjoying it (Krömker & Sandweg, 2001). The grandparents who participated in our research were at least 70 years old and very inexperienced with technology. Their lack of confidence with technology and gaps in their knowledge about how modern technology could support relationships with their grandchildren made it difficult for them to articulate their needs. This meant that their involvement needed to be planned carefully.

Additionally, there are characteristics of the home that make designing domestic technologies unique. Domestic needs are often unspoken; relationships are not straightforwardly hierarchical; lived life is idiosyncratic and even exotic (Howard et al., 2006). The grandparent-grandchild relationship is an example of a set of complex social interactions. Technologies for strengthening bonds within separated families have to fulfil hard-to-define goals such as "being playful", "engaging over distance" and "having fun". Such social goals, which can be ambiguous, non-instrumental, subtle and long term (Paay, Sterling, Vetere, Howard, & Boettcher, 2009), are difficult to describe in ways that can be easily appropriated by development teams. Development tools typically deal best with clearly defined, hierarchical goals that endure over a specified time. Domestic and social goals do not fit well with traditional development tools.

In this paper we are concerned with a particular type of social goal—the goal of having fun. Fun comes in many ways and there are endless possibilities of how fun can be realised between people. Fun and enjoyment are as important in the home and leisure context as productivity and efficiency are in the work context (Blythe, Hassenzahl, & Wright, 2004). Therefore, research about positive emotions around technology use is becoming increasingly important (Hassenzahl, 2003; Hassenzahl, Heidecker, Eckoldt, Diefenbach, & Hillmann, 2012). We are particularly interested in how domestic technologies mediate the shared experiences and emotions such as having fun and joy in the social interactions between grandparents and their grandchildren.

In addition to the challenges faced by developers of domestic technologies in adequately addressing social goals, the intergenerational problem presents unique challenges. Catering for specific needs of the young as well as for the old and involving them in the design process is problematic. This is complicated further when the intergenerational relationship is nurtured over a distance. Since human activities cannot be well understood if separated from the social domestic context where they take place (Hagen & Robertson, 2009), a further challenge is adequately addressing this situational context. Therefore, methods, tools and techniques involving end users must be sensitive to the very young and the very old, and must address activities undertaken when participants are not co-located.

In order to create fun domestic technologies and to inform software development, we need methods that are able to carry the complex, abstract and often ambiguous insights of field data collections into the development process. Social needs are often neglected in existing software engineering processes (Sommerville, 2007; Viller & Sommerville, 2000). This implies that actively including developers in the user-centred design process will lead to improved outcomes. However, to do this we need a way to communicate the insights from fieldwork with artefacts that are shared by all three stakeholder groups—the field researchers, the software engineers and still carry the voice of the user.

This paper examines a user-centred design activity that extends notions of participation. Field researchers facilitating active user input about their needs and routines around domestic technology use, and technology developers responsible for interpreting the user data for actual technologies, share the purpose of creating human-oriented technology but face different challenges. They are also participating stakeholders in the design process. Thus the participants of this study are not only grandparents and grandchildren, but also include field researchers and software developers. We aim to provide new insights into the broader inclusion and idea exchange of different stakeholders in the design of social technologies in the home.

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Shared Artefacts as Bridges between Stakeholders

Design is a team activity that often involves many stakeholders in order to develop products that are meaningful—in our case meaningful to the private lives of grandparents and grandchildren. Models from Agent-Oriented Software Engineering (AOSE) have successfully been used as shared communication artefacts between stakeholders (Paay et al., 2009; Boettcher, 2006). They offer a high-level view for representing, exploring, and discussing overall user goals. AOSE models are a tool for representing and discussing user motivations for different stakeholders and serve as a communication artefact between fieldworkers and software engineers. For field researchers AOSE models are a place to abstract to and record complex social goals. For software engineers AOSE models are a starting point to discuss the meaning of requirements for social interactions for developing novel technologies for the domestic domain (Pedell, Miller, Vetere, Sterling, Howard, & Paay, 2009). As they are suitable to record the activities of domestic users we see them as an opportunity to become a means of communication or specific kind of boundary object (Star, 1989) between the users and software engineers.

As AOSE models represent high-level abstract concepts they are likely to be unsuitable for direct discussion with domestic users – in particular with young children. But how do we then ensure that the models are more than just a participatory artefact between field researchers and software engineers, but can also be seen as a shared artefact with the grandparents and grandchildren during the design process; representing their voice and needs?

In our project the direct participation of the grandparents and grandchildren happened via the installation of three *technology probes* (Hutchinson et al., 2003). Technology probes are prototype-like devices that are specifically designed to collect participant data and motivate redesign (Arnold, 2004; Rouncefield, Crabtree, Hemmings, Rodden, Cheverst, Clarke, Dewsbury, & Hughes, 2003; Hemmings, Clarke, Crabtree, Rodden, & Rouncefield, 2002). Technology probes are also well suited to participatory approaches to design (Graham & Rouncefield, 2008). Through their ability to capture the nuanced aspects of everyday life, the results of technology probe analysis offer a useful starting point for the software development process. The technology probe results can be re-expressed in terms of the AOSE models which are well understood by the software engineers.

The three technology probes were motivated by the AOSE goal model (See Figure 1). The probes used synchronous touch screens and mobile phones for displaying and sending photographs, stories and messages that were shared among the grandchildren and grandparents' households. Consistent with notions of technology probes (Hutchinson et al., 2003), our probes were simple to use and constrained the user as little as possible, thereby facilitating flexible interactions without strict assumptions about how technology was meant to be used. The data gathered using probes is fragmentary and unstructured, thus the process of translating field data to the abstract generalisation required in development is difficult. In order to facilitate this transition the field data was analysed with and represented in AOSE models—the artefact through which field researchers and software engineers communicated about the needs of the grandparents and grandchildren.

This paper describes how we used the AOSE goal models to create a communication mechanism between end-users, field researchers and software engineers (who then used the models as tools for analysis and for data representation). The envisioning of the future technology takes place with help of the technology probes we used. Via the interaction with these probes, social practices and needs can be explored and then communicated in interviews. The grandparents in particular had a direct impact on future design as co-designers as these needs then have been translated into features of a technology. Importantly this approach does not require participants to be removed from their social domestic context. Users remain in their own world—in the home.

The technology probes do the work of involving the user. When combined with the AOSE models and the field data, these shared artefacts help stakeholders move between the worlds of activity, design and development. That way the artefacts become bridging elements or "information vessels" (Paay et al., 2009) that allow the social activities in the home to permeate discussions of field researchers and software engineers.

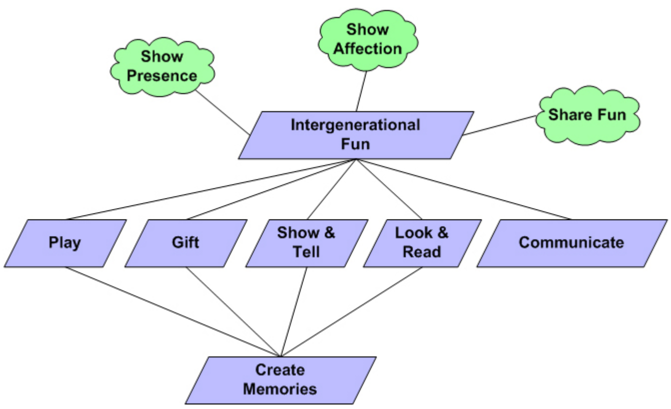

Figure 1. AOSE Goal model representing intergenerational fun.
Goals are represented as parallelograms. Quality attributes are represented as clouds.

Aims

In this paper we explore the role of agent models, technology probes and field data to provoke shared conversation among different stakeholder groups. In interleaving shared artefacts from fieldwork and agent-oriented models we expect knowledge can be more easily shared and common understanding can be more readily achieved. In doing so we aim to broaden participation in the design process with methods, tools and techniques to explicitly include field researchers and software engineers.

We aim to establish tools that facilitate the inclusion of three major stakeholder groups into the design process. These stakeholders are the users of domestic technologies (i.e., the grandparents and grandchildren), field researchers, and software engineers.

Domestic users are the grandparents and grandchildren who interact with technology probes in their homes. The technology probes loosely embody the goal models. Thus the high-level goals can be explored through the daily use of the technology probe. The users do not deal with abstract AOSE goal models directly but via the technology probe. Active involvement is leveraged directly from in-situ social activity. Grandparents and grandchildren contribute in our process by interacting with each other and engaging in social activities such as playing and gifting. Questions concerning technological design and development are present (because of their use of the technology probes informed by the goal models) but they remain background issues. Our approach ensures that their primary focus remains on the communication and interaction with their family members—an interaction that motivates the use of technology in the first place.

Field researchers collect rich field data and use the AOSE models (See Figure 1) for analysing this data. Their aim is to learn more about the high-level abstract goals of the models and to gain a deeper understanding of the goals' implications, with respect to use and design of domestic technologies. The AOSE model provides a very simple structure to be "filled in" and exemplified by field researchers with concrete instances of use behaviour and their meaning for the grandparent-grandchildren interaction.

Software engineers use the models to understand and define high-level requirements in domestic use. Via the AOSE models the software engineers have a connection to the domestic users without necessarily communicating directly with them. With the help of the examples represented as instantiations of the goals they are able to gain an understanding of technology use at home. As the data is based on probe use and the probes are based on the models the results can be understood by engineers in terms of models they are familiar with as well as technologies they have helped to develop. Both technologies and models are artefacts well known to software engineers and the close relationship between the models and the probe technologies was expected in helping to understand and structure more detailed descriptions of their use.

The three stakeholder groups each participate in the design process. They contribute crucial knowledge and skills to technology development that needs to be made available and shared with the other two stakeholder groups. All these stakeholder groups have their own perspective, needs and language to express this knowledge and these skills. Our aim is to explore in more detail the tools and methods that make a shared communication and transfer of knowledge between different stakeholder groups in the domain of domestic technology development possible. The next section explains what the agent-oriented models look like and the benefits we see in using them for analysis.

Tools for Communication

The tools we are using are agent–oriented goal models, the technology probes and the field data (interviews and logged data). These are described in the following sections.

Communication Artefact 1—*Agent-oriented Model*

We use AOSE models to record high-level goals for social use of domestic technology. Goal models are useful at early stages of requirements analysis to arrive at a shared understanding (Jureta & Faulkner, 2007); and the agent metaphor is useful as it is able to represent human behaviour. Agents can take on roles associated with high-level goals such as "playing" or "gifting" represented in the model. Therefore they are suitable to represent rich data and complex social concepts. In doing so they are a starting point for agent-oriented system development (Sterling & Taveter, 2009). Importantly, AOSE goal models can provide an account for a social concept such as intergenerational fun. The goals depicted as parallelograms shown in figure 1 represent meaningful activities in the grandparents-grandchildren interaction. This high-level model evolved from former field studies with grandparents and grandchildren (please refer to Paay et al., 2009). The quality goals represented by clouds are intentionally ambiguous high-level attributes that are often subjective, context-specific and imprecise. We include such quality goals as part of the design discussion and maintain them as social concepts while discussing high-level requirements of a system. For this purpose the AOSE goal models have to be simple yet meaningful enough to represent the goals of social interactions.

The goal models have proven to be useful shared artefacts for software engineers and field researchers in other projects for high-level requirements elicitation (Paay et al., 2009). In this paper we explore the interrelation between three artefacts (AOSE Models, Technology Probes and Field Data) in more detail with the aim of enabling inclusion of other stakeholders, specifically the grandparent and grandchildren to voice their point of view in the design process.

Benefits of Goal Models in Technology Design

The agent-oriented models are particularly suitable to be combined with technology probes in field studies. Firstly, we see agent-oriented models as a suitable way to express field data. As data gathered using probes are fragmentary and unstructured, the process of translation from field data to the abstract generalisation required in development is difficult. A process of combining technology probe data collection and agent-oriented models allows us to talk about intangible outcomes; such as that arising from fieldwork, which can be surprising, complex, but subtle. The agent-oriented models provide a place where abstract design concepts can be collected and represented (Pedell et al., 2009). They are a lens through which use activities can be analysed and recorded and then discussed among researchers and software engineers.

Secondly, AOSE models are part of a development methodology and can be combined with motivational scenarios, roles and domain models (Sterling & Taveter, 2009), each of them describing and providing context of the domain. Context is key in understanding social activities. Therefore, it is necessary to record and represent context in order to prevent this important part of the data being lost after the data analysis (Hemmings et al., 2002; Hagen & Robertson, 2009).

Communication Artefact 2—*Technology Probes*

We built three simple applications that were inspired by the intergenerational fun model from figure 1; *collage*, *electronic magic box* and *storytelling*. All three applications included technology probe capabilities as we wanted to explore the high-level concepts of "playing", "gifting", "show & tell", "look & read" and "communicate" in more depth. Although all probes have a specific focus we expected that all high-level activities could be explored with all three applications, giving a rich picture about the variations and instances these activities may take on.

At the beginning of the field study neither the researchers, software engineers nor the grandparents and grandchildren had a clear idea about how the final technology would look like. It was particularly important to engage the older grandparents in simple technology use first that they could confidently handle in the interaction with their grandchildren to ensure that future design is grounded in a thorough understanding of users' experiences, requirements, and preferences (Lindsay, Jackson, Schofield, & Olivier, 2012).

Generally, it is important that technology probes are able to collect data about use to inform a better understanding not so much about how to improve the technology but the actual needs in supporting specific activities (in our case activities evolving around building and maintaining the relationship of grandparents and grandchildren) within this domain (also see Hutchinson et al., 2003).

Collage: The first technology probe that was introduced in the participants' homes' is collage; a shared domestic display using mobile camera-phones as an input device and a touch screen for synchronous interaction between family members. Via the phones, photographs and text messages are sent to the touch screens simultaneously. The photographs and messages provide a constant presence, flowing down continuously on the screen (older pictures are smaller than new pictures and shown less frequently), much like a waterfall. These objects can be stopped, moved around, enlarged and arranged (See Figure 2). *Collage* enables a sharing of often serendipitous interactions without being intrusive. *Collage* facilitates particular simple forms of playful interaction and communication via the shared touch screen.

Figure 2. Collage.

Electronic magic box: The second technology probe allowed the sending of a treasure box that could be filled with photographs and messages. As shown in figure 3 the box is placed in a forest of fern trees and appears either closed (a new box has arrived) or open (no new box has arrived). A scroll either sealed or with a broken seal indicates if the box in the other household has been opened and the content been looked at. In order to be able to access the content the receiver has to play a maze game to 'find' and open the box. An opened message can be saved in a collection book. Emphasis in this application was put on the goals of "gifting" and "playing".

Figure 3. Electronic Magic Box.

Storytelling: The third technology probe specifically explored the goals "show and tell" and "look and read". The application contains an open audio channel, electronic books, crayons and photographs that are sent directly to the synchronised storytelling system via the mobile phones. Any member of one family can initiate a storytelling session. The photographs then collapse to the bottom, thus providing some shared space for opening electronic books. During reading sessions the pencils and photographs can still be used in order to complement the chosen story or build the basis of a made-up story on empty pages (See Figure 4).

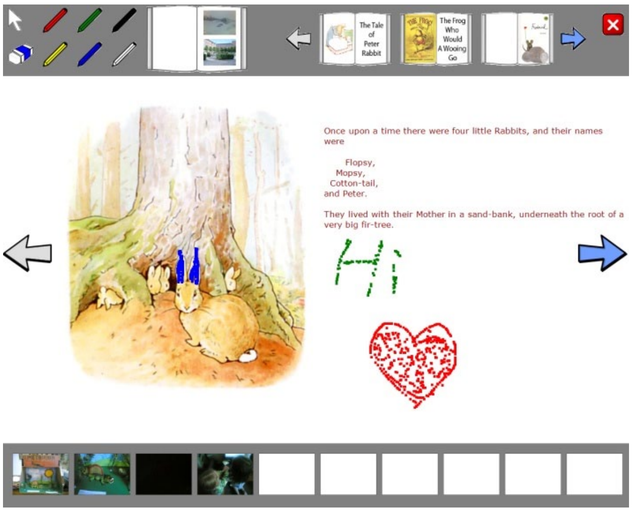

Figure 4. Storytelling.

The probes were seen as instances of the goal model. While each of the three probes had a focus on certain activities they all aim to achieve the high-level quality goals to “show presence”, to “share fun” and to “show affection”. These high level qualities are seen as overarching all the activities and are all seen as key to any kind of grandparent-grandchild interaction.

The three probes also had logging capabilities (as is typical of technology probes) to monitor and record the use of the application. The interactions of all three systems, the messages and photographs were saved on different servers.

Benefits of Probes for Technology Design

Probes are particularly suited to investigating people’s everyday life in situations difficult to reach with traditional social science methods such as questionnaires, interviews, focus groups or participant-observation. Rather than relying on the presence and intervention of the researcher, probes are designed to encourage and empower subjects to collect data themselves (Arnold, 2004). The participants use the probes to provide some insight, at their discretion, about their daily lives.

Personal information and story generation are two important benefits that we see in the use of probes as artefacts contributing the users’ point of view. Due to their logging functionality technology probes ensure that participation of their users is highly visible and can be recounted (Graham & Rouncefield, 2007).

Communication Artefact 3—*Field Data*

The field data includes data from interviews and logs from technology probes. This data is seen as an important participatory artefact, particularly for the field researchers. With the help of field data we are able to illustrate a number of pathways from the goal model to the applications. In matching the data from the probe study to the overall goals we were expecting to find out how well the mapping between models and the concepts in reality is done. This way we can learn about the goals, improve the mapping to the technology probes (if necessary) and get a more detailed understanding on the capabilities of the models as a shared artefact between field researchers and software engineers. The field data is the communication artefact of the field researcher.

The three participatory artefacts are highly inter-dependent. All three artefacts carry information about grandparent-grandchildren interactions. The models encapsulate the information in an abstract language and the field data in a detailed, descriptive yet fragmentary language. Both emerge from the probe interactions. Table 1 gives an overview of the different participating groups, the artefacts and the environments the different stakeholder groups are located in.

Table 1. Overview of artefacts, participants using the artefacts and their environments.

Participating Stakeholders	Environments	Artefacts
Software Engineers	Software Development	AOSE Models
Field Researchers	Design	Field data
Grandparents & Grandchildren	Use in Domestic Settings	Technology Probes

The Intergenerational Fun Study

Study Design and Participants

We are seeking to understand how grandparents and grandchildren can utilise technology to interact in a fun and meaningful way, especially when the two parties are geographically separated. This is a particularly challenging problem because we must account for two groups who are from different generations and who have experienced technology in different ways. Furthermore, young children are generally unable to read and write, so standard communication technologies such as email do not facilitate such interaction; nor are they particularly fun! To support the parallel investigation, we enlisted three different extended families in a total of six households—that is, three sets of grandparents and their respective grandchildren—in which the grandparents and grandchildren had an existing strong and loving relationship, but were not part of the same household. Two families had two of the probes installed in their home and one all three (one of the probes in one family at a time). Every application was installed in the home between three and six weeks (See Table 2) over a period of four months. All families were living in the city of Melbourne between thirty minutes and an hour’s drive apart. All grandparents had regular contact with their grandchildren (at least once a week) and all of them described having a strong and loving relationship.

We introduced the three probe technologies to the families. Family one consisted of an 8 year old girl living with her mother, about 12 kilometres from her grandmother. Family two consisted of three grandchildren of the age of 18 months, 6 years and 8 years, living with their parents about 8 kilometres from their grandparents. Family three consisted of two grandchildren aged 5 and 6, living with their parents about 16 kilometres from their grandparents.

Table 2: Application of the three probes per family.

	Technology Probes		
	Collage	eMagic Box	Storytelling
Family 1	6 weeks	6 weeks	-
Family 2	3 weeks	3 weeks	6 weeks
Family 3	3 weeks	-	3 weeks

Data Collected

Interviews

We conducted three to four interviews per household about the probe use (usually grandparent household and parents/grandchildren household separately) leading to twenty interviews altogether. The parents being present in the grandchildren interviews were an important source of information as they were observing the ongoing interactions without being directly involved and were able to make comparisons on the basis of how the interactions happened without the introduced technology probes. During the interviews we did not ask for goals such as "playing" or "gifting". These goals are implicit in the system. We were more interested in the actual interactions and how the qualities were judged by the participants. For example we would ask: "what kind of interactions did the system support?" and "what activities did you particularly enjoy?"

Technology Probe Data

- *Collage:* Logs of interactions (movements of all objects and times), 700 pictures and 80 text messages for three families
- *Storytelling:* 6 hours of audio-recordings, logs of interactions (drawings and movements of all objects) across two families
- *Electronic magic box:* 102 boxes (electronic letters and photographs) and sending times for two families

Mutual Understanding via Collaborative Analysis

Using AOSE Goal Model as an Analytical Lens

The interviews, photographs and messages (text messages and electronic letters) were analysed using content analysis according to Patton (2002). The probe data of each application and the interviews were analysed focussing on the main goals and quality goals as overarching themes. This procedure enabled us to find sub-themes for all the goals and therefore to learn more about typical activities between grandparents and grandchildren per theme. Each sub-theme was expanded by compelling examples and instances of these goals in the specific context of intergenerational fun using the three applications. The photographs and messages were downloaded from the servers and analysed weekly. The movements and interaction times were not analysed at this stage.

The findings were reported back to the overall team during the weekly team meeting. The high-level goals were discussed in the light of the newly reported data. This way the goals enabled the whole team to learn more about the high-level goals, but also reflect on the data from their own perspective and feed these thoughts back into the team discussion. As the goal models are suitable to record the activities of domestic users we see them as an opportunity to become a means of communication or specific kind of shared artefact between the users and software engineers. The models in combination with the field data enabled both stakeholder groups to express their understanding in different ways and to collaboratively discuss the meaning of the collected data. As domestic users usually find it very difficult to describe what the meaning of their activities is in abstract terms when dealing with a diffuse overall goal such as fun, we ensured that their focus remained on the communication and interaction with their family members, but attached their use stories to the goals in large detail.

Stakeholder Discussions as Data Source

As the team met once a week and discussed the field data, the role of the probes and the models, these discussions themselves were seen as a data source and all recorded and transcribed to investigate how the three artefacts led to a better mutual understanding between the three stakeholder groups. The interviews, being one main data source, comprised the strong voice of the users; the grandparents and grandchildren. Software engineers and field researchers participated both in these interviews and brought their interpretation of the data to the table.

The multidisciplinary team went through a process of analytic conversations in respect to unpacking the field data that was collected, and in the further understanding of goals and quality goals and identification of new goals within that data. This process involved several steps of understanding the field data, refining the goal models and eliciting user needs to be formulated into high level user requirements similar to the procedure previously applied by Paay et al. (2009). The field data as well as the goal models played a central role in the team meetings, in knowledge transition and documentation (as records of analytical outcomes serving as design rationale) and as starting points for discussing different interpretations.

The meetings gave the software engineers the opportunity to participate in discussions of the technology probe returns, as well as becoming familiar with the various forms of data being collected that they would need to understand to conceptualise the development of a novel technology. In addition, whenever possible the software engineers were invited to participate in the interviews with grandparents and grandchildren to hear about the data personally and firsthand. The involvement of software engineers in the field data collection as well as the analysis of the data within multidisciplinary teams are both recommended methods for bridging the gap between field research and software engineering (Diggins & Tolmie, 2003).

In order to inform innovative design, the field researchers analysed the data to find clues about how grandparents and their grandchildren related to each other via the probe use and how a novel technology might support that. The field researchers deliberately searched for scenarios that were outstanding, unexpected and interesting; life snippets that were difficult to describe and events that inspired them to further discussions. They looked for shared activities that they considered uncommon using current communication technologies, which could help them make sense of the family relationships in the domestic space that supported goals such as "play" and "show affection". They intentionally tried not to condense and simplify the data because they wanted to maintain the richness, subtleties and complexity of family relationships. For the field researchers, the results from the field study were the detailed stories about unexpected technology use and life routines of each family.

The model was the main shared artefact for recording the emerging understanding of the grandparent/grandchild relationship. Due to its relative simplicity it became the central information source around which conversations about meanings, motivations, interpretations and the family anecdotes were attached. Hence, the field researchers used the model as structure or reminder for underlying stories, examples and scenarios to document their rich and concrete findings. The significance of the model as a record for the software engineers was in the actual terminology used for the goals. The engineers used these words to abstract and generalize the findings with their underlying stories. They were looking for the kinds of roles that people were taking on in these stories and what was motivating their exchanges, for the purpose of capturing these as goals in the models. These stories provided memorable examples that helped the software engineers to identify and represent them as roles, goals and quality goals in the models. Overall, the goal model facilitated conversations between software engineers and field researchers by sharing their understanding of the rich data and spinning ideas off each other pointing towards innovative technology solutions.

Results on Domestic Technology Use

In this section we describe the data from the technology probe use. Some of the sub-themes that were found are illustrated on the example of the goal "play" and the quality goal "show presence".

Play (Goal)

Disruptive Play

Our data showed that grandchildren, during storytelling sessions, tried to be disruptive in several ways. For example, the grandchild wiping off the writing of the grandfather as soon as it appears on the screen (See Figure 5) another child flicking the pages before the grandfather has a chance to read them out aloud. These interactions are leading to a type of play, even though it is a disruptive way of play. It is being naughty in a safe way because the other person is not in the same room. Disruptive play is one example of playful engagement and according to our data it is quite a typical one during storytelling sessions. It is also typical for the interactions with *collage,* when carefully arranged patterns are purposely dissolved on the screen or participants conduct a "tug of war" over a picture. This kind of engagement often leads at a first glance to annoyance on the grandparents' side, but looking closer into it, disruptive play is a way to engage on a very emotional level and annoyance was immediately followed by laughter on the grandparents' side. Sometimes grandparents would counteract this teasing behaviour in a humorous manner. For example, one grandfather would just "keep reading" as he knew the story by heart despite the child having flicked the pages or even changed the book. Another strategy of the grandparents was to simply read whatever was in front of them without paying any attention if it made sense or not. These resulting incompatible snippets of storyline would lead to fits of laughter on the grandchild's side. The way the grandparents responded to the playful disruptions showed how both sides could make positive use of the technology and build on their relationship in having fun together in a purposeful way that was not tied to the conventional use of the system's functions.

Figure 5. Using the eraser function in the storytelling probe.

Non-competitive Play

Regarding the disparity of the age of the young participants it was seen as advantageous that the applications provided opportunities to play without rules and without winning. Everybody could just respond however they wanted to without anybody being "on top" or the winner. The age difference between the children did not really matter as they could participate equally. The systems were accessible to all of them and initiation and length of interactions was not in any way determined. One of the grandmothers expressed it this way: *We were participating more as equals in the interactions more than if you would play "Connect4" or "Tic-Tac–Toe", because the adult has the advantage of being able to see a bit further ahead and the child can't in the same way. You could do whatever you wanted what is good for kids like Andrew who cannot lose.* This way every participant could not only take control of whether to join the game, but also control of how to participate.

Made Up Games—Guessing Games

A form of play that took place equally in all three applications were simple guessing games such as "Joe added two extra photos, see if you can find them!" and guessing what a photo showed. The solution was, for example, a detail of the house, a fried breakfast toast or a half-hidden animal photographed in the garden. With the call "who is hiding underneath?" Family members were encouraged to guess or to move pictures that were piled on top of each other in *collage*. Such games would involve all family members such as one where one family took photographs of their feet either barefoot or wearing another family member's shoes (See Figure 6). These games are not directed at one particular person in the household but for all to share and to react on.

Figure 6. "Whose feet?"—Shared play via collage.

Playful customs continued over distance

Other games were directed from one family member to another, often taking up shared experiences or little customs established among them. One of them is the "high five" between the 18 month old granddaughter and her grandfather, performed whenever they met face-to-face. This customary handshake was replicated via the two touch screens, depicted with a photograph and accompanied by a sent text message from the grandfather "give hand, grandpa" (Figure 7—see photograph on the left) and a response photo (Figure 7—photograph on the right). Another custom was the imitation of character voices in the *storytelling* system. While this is customary during co-located reading sessions it took a new level over a distance. One children's book featuring a little monster was read with such impressive loud growls by one grandfather that it caused real irritation at first with the grandchildren (as they had never heard anything like this from the grandfather) to become quickly the favourite book of the family causing tears of laughter in the grandchildren household. The mother confirmed how much fun this interaction caused: *I will miss hearing Lilly and Jen laughing so hard when grandpa was reading and growling on the other end.*

Figure 7. The handshake: "give hand grandpa".

Show Presence (Quality Goal)

Constant Presence

All three applications contributed to a feeling of presence of the family members in the other households—although this quality played out in different ways. *Collage* was seen as a constant subtle presence, a reminder of the grandparents or grandchildren. One grandmother expressed it this way: "*Collage made me feel closer to them—as if they were in the next room* and *Photographs would suddenly appear and I would think about the grandkids when otherwise I wouldn't have*". In particular it is the depiction of people themselves that creates this presence for one of the grandfathers: "*My favourite photographs are where all three kids are seen at the same time—these pictures are so precious to me! [...] I encouraged the kids to send more people pictures not only objects*". The photographs were also a way to build up anticipation that would lead to regular checks from both sides to see if there were new pictures on *collage*. Even though there were not always new postings this activity was some time spent thinking about the other.

Immediacy

The most excited that grandparents would get was when they could see pictures on *collage* from their children and grandchildren while they were away on holiday. They were able to participate in the loved ones lives over a distance while things were happening (e.g. photo of the plane or from the beach) and did not have to wait until their grandchildren returned from vacation. This was for them a new experience of immediacy that they did not have without the system. *Storytelling* was seen by all of the grandparents to have a quality of "immediacy of interaction": *"Collage reminded me. So the Collage is probably more about what it does for ME whereas the Storytelling is more about what it is doing in an immediate way for the relationship"*. Similarly the children had a more concrete perception of the "grandfather being on the other end" while using *storytelling*. According to all parents the actual time of co-presence in the system was longer than interacting on the phone, for example. The *electronic magic box* only indicated presence. Kids would be excited looking if a new box had arrived, but if the exchange would take too long (no box arriving within a day) then they would lose interest and not look anymore for a box, or the parents would call to prompt grandparents to send something.

Children enjoyed playing the maze game, but grandparents were not interested in this kind of activity as it did not involve any direct interaction or shared presence with their grandchildren and so the grandparents were only interested in the box content itself. We have found that different applications and activities can contribute to the quality of "showing presence". Presence can have facets that are different but equally important such as *instant or immediate interactions* (*storytelling*) and *subtle cues or reminders* of the other being there (*collage*).

Obscured Presence

Other forms of presence that were also part of playful and fun interactions were facilitated by the storytelling system. While the grandchildren were always very obvious and clear about their actions, the grandparents sometimes liked to obscure or exaggerate their presence. One grandfather would scribble something on the screen but pretended not to be the cause of this action. Although the grandchild suspected the grandfather she was not really sure and this behaviour led to a conversation of "who really had used the crayon". In another example one grandfather pretended he could see the granddaughter through the system. The granddaughter would believe this as they could see the same pictures. To avoid being seen she would hide behind the screen assuming the camera was on the front (as she was used to from Skype). The grandfather would play along and reinforced her belief that he could see her. This little interaction was similar to "hide and seek" over a distance but could not be maintained as the granddaughter understood after a while that there was no camera, but it remained a nice memory for both of them and they would keep referring to it later on.

The extensively described step of engaging grandparents and their grandchildren in use activity helps not only to focus on the role and functionality of the application, but to learn about subtle social interactions mediated by technology. Learning from the technology probes helped us to understand the needs of the grandparents and grandchildren, specifically the way they want to communicate to each other over a distance.

Informing New Technology Design Based on Field Study Data

The three technology probes allowed us to focus on individual aspects and simplify interactions and then use the data gained to help shape the interactions in later technology design. Trying to define the interactions upfront would have been very difficult. It was the actual family interactions and the high degree of which all families were willing to reveal their family life and personal feelings about technology use via the engagement with the three technologies that led to these insights. The personal exchanges enabled us to build a more complex prototype. We collated what we learned about our domain and used this information to build a system for supporting intergenerational fun.

To build this improved system, we studied the goals that describe the high-level goals from our model, and specified sub-goals in our data analysis that describe specific functionality of the three technology probes, while focusing on the related quality goals. A step like this requires us to make decisions about the system design, and these decisions are based on the understanding contained in the agent-oriented goal model. As an example, consider two sub-goals of the goal play from Figure 1: "disruptive play" and "non-competitive play". To support these goals and their related quality goals, specific functionality is required, but also a good understanding of the grandparent–grandchild interaction. These sub-goals describe functional goals to achieve their parent goal. To negotiate fun play, the technology should be made as flexible as possible to cater for interactions with children of different age groups enabling equal participation. In the new system, we attempted to leave the users' actions unconstrained. In the *storytelling* system, the most important feature is that anyone can control the story, allowing the grandchildren to playfully disrupt the grandparents. This was not the intended use of the *storytelling* application, but it ended up being important as it facilitated an experience of power for the children that they did not have in face-to-face interactions. Technologies that are able not only to support existing family interactions, but are able to go the step further to new forms of (desired) interactions hold real potential. Not all use can and should be predictable to give space for such new patterns of use. The future evaluation and use of this system trying to complement the best of both systems will give further insights on technology development. The system also needs to cater for different interests. While children are interested in playing by themselves grandparents are interested in the presence and shared play with their grandchildren only.

We also learned from the technology probes that social systems, especially those involving both young and elderly participants, must allow the users to build up their confidence. More experienced computer users, especially those familiar with applications such as telephony software, were comfortable with the *storytelling* application, but some of the grandparents not having used technologies before preferred *collage*. Confidence turned out to be so important that is was added later on as separate goal to the goal model. As a result, our new system starts in a simple Collage-like mode of a waterfall of photos and messages, and supports additional functionality that can be built up after mastering the initial functionality. For example, once the users have mastered the uploaded of photos and playing around with them on the touch screen, they can bring up a virtual crayon palette and draw on the photos.

All three systems allowed distant intergenerational interactions between grandparents and their grand-children contributing in a positive way to the relationship and even complementing face-to-face interactions as families would talk about their remote interactions when catching up face-to-face.

With these results, researchers were able to view the important qualities in the light of the use activities dealing with the different technologies. Hence, the technologies were built with the qualities of “share fun”, “show presence”, and “show affection” in mind—the results can be interpreted as a lightweight evaluation of these qualities. The fun qualities being deeply rooted in family values have been confirmed as being a relevant outcome of interactions such as playing and storytelling. The systems and the results obtained from them, allowed us to gain an even better understanding of intergenerational fun and aspects for a strong tie grandparent-grandchild relationship.

The results section described different kinds of intergenerational play as an example of one activity contributing to intergenerational fun. Fun qualities such as “show presence”, “show affection” and “share fun” were analysed in the light of the interactions with the technologies. The strength and weaknesses for each technology probe was better understood in reflection on the fun qualities. Different families favoured different technologies depending on size of the family, age of the children, individual preferences, family routines, and technology experience.

Using the results of this study, we have produced a more detailed goal model in order to inform a system for intergenerational fun.

Discussion

Interrelations of the Different Artefacts

Our aim was to provide shared tools of communicating for technology design that led to increased contribution and understanding across stakeholder groups in data analysis and development. The close relationship between the artefacts used to share information relevant to design was ensured by firstly building all three probes with the high-level goals and qualities of the model in mind and then using the models as a lens for analysis of the field data. The repetitive use of the models for development, analysis and then representation created a close link between the other two artefacts and the goal models. With every team discussion a little bit more about the goals of the models was learnt by the software engineers and field researchers. Examples of social interactions between family members were accumulated in sub-themes, while the goals themselves remained in a simple high-level view. Relating the artefacts in this way broadened participation among multiple groups and facilitated a shared understanding of social interactions of grandparents and grandchildren for design.

There were a lot of contact points between the artefacts and the participants and the way they shared information: The field data was owned by the domestic users and shared with the field researchers during the interviews and via the logged data. The AOSE models have allowed us first to create and then use the technology probes, allowing more participation of the domestic user. There was also a strong connection between the field data and the models due to the way the models were used for analysis. We found a strong ownership of the models by the software engineers as they are able to use the models as a starting point for development (Sterling & Taveter, 2009). The meaning of the goal model was negotiated and discussed with the field researchers leading to a shared understanding. All three stakeholder groups were able to communicate via at least one of the design artefacts to the other stakeholders. Because all three artefacts were interleaved and closely connected they served as a bridging element between the stakeholders and communicated similar information. Using three artefacts with highly overlapping information helped the three participant groups to communicate with each other, to mediate information and broaden participation. All three artefacts together served as concrete reflections of a set of interactional data used for both analysis and design.

Here we discuss what we experienced as the gains from the different stakeholders involved using the different shared artefacts for the design process.

Between Field Researcher and Domestic Users

We saw some evidence of the benefits for the grandparents and grandchildren, as they were genuinely having fun together. Much of the essence of family life cannot be seen through the lens of productive activity or purposeful communication. We have to deal with different values and goals due to the fact that we deal with non-traditional users. We only can understand and support family life when we understand these underlying values of family life and follow what they consider as pleasant and enriching ways to spend their time with their loved ones—in this case their grandparents or grandchildren. Only when real fun interaction is happening can useful contribution to the design discussion take place, in the sense that useful data can be passed on to software engineers as something relevant for creating social requirements in technology development. Other benefits were an increased volume of interaction in all families; grandparents took a greater interest into the everyday life of their grandchildren and the grandchildren engaged much stronger via the different applications than they usually do on the phone. These genuine and beneficial interactions were communicated to the field researchers via the interviews and the logged probe data itself provided glimpses of these genuinely joyful interactions.

Between Field Researcher and Software Engineers

The agent artefacts took on a crucial role in the participatory conversation between the field researchers and the software engineers. The data collected provided rich examples for the different goals and helped to build a common understanding amongst software engineers and field researchers how complex social goals such as “having fun” are established by different domestic technology probes. This way the models delivered some context that often gets lost after the data analysis and helped to trace the design decisions based on the actual user activities. The goal model helped to trace examples and fragments of the data to design considerations. Consequently there was less “fishing” in a massive pool of qualitative data leading to more consistency in the process through the use of one high level artefact for orientation and discussion. The models acted as a guide for conversations without being too directive, but the structure could be used without causing immediate constraints. Results could be compared and explained against the model.

Let us take for example the high-level goal "play": Everybody has an idea about the meaning of play and can give examples. However, having three different probes allowed us to explore different facets of "play" in the context of intergenerational play at home. We looked at play from different technical angles in the light of interactions of grandparents and their grandchildren. The importance of "disruptive play" came as a surprise to the software engineers and was only understood with the rich examples given from the use of *collage* and *storytelling* as something positive. Furthermore "disruptive play" matched with the quality attribute "show presence". The consequence for development is not to simply provide games, but all sorts of opportunities to engage with each other in a playful manner. The discussed and enriched models were seen as a solid foundation by the software engineers for creating more accurate software requirements specifications, which is one of the main challenges in systems development (Pekkola et al., 2006).

Between Domestic Users and Software Engineers

The AOSE models are bridging elements between different stakeholders in the design process on two levels: not only between the field researchers and the software engineers, but also between the participating family members and the software engineers as the models represent the activities carried out by the grandparents and grandchildren via the three technology probes. The AOSE models have allowed us first to create and then use the technology probes allowing more participation of the domestic user and providing the software engineers with their personal stories about their relationships and how technology can mediate this relationship.

Conclusions

In this paper we explore the role of stakeholder participation in technology design when multiple groups are involved. Using three artefacts with overlapping information helped the three participating stakeholder groups to communicate with each other, to mediate information exchange and to deepen participation. Together, the three artefacts together served as concrete reflections of a set of interactional data used for both analysis and design (Muller, 2007).

It was shown that the participating families had positive experiences using the technology probes. Not only did this insight provide some indication that we are on the right track in designing technologies for intergenerational fun, but also provided some confirmation on the value of our model from participants' point of view. With the interview statements field researchers and software engineers were able to view the goal qualities in the light of the user activities. The results can be interpreted as a lightweight kind of evaluation of these qualities. Software engineers, who originally would not have been able to derive requirements or needs from the quality attributes themselves, could do so now as they understood them better in the light of the user activities. These qualities have been confirmed as being a relevant outcome of interactions such as playing and storytelling.

The next step in our research will explore the high-level goals and their application for intergenerational fun with the more complex prototype. In combining the insights of domestic use from the simple probe technologies involving a more complex technology we expect to be able to cover goals and quality attributes of the whole goal model in a more informed way.

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References

1. Arnold, M. (2004). The connected home: Probing the effects and affects of domesticated ICTs. In A. Clement & P. Van den Besselaar (Eds.), *Proceedings of the 8th Conference on Participatory Design: Artful Integration: Interweaving Media, Materials and Practices* (Vol. 2, pp. 183-186). New York, NY: ACM Press.
2. Balka, E. (2006). Inside the belly of the beast: the challenges and successes of a reformist participatory agenda. In G. Jacucci & F. Kensing (Eds.), *Proceedings of the 9th Conference on Participatory Design: Expanding Boundaries in Design* (pp. 134-143). New York, NY: ACM Press.
3. Blomberg, J., & Karasti, H. (2012). Ethnography: Positioning ethnography within participatory design. In J. Simonsen & T. Robertson (Eds.), *Routledge international handbook of participatory design* (pp. 86-116). New York, NY: Routledge.
4. Blythe, M., Hassenzahl, M., & Wright, P. (2004). More funology. *Interactions, 11*(5), 37-50.
5. Boettcher, A. (2006). Moving From Cultural Probes to Agent-Oriented Requirements Engineering", *Proceedings of OZCHI 2006* (pp. 20-24): ACM Press.
6. Brandt, E. (2006). Designing exploratory design games: A framework for participation in participatory design?. In G. Jacucci & F. Kensing (Eds.), *Proceedings of the 9th Conference on Participatory Design: Expanding Boundaries in Design* (pp. 57-66). New York, NY: ACM Press.
7. Brandt, E., & Grunnet, C. (2000). Evoking the future: Drama and props in user centered design. In T. Cherkasky, J. Greenbaum, P. Mambrey, & J. K. Pors (Eds.), *Proceedings of the 6th Conference on Participatory Design: Designing Digital Environments: Bringing in More Voices* (pp. 11-20).

Palo Alto, CA: CPSR.

8. Dearden, A., & Rizvi, H. (2008). Participatory IT design and participatory development: A comparative review. In D. Hakken, J. Simonsen, & T. Roberston (Eds.), *Proceedings of the 10th Conference on Participatory Design: Experiences and Challenges* (pp. 81-91). Indianapolis, IN: Indiana University.
9. DePaula, R. (2004). Lost in translation: A critical analysis of actors, artifacts, agendas, and arenas in participatory design. In A. Clement & P. Van den Besselaar (Eds.), *Proceedings of the 8th Conference on Participatory Design: Artful Integration* (pp. 162-172). New York, NY: ACM Press.
10. Diggins, T., & Tolmie, P. (2003). The 'adequate' design of ethnographic outputs for practice:Some explorations of the characteristics of design resources. *Personal and Ubiquitous Computing, 7*(3-4), 147-158.
11. Esnault, L., Daele, A., Zeiliger, R., & Charlier, B. (2009). Creating an innovative palette of services for communities of practice with participatory design. In U. Cress, V. Dimitrova, & M. Specht (Eds.), *Proceedings of the 4th European Conference on Technology Enhanced Learning: Learning in the Synergy of Multiple Disciplines* (pp. 304-309). Berlin, Germany: Springer.
12. Graham, C., & Rouncefield, M. (2008). Probes and participation. In D. Hakken, J. Simonsen, & T. Roberston (Eds.), *Proceedings of the 10th Conference on Participatory Design: Experiences and Challenges* (pp. 194-197). Indianapolis, IN: Indiana University.
13. Graham, C., Rouncefield, M., Gibbs, M., Vetere, F., & Cheverst, K. (2007). 'How probes work'. In B. Thomas & M. Billinghurst (Eds.), *Proceedings of the 19th Australasian Conference on Computer-Human Interaction: Entertaining User Interfaces* (pp. 29-37). New York, NY: ACM Press.
14. Hagen, P., & Robertson, T. (2009). Dissolving boundaries: Social technologies and participation in design. In M. Foth, J. Kjeldskov, & J. Paay (Eds.), *Proceedings of the 21th Australasian Conference on Computer-Human Interaction* (pp. 129-136). New York, NY: ACM Press.
15. Hassenzahl, M. (2003). The thing and I: Understanding the relationship between user and product. In M. Blythe, K. Overbeeke, A. Monk, & P. Wright (Eds.), *Funology: From usability to enjoyment*. (pp.31-42). Norwell, MA: Kluwer Academic Publishers.
16. Hassenzahl, M., Platz, A., Burmester, M., & Lehner, K. (2000). Hedonic and ergonomic quality aspects determine a software's appeal. In T. Turner & G. Szwillus (Eds.), *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 201-208). New York, NY: ACM Press.
17. Hassenzahl, M., Heidecker, S., Eckoldt, K., Diefenbach, S., & Hillmann, U. (2012). All you need is love: Current strategies of mediating intimate relationships through technology. *ACM Transactions on Computer-Human Interaction, 19*(4), No. 30.
18. Hemmings, T., Clarke, K., Crabtree, A., Rodden, T., & Rouncefield, M. (2002). Probing the probes. Domestic probes and the design process. In T. Binder, J. Gregory, & I. Wagner (Eds.), *Proceedings of the 7th Conference on Participatory Design: Inquiring Into the Politics, Contexts and Practices of Collaborative Design Work* (pp. 42-50). Palo Alto, CA: CPSR.
19. Howard, S., Kjeldskov, J., & Skov, M. (2007). Pervasive computing in the domestic space. *Personal and Ubiquitous Computing,11*(5), 329-333.
20. Hutchinson, H., Mackay, W., Westerlund, B., Bederson, B., Druin, A., Plaisant,C., Eiderbäck, B. (2003). Technology probes: Inspiring design for and with families. In G. Cockton & P. Korhonen (Eds.), *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 17-24). New York, NY: ACM Press.
21. Jureta, I. J., & Faulkner, S. (2007). Clarifying goal model. Conceptual modelling. In J. Grundy, S. Hartmann, A. Laender, L, Maciaszek, & J. Roddick (Eds.), *Proceedings of the 26th International Conference on Conceptual Modeling* (Vol. 83, pp. 139-144). Darlinghurst, Australia: Australian Computer Society.
22. Krömker, H., & Sandweg, N. (2001). Gestaltung von User Interfaces für Jedermann [Design of user interfaces for everyone]. *e&i Elektrotechnik und Informationstechnik, 118*(5), 262-266. Lindsay, S., Jackson, D., Schofield, G., & Olivier, P. (2012). Engaging older people using participatory design. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 1199-1208). New York, NY: ACM Press.
23. Markus, M. L., & Mao, J. (2004). Participation in development and implementation – Updating an old, tired concept for todays' IS contexts. *Journal of the Association for Information Systems, 5*(11-12), 514-544.
24. Miller, T., Pedell, S., Sterling, L., Vetere, F., Sterling, L., & Howard, S. (2012). Understanding socially-oriented roles and goals through motivational modelling. *Journal of Systems and Software*, *85*(9), 2160-2170.
25. Muller, M. J. (2007). Participatory design: The third space in HCI (revised). In J. Jacko & A. Sears (Eds.), *The human-computer interaction handbook* (2nd ed., pp. 1051-1068). Mahway, NJ: L. Erlbaum.
26. Paay, J., Sterling, L., Vetere, F., Howard, S., & Boettcher, A. (2009). Engineering the social: The role of shared artifacts. *International Journal of Human-Computer Studies, 67*(5), 437-454.
27. Patton, M. (2002). *Qualitative research and evaluation methods*. Thousand Oaks, CA: Sage Publications.
28. Pedell, S., Miller, T., Vetere, F., Sterling, L., Howard, S., & Paay, J. (2009). Having fun at home: Interleaving fieldwork and goal models. In M. Foth, J. Kjeldskov, & J. Paay (Eds.), *Proceedings of the 21th Australasian Conference on Computer-Human Interaction* (pp. 309-312). New York, NY: ACM Press.
29. Pekkola, S., Kaarilahti, N., & Pohjola, P. (2006). Towards formalised end-user participation in information systems development process: Bridging the gap between participatory design and ISD methodologies. In G. Jacucci & F. Kensing (Eds.), *Proceedings of the 9th Conference on Participatory Design: Expanding Boundaries in Design* (pp. 21-30). New

York, NY: ACM Press.

30. Robertson, T., & Simonsen, J. (2012). Participatory design: An introduction. In J. Simonsen & T. Robertson (Eds.), *Routledge international handbook of participatory design* (pp. 1-18). New York, NY: Routledge.
31. Rouncefield, M., Crabtree, A., Hemmings, T., Rodden, T., Cheverst, K., Clarke, K., Dewsbury, G., & Hughes, J. (2003). Adapting cultural probes to inform design in sensitive settings. In S. Viller & P. Wyeth (Eds.), *Proceedings of the 15th Australasian Conference on Computer-Human Interaction* (pp. 4-13). Queensland, Australia: University of Queensland.
32. Sanders, E. B. -N. (2000). Generative tools for co-designing. In S. A. R. Scrivener, L. J. Ball, & A. Woodcock (Eds.), *Proceedings of Conference on CoDesigning* (pp. 3-12). Dordrecht, the Netherlands: Springer
33. Sandweg, N., Hassenzahl, M., & Kuhn, K. (2000). Designing a telephone-based interface for a home automation system. *International Journal of Human-Computer Interaction, 12*(3&4), 401-414.
34. Sommerville, I. (2007). *Software engineering* (8th ed.). Essex, UK: Addison Wesley.
35. Star, S., L. (1989). The structure of ill-structured solutions: Boundary objects and heterogeneous distributed problem solving. In M. Huhns & L. Gasser (Eds.), *Distributed artificial intelligence* (Vol. 2, pp. 37-54). San Francisco, CA: Morgan Kaufman.
36. Sterling, L., & Taveter, K. (2009). *The art of agent-oriented modelling*. Cambridge, MA: MIT Press.
37. Viller, S., & Sommerville, I. (2000). Ethnographically informed analysis for software engineers. *International Journal of Human-Computer Studies, 53*(1), 169-196.