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Shared artefacts as participatory Babel fish
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ABSTRACT
We propose an interwoven set of shared artefacts for stakeholder participation for designing domestic technology for intergenerational fun. Our toolkit includes technology probes, associated fieldwork, and conceptual goal models. We used the high-level goal models, derived from Agent-Oriented Software Engineering (AOSE), as a template to analyse rich field data collected via three technology probes with grandparents and grandchildren. The goal models combined with technology probes and field data, provided a uniquely inclusive set of artefacts for the participation of stakeholders in the design process.

Author Keywords
Stakeholder participation, shared artefacts, agent-oriented modelling, domestic technologies, technology probes.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

CHALLENGES FOR PD IN DEVELOPMENT
Moving PD out of the office
Designing technology for the home is particularly challenging (e.g. Howard et al., 2006, Hagen & Robertson, 2009). Domestic technology is generally successful if it satisfies both functional and non-functional needs and if every member of the family from the very young to the very old is capable of operating and enjoying it (Sandweg et al., 2000). But there are characteristics of the home that make designing domestic technologies unique. Technologies for strengthening bonds within separated families must fulfil hard-to-define goals such as “being playful” and “engaging over distance”. Such social goals - which are ambiguous, non-instrumental, subtle and long term (Paay et al., 2009) - are difficult to describe and account for in ways that are appropriate for technology development. Development tools typically deal best with clearly defined, hierarchical goals that endure over a specified time frame. Domestic and social goals do not fit well with traditional development tools and Participatory Design (PD) processes. Here, 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 in the interaction between people. Fun and enjoyment are as important in the home as productivity and efficiency are in the work place (Blythe et al., 2004).

We are particularly interested in how domestic technologies mediate shared experiences and emotions, such as having fun and joy, between grandparents and grandchildren. We aim to provide new insights into the participation of a broader set of stakeholders in the design of social technologies in the home.

Placing users in the home
In addition to the challenges faced by technology developers to adequately address social goals, the move from users to inhabitants is not easy as domestic needs are often unspoken; relationships are not straightforwardly hierarchical; lived life is idiosyncratic and even exotic (Howard et al., 2006). In particular the intergenerational problem has unique PD challenges. The grandparent-grandchild relationship is an example of a set of complex social interactions and roles and it is not obvious what kind of technology supports a strong intergenerational relationship. 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 of individuals in the home. Therefore, PD methods, tools and techniques in our research must be sensitive to extreme age groups, and must address activities undertaken in the home when participants are not co-located.

Shared artefacts in the collective endeavour of PD
The PD community widely acknowledges that activities such as workshops, storytelling, performance techniques, games and prototyping improve understanding and communication between stakeholders (e.g. Brandt, 2006; Muller, 2007). However a main problem is how to share the results of participatory activities into the design and development process. This problem is exacerbated because there is often a lack of a shared language among multiple stakeholder groups (Markus & Mao, 2004; Pekkola et al.; 2006). Few PD methods explicitly look into the problem of transferring the results of field studies to those responsible for technological development (dePaula, 2004; Pekkola et al.; 2006). The role of software engineers and other technology designers as participants in the design process is poorly supported by PD approaches. Clearly, 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 participating stakeholders.

In order to create fun domestic technologies and to
inform software development, we need tools that are able to carry the complex, abstract and often ambiguous insights of field data collections into the development process. This means it is not enough to involve domestic technology users in a participatory way, but also to include the developers and to be able to pass on and discuss the insights from participatory design with the users to them. However, to do this we need a way to communicate the insights from fieldwork with artefacts that are shared by field researchers and software engineers and still carry the voice of the user.

**Living the tension brought on by multiple traditions**

Differences exist not only between technical and non-technical stakeholders, but also within 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). Field researchers facilitating participatory design activities, and technology developers responsible for interpreting the designs for actual technologies, share the purpose of creating human-oriented technology but face different challenges. Software engineers have their focus on future technologies and social needs are often neglected in existing software development processes (Sommerville, 2007). The researchers’ focus is on the current lives of people. Consequently there are gaps and disconnections that both professional groups have to make up in the design process. Thus the participants are not only grandparents and grandchildren, but also include field researchers and software developers. We aim to broaden participation in the design process to explicitly include field researchers and software engineers in order to bridge different professional worlds.

**PARTICIPATION OF THREE STAKEHOLDER GROUPS**

Our focus is to establish tools that facilitate the inclusion of three major stakeholder groups into the participatory design process. These are the users of domestic technologies, field researchers, and software engineers.

**Field Researchers** collect rich field data and use the models from Agent-Oriented Software Engineering (AOSE) models (Figure 1) for analysing these 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” by field researchers with concrete instances of use behaviour and their meaning for the grandparent-grandchildren interaction.

**Domestic users** are the grandparents and grandchildren who interact with technology probes (Hutchinson et al., 2003) in their home. Technology probes are specifically suitable for collecting data in the domestic domain (Arnold, 2004) and are seen to be participatory (Graham & Roucefield, 2008). Through their ability to capture the nuanced aspects of everyday life, technology probes provide an entre into the participatory design process.

The technology probes loosely embody the goal models. Thus the high-level goals can be explored through the daily use of the technology probe, while the users do not deal with abstract goal models directly. Participation is leveraged directly from in-situ social activity. Grandparents and grandchildren participate 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 involvement in the study) but they remain background issues. Our approach ensures that their primary focus remains on the communication and interaction with their family members.

**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 examples represented as instantiations of the goals they are able to gain an understanding of technology use at home. As the data are 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.

The three stakeholder groups each participate in the design. 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 these. Our aim is to explore in more detail the tools that make a shared communication and transfer of knowledge between different stakeholder groups in the domain of domestic technology development possible.

**TOOLS FOR PARTICIPATION**

The participatory tools we are using are agent-oriented goal models, technology probes and field data.

**Agent-oriented model (participatory artefact 1)**

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

![Figure 1. AOSE model representing intergenerational fun.](Image 534x730 to 536x742)
activities in the grandparents-grandchildren interaction. This high-level model evolved from former field studies with grandparents and grandchildren (Vetere et al., 2009). The quality goals represented by clouds are fuzzy 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 goals of a system. For this purpose the AOSE goal models have to be simple yet meaningful enough to represent the goals of social interactions.

**Benefits of the goal models in participatory design**

The AOSE models are particularly suitable to be combined with technology probes in field studies. Firstly, we see AOSE 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 AOSE models allows us to talk about intangible outcomes; such as that arising from fieldwork which can be surprising, complex, but subtle. The AOSE 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, which is important because contextual information offered by technology probes is often lost after data analysis.

**The three technology probes (participatory artefact 2)**

We built three simple applications that were inspired by the intergenerational fun model from Figure 1 that enabled interactions between grandparents and grandchildren. The applications used synchronous touch screens and mobile phones for displaying and sending photographs, stories and messages that were shared among the grandchildren and grandparents households. The applications were simple to use and tried to constrain the user as little as possible thereby facilitating flexible interactions without strict assumptions about how technology was meant to be used. The technologies were used as a tool through which the grandparents and grandchildren participated in the design process. All three applications included technology probe capabilities (logging of interactions) as we wanted to explore the high-level concepts of “playing”, “gifting”, “show & tell”, “look & read” and “communicate” in more depth. 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 overarching the activities and all seen as key to any kind of grandparent-grandchild interaction.

**Benefits of probes for participatory design**

Probes are particularly suited to empower subjects to collect data about their daily lives (Arnold, 2004). In this study we regard probes as informational rather than cultural, designed to inform about daily life rather than to inspire design (Vetere et al., 2005). Information and story generation are two important benefits that we see in the use of probes as participatory artefacts. Due to their logging functionality, technology probes ensure that participation of their users is highly visible and recountable (Graham & Rouncefield, 2008).

Participatory design can be seen as a move of end users into the world of researchers and developers or vice versa (Muller, 2007). We suggest that this move 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 participatory work. When combined with the AOSE models and the field data, these participatory artefacts help stakeholders move between the worlds of activity, design and development. That way the probe technologies 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.

**Field data (participatory artefact 3)**

The field data includes data from interviews and logs from technology probes. These data are 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 are able 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.

**INTERRELATIONS OF THE DIFFERENT ARTEFACTS**

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 participatory artefacts, the different participating groups and their environments (or domains of influence).

<table>
<thead>
<tr>
<th>Participants</th>
<th>Environments</th>
<th>Artefacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software engineers</td>
<td>Development</td>
<td>AOSE Models</td>
</tr>
<tr>
<td>Field researchers</td>
<td>Design</td>
<td>Field data</td>
</tr>
<tr>
<td>Grandparents &amp;</td>
<td>Domestic/Home</td>
<td>Probes</td>
</tr>
</tbody>
</table>

**Table 1: Artefacts, participants and their environments.**

The high-level goals were discussed in the light of the findings once per week. 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
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 shared artefact between the users and software engineers. The models in combination with the data enabled both sides to articulate their understanding in different ways and to collaboratively negotiate 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.

There were a lot of contact points between the artefacts and the participants and the way they shared information: The field data were 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 to discuss the meaning of requirements for development.

**DISCUSSION**

Our aim was to provide shared tools for technology design that led to an increased feeling of participation and understanding across stakeholder groups. 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 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. Examples of social interactions between family members were accumulated in subthemes 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 intergenerational interactions for design.

All three stakeholder groups were able to communicate via at least one of the participatory artefacts to other stakeholders. Because all three artefacts were interleaved and closely connected they served as a bridging element between the stakeholders and communicate similar information. Using three artefacts with highly overlapping information helped the three participant groups to communicate to each other, to mediate information and broaden participation. All three participatory artefacts together served as concrete reflections of a set of interactional data used for both analysis and design.

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