Pedell, S., Miller, T., Sterling, L., Vetere, F., & Howard, S. (2012). Substantiating agent-based quality goals for understanding socio-technical systems

Originally published in F. Dechesne, et al. (eds.) *Advanced agent technology: revised selected papers from the International Conference on Autonomous Agents and Multi-Agent Systems (AAMAS 2011), Taipei, Taiwan, 02–06 May 2011* . Lecture notes in computer science (Vol. 7068, pp. 80–95). Berlin: Springer.

Available from: http://dx.doi.org/10.1007/978-3-642-27216-5_7

Substantiating agent-based quality goals for understanding socio-technical systems

Sonja Pedell[1], Tim Miller[2], Leon Sterling[3], Frank Vetere[1], and Steve Howard[1]

[1] University of Melbourne, Department of Information Systems, Victoria, 3010, Australia, {pedells,fv,showard}@unimelb.edu.au
[2] University of Melbourne, Department of Computer Science and Software Engineering, Victoria, 3010, Australia, tmiller@unimelb.edu.au
[3] Swinburne University, Faculty of ICT, Victoria, 3022, Australia, lsterling@swin.edu.au

Abstract. In this paper we propose a method for using ethnographic field data to substantiate agent-based models for socially-oriented systems. We use the agent paradigm because the ability to represent organisations, individuals, and interactions is ideal for modelling socio-technical systems. We present the results of in-situ use of a domestic application created to encourage engagement between grandparents and grandchildren separated by distance. In such domains, it is essential to consider abstract and complex quality requirements such as *showing presence* and *sharing fun*. The success of such domestic technologies is based on the meaningful realization of these difficult-to-define quality goals. Our method addresses the need to adequately inform these quality goals with field data.
We substantiate the quality goals with field data collected by introducing an application into the home of three families. The field data adds an understanding of what *sharing fun* means when "filled" with concrete activities. The quality goals served as a template to explore and represent the rich field data, while the field data helped to formulate the requirements for a more complex and refined technology. This paper's contribution is twofold. First, we extend the understanding of agent-oriented concepts by applying them to household interactions. Second, we make a methodological contribution by establishing a new method for informing quality goals with field data.

Keywords: Socially-oriented requirements, ethnography, quality goals

1 Introduction

Despite best efforts, contemporary technologies often fail to meet basic human needs and desires. Recent developments have ensured technologies are generally accurate, reliable, and usable. However, meetings these measurable requirements and qualities constitute only part of what it means to design technology for people. As social beings we have complex and hard-to-measure needs, such as

to experience social connection and empathy, to care for others and be cared for, and to share pleasure. These particular types of social requirements cannot be easily reduced to functional specifications. The functionality of a socially-oriented system is often unclear: how does one measure whether a system is able to facilitate a complex goal such as "being fun?"

Pavel et al. [15] argue that agent-based models are suitable for understanding the complex topics inherent to socio-technical systems because the concepts used in these models are suitable for expressing the organisational and behaviour aspects of individuals and their interactions. Our reason for using agent modelling is because they allow us represent human behaviour as well as representing the software system behaviour as a software agent. We define a method to learn more about quality goals in these systems and illustrate it via a case study for exploring intergenerational relationships. We believe that our approach can be applied to other areas where complex social goals have to be considered that need to be written down and implemented in a policy.

Good policies guide decisions and achieve rational outcomes containing the 'what' and 'why' something needs to be done [2]. The 'what' and the 'why' we capture in a motivational goal model. With the associated quality attributes of the goals, we aim to understand the concrete activities for each role to achieve these goals in reflecting on 'how' these goals are fulfilled best. Our tools and techniques are relevant for any social topic involving technology use, but we also argue that they can guide policy decisions in the same way they guide technology design decisions. The difference comes at the production stage, where policies are explicitly written down and have a more formal character in guiding social behaviour. We suggest this paper is relevant for policy making for the following reasons: (1) for giving clear guidelines that can be followed; (2) for understanding of quality goals that are relevant for policy making; and (3) as a basis for communication when defining non-instrumental goals.

In our method, developers first define a high-level goal model that includes the high-level quality goals, such as having fun. Ethnographic techniques are then used to obtain data about the particular domain, and the goal models are used as a template through which the data is analysed. From the data, themes are extracted, and each theme is attributed to a high-level quality goal. If a theme does not match a quality goal, this triggers a discussion as to whether a new quality goal is required. The result is an agent model with concrete themes for achieving quality goals.

Our particular case study focuses on technology for supporting the relationship between grandparents and grandchildren that are separated via distance. This case study presents many interesting and challenging problems for defining innovative technologies with hard-to-define quality goals.

There are several broad aims within our larger research project, including:

1. To increase the modelling capability of social domains using agent concepts.
2. To understand the goals and their associated qualities better in the light of technology use over a distance.

3. To provide a method for designing and implementing quality requirements within complex social settings, such as the domestic space.
4. To build domestic technologies that are better suited to the needs of grandparents and their grandchildren.

2 Socially-oriented requirements engineering

When information and communication technologies began diffusing into the home they did so originally mostly as extensions of our places of work, but this is changing [13]. 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. But there are characteristics of the home that make designing domestic technologies unique and challenging. Domestic needs are often unspoken; relationships are not straightforwardly hierarchical; lived life is idiosyncratic and even exotic [8]. 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 [13] — 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 software engineering methods and processes.

Getting from domestic lives and routines to useful and suitable technologies for the home presents many challenges. One of the big challenges for domestic design is that there is no such thing as a "typical home" [19]. Leonardi et al.[12] describe the home as "*a 'territory of meaning', a place where pleasure, affect and aesthetics are deeply interwoven with the functional and utilitarian dimensions.*" There is still a gap on how to design these technologies as inhabitants have needs that are not easy to articulate, they represent a diverse population, and needs are non-functional and often even ambiguous [8].

Ethnographic data can be used to understand social activity as it happens [18]. In order to create 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. However, to do this we need a way to represent the insights from fieldwork with artefacts that are shared by field researchers and software engineers, and still carry the voice of the user. Software engineers have their focus on future technologies and social needs are often neglected in existing software development processes. The researchers' focus is on the current lives of people. Consequently there is a gap that both groups have to bridge in the design process.

This work is not about the development itself, but the way discussions and thinking take place when talking about the goals and values of socio-technical systems. First, we gain an understanding of the social part of the system as a basis of what is needed to implement a system that is fit for purpose. The behaviour of the software cannot be defined without understanding the social aspects of the social-technical system in which the software operates.

2.1 Modelling field data

The value of matching socially-oriented studies of human interaction with user requirements has been acknowledged (e.g. Viller and Sommerville [18]). Other researchers describe bridging the gap between the output of field studies and the required input to system designs through meta-modelling [10]. This mapping is based on plans and procedures that need to be clearly specified. However this is not straightforward for socially-oriented requirements. Eliciting socially-oriented requirements from field data involves working in a milieu in which it is essential to capture concepts accurately but flexibly at a high level, without losing the liveliness and vitality of those concepts through over specification. The rich information and knowledge gathered in the field needs to be reshaped to accommodate the more formalized and rigorous models of software requirements elicitation and design when identifying goals for the system, and how they should be operationalised. We want to maintain the richness of data while generating models that can be implemented into technologies. To this end, we suggest that quality goals are a necessary part of the abstraction process because they permit a level of ambiguity that is necessary to represent the complex social concepts found in field data.

2.2 Intergenerational fun

We are particularly interested in how domestic technologies mediate shared experiences and emotions, such as having fun and joy, between grandparents and grandchildren. 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. This is complicated further when the intergenerational relationship is nurtured over a distance.

We must look at a family's life more closely to understand emerging interactions in technology use. We analyse these interactions in the light of these interactions and their qualities in order to draw conclusions about the affordances of domestic technologies. Existing technologies are not adequate to bridge the distance between grandparents and their grandchildren [4]. The phone is still the most commonly used technology for children to get in touch with remote family members [16]. However, it is problematic and not suitable for intergenerational interactions as much of the communicated contextual information is lost [1].

2.3 Motivation models

The work in this paper builds mainly on the work of Sterling and Taveter [17]. Their work has focused on how to make high-level agent-oriented models palatable to design discussions. This is achieved using goal models with a straightforward and easy syntax and semantics. Goal models are useful at early stages of requirements analysis to arrive at a shared understanding and ontology [7, 11]; and the agent metaphor is useful as it is able to represent the concepts that we want to capture for socially-oriented systems, such as agents taking on roles

associated with goals. These goals include quality attributes that are represented in a high-level pictorial view used to inform and gather input from stakeholders. In Sterling and Taveter's notation, goals are represented as parallelograms, quality goals are clouds, and roles are stick figures; see Figure 1. These constructs can be connected using arcs, which indicate relationships between them.

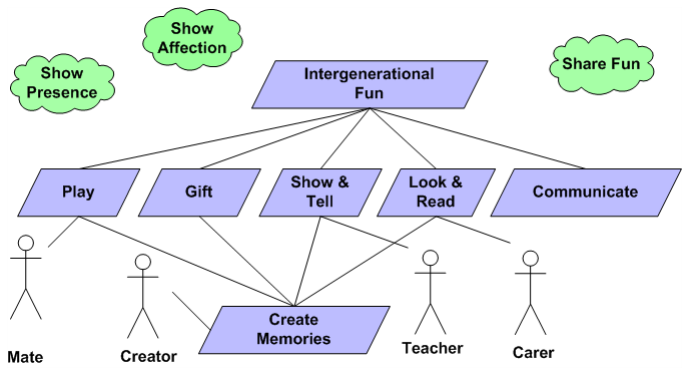

Fig. 1. Motivation model representing *intergenerational fun*.

Quality requirements at the early stages of elicitation tend to be imprecise, subjective, idealistic and context-specific, as discussed by Jureta and Faulkner [11]. Garcia and Medinilla [5] describe high-level quality goals as a specific form of uncertainty that can be used as a descriptive complexity reduction mechanism and to model and discuss uncertainties in the environment. In our requirements elicitation process, we seek complexity reduction without losing the richness of the concepts themselves. Instead of eliminating uncertainty early in the process, we embrace it and withhold design commitment, at least until there is clarity and understanding [6]. High-level goals associated with activities can act as a point of reference for discussing the usefulness of design alternatives to achieve these goals instead of a decomposition into single requirements. The multi-agent paradigm offers benefits over other paradigms because the concepts used in modelling, such as roles, goals, and interactions, are part of everyday language.

From a software engineering point of view the models enable us to take the outputs from a field study and use them to inform socio-technical software design. This is achieved by taking account of the richness of human social interaction provided by the field data, encapsulating quality attributes of that interaction into quality goals in the models and using these models as artifacts for designing technologies that really support and enhance domestic social interaction.

2.4 Modelling with quality goals

Focusing on quality is well established within software and systems engineering. Software engineers are aware of the need to express quality attributes of software

as well as functional capabilities of software. These quality attributes are referred to using a variety of terms including: non-functional requirements, constraints, quality attributes, quality goals, or quality of service requirements.

We use the construct of quality goals attached to functional goals to represent the quality attributes of social interactions. Social quality goals are essentially non-functional and are designed to encapsulate social aspects of the context into the software requirements model, thus providing a mechanism to carry subtle nuances of those social aspects through to the implementation phase. These social quality goals remain interpretively flexible, even until the final product, opening up a variety of possible interpretations both in the design and use of the system. We maintain that there is benefit in articulating quality goals without the need to resolve them into measurable goals. Sterling and Taveter's agent-oriented models allow the expression of non-functional requirements by attaching quality goals to goal models.

In our approach there is a direct pairing between system goals and quality goals, whereas non-functional goals do not necessarily have a direct relationship with functional goals [3]. This makes it more difficult to carry them through the process in an unresolved state. Relating an abstract and unresolved quality attribute to a system goal enables a focus on social goals within the design process.

Our starting point is the simple model of motivations of the socio-technical system shown in Figure 1. By capturing and representing quality goals in agent-oriented models we make a commitment to important aspects of social interactions that can remain unresolved, giving interaction designers and software engineers alike a focal concept for analysing and designing around complex social concepts. By externalizing them in a simple format the models become shared artifacts that are able to sustain multiple interpretations across disciplines [13]. Quality goals allow a focus on understanding the reasons why people do things, or the essence of a relationship rather than describing a physical action. In doing so, quality goals capture something that is more dynamic and fluid than other elicitation mechanisms found in usual software engineering practices.

3 Method

Then how can these social goals and attached qualities be fulfilled when using technology and what tools are used best to explore the use of domestic technologies? The success of a design in achieving its goals can really only be investigated after implementation. Therefore we started with building lightweight technologies that focus on certain goals of the goal model. On the goal model level we do not prescribe how to use specific technologies. We purposely keep them on a high level that they are representative and comprehensive to a satisfactory degree, but are independent of one concrete implementation. This way we were able to learn more about qualities that are arising as a consequence from technology use in tying back concrete activities of technology use to the motivational model. With the insights gained from using simple technologies we hope to predict more

accurately what will work when building more complex technologies that cover the complete goal model. The main components of our method are the following. We purposely speak about the components of a method and not a process as the activities of these components are taking place iteratively depending on the available knowledge of the user domain.

The main features of our approach are:

- Use of agent-oriented models with a focus on quality goals.
- The implementation of lean, but focused technologies.
- Iterative exploration and discussion of social requirements.
- Lightweight evaluation of quality goals in ethnographic studies.
- Analysis of quality goals and elicitation of social requirements.
- Refining of user needs.

3.1 Electronic Magic Box

We built an application called *electronic Magic Box*, which was inspired by the motivational model in Figure 1. The electronic Magic Box uses synchronous touch screens for displaying and mobile camera phones for sending photographs and messages that were shared among the grandchildren and grandparents households. Each family unit was allocated one mobile phone and one touch screen — that is, one for the grandparents to share — and one for shared use by the children (and parents). The mobile phones were important as we wanted the sharing of everyday experiences that could operate at a distance. Grandparents and grandchildren could carry the phones with them and share photographs of events and ideas with the others sending it to the system. The system was easy to use and tried to constrain the user as little as possible, thereby facilitating flexible interactions without strict assumptions about how technology was mean to be used. The screens were placed in high traffic areas in the family homes such as in the lounge room or the kitchen counter — easily accessible and surveyed by the family members. While our focus was on the grandparent-grandchildren relationship, the parents took on an important role in facilitating interactions and observing them without being directly involved in the use of the system.

We wanted minimal ongoing intervention from the researchers themselves while allowing us to observe the transactions between the participants. The system has logging capabilities to monitor and record the use of the application such as technology probes [9]. Probes are specifically suitable for collecting data in the domestic domain through their ability to capture the nuanced aspects of everyday life. In this study we regard probes as informational, designed to inform about daily life rather than to inspire design. Information and story generation are two important benefits that we see in the use of probes.

The electronic Magic Box allowed the sending of a treasure box that could be filled with photographs and messages. Figure 2 shows the layout of the homepage. On the left side area of the homepage, seven picture based links (home, Magic Box, scroll, collection book, settings, admin, and logout) can be found that guide to a number of destinations within the application. 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.

Fig. 2. Homepage of electronic Magic Box.

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 goal *gift*, but the concept certainly carried elements of and was inspired by the other high-level goals or motivations like *playing*, *show & tell*, *look & listen*, *communicating* and *creating memories*.

4 Study

4.1 Study design and participants

We introduced the electronic Magic Box to three families. The application was installed in the family homes between three and six weeks over a period of four months. Family one consisted of one eight year old girl living with her mother, with her grandmother living 12 kilometres away (parent of mother). Family two consisted of three grandchildren of 18 months (girl), six years (girl) and eight years (boy) living with their parents 8 kilometres from their grandparent (parents of mother). Family three consisted of two girls in the ages of five and six and their parents with a distance of about 16 kilometres from their grandparents (parents of mother). All grandparents had regular contact with their grandchildren (at least once a week) and all of them described having a strong and loving relationship.

4.2 Data collected

We conducted three to four interviews per household about the probe use (usually grandparent household and grandchildren household separately). The parents were present in the grandchildren interviews. This was an important source of information as the parents were observing the ongoing interactions without being directly involved, and were able to make comparisons on the basis of how the interactions occurred before the introduction of the system.

During the interviews, we did not ask for goals such as *play* or *gift*. 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?'. The technology probe data collected with the electronic Magic Box application included 102 boxes (electronic letters and photographs) and time stamps for all messages.

4.3 Analysis

The transcribed interviews together with the photographs and messages (text messages and electronic letters) were analysed using content analysis according to Patton [14]. The data was analysed focusing on the quality goals as overarching themes. We investigated and evaluated the activities and interactions and not the technology per se. This procedure enabled us to find sub-themes for all of the quality goals and therefore to learn more about each goal in the light of typical activities between grandparents and grandchildren. Each sub-theme was briefly described and substantiated by compelling examples and instances of these goals in the specific context of intergenerational fun using the applications.

We analysed the interview data according to what we could learn about the quality goals. The photographs and messages were downloaded from the servers and analysed and discussed biweekly. The essence of the quality goals is based on experiences and judgement of the participants regarding their interactions and not easy accessible by the field researchers. Therefore, the interview data played a major role in this analysis as we wanted expand from the activities and original goals to inform the quality goals. The photographs and messages were mostly to back up and illustrate the results with use episodes and participant stories.

This analysis procedure helped us to keep the focus on the human needs with the technology as mediator. We avoid the risk of focusing on the technology as our aim is not to create a perfectly running technology, but implementations that support us in further investigating the social requirements themselves. Even further this approach validated our existing understanding. We were looking for describing social requirements, looking for examples for "this was fun" or "this was not fun". If we had never a comment that said "this was fun" or "this made me feel connected", we would feel invalidated in our original motivational model.

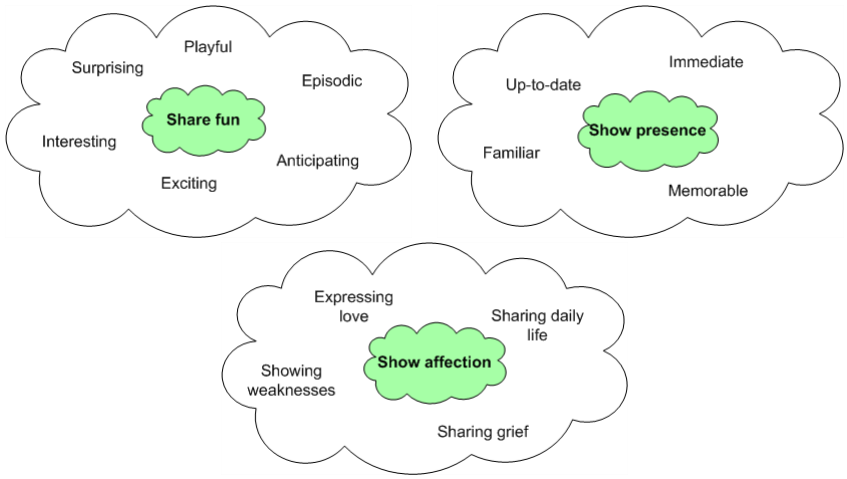

Fig. 3. Quality clouds for the quality goals *share fun*, *show presence* and *show affection*.

5 Results

Many of the insights concerned how to expand or better the system itself such as including more games, providing music options or the possibility to send several boxes in a row. Our focus here is on what we learnt about the quality goals and therefore about the family interactions facilitated by the system and not about the functionality of the electronic Magic Box itself. Different to other approaches, our aim is not to improve the existing system, but to learn more about the quality goals attached to the functional goals, to represent our leanings, and make changes if necessary to our high-level goal model.

5.1 Substantiating the quality goals

The sub-themes that emerged from our data analysis were organised as characteristics to the quality goals into *quality clouds*, shown in Figure 3. The quality clouds consist of one quality goal linked to a functional goal, with associated qualities factored around. The quality clouds can be seen as an abstract representation of field data into which we are able to zoom into the associated quality goal more closely. In this process the sub-qualities or quality attributes were formulated into adjectives to re-connect the qualities in discussions more easily to the functional goals they are attached to. Each sub-quality of a main quality goal is briefly described and directly linked to the respective quotations in the interview data. Here, we only show some of the quotations that led to the quality cloud *show affection* to demonstrate our procedure. Some of the sub-qualities from the clouds that brought us unexpected insights are exemplary described in more detail.

5.2 Quality goal *share fun*

Anticipation: A feeling of looking forward to hear from the other family member.

Grandparents as well as grandchildren were excited when they saw a closed box on the screen and eager to view the box content as soon as possible. All participants involved kept checking the status of the application regularly when they had sent off a box. One grandmother told us:

"... when I opened it up and there was a message — when the box was closed on the screen — that was fun."

Another grandparent expressed it this way:

"I turned it on in the morning. If the red seal was still on I thought 'darn — nothing new' "

Surprise: Something unexpected that happened that was caused by the sender of the box.

When an empty box was sent a kangaroo would jump out of the box (see Figure 4). The families described they had a lot of fun when this function was discovered. One child explained:

"I never knew what was in the box — every box was a surprise — in particular the kangaroo — that was good."

Fig. 4. The surprise kangaroo.

5.3 Quality goal *show presence*

Immediacy: Maintaining the feeling of presence in renewing the contact within a brief time frame.

The grandchildren would lose interest if it took longer than a few hours until a box was sent back while with one grandmother it increased the anticipation.

"If I didn't have a message I was quite disappointed. When the seal was on I was wondering: 'what are they doing'? That made me think much more often of them during the day than it would have otherwise." [grandparent during interview].

"Sometimes when the grandparents would not send back a box and the kids got really impatient I would give them a call: 'I think a box is awaited pretty urgently over here'." [parent during interview].

Giving updates: Having the urge to communicate to a close person all topical news as soon as possible.

Grandparents and grandchildren showed a similar frequency pattern in using the electronic Magic Box as before. A grandmother and her granddaughter with a lot of contact to each other used the application more regularly than the other families where the contact was not as frequent:

"I don't think you can get them interact more than they do. There was always an open flowing communication between the two of them and it was always positive. Now it was a bit different. Instead of Andrea coming home and telling what happened at school it would be about the computer or the photos: 'Have you opened the box? You haven't opened the box!'." [parent during interview].

This shows how some aspects of the relationship have influence on the use of the electronic Magic Box. Interest is based on a stable and loving relationship.

5.4 Quality goal *show affection*

Show weaknesses: Family members are comfortable not only showing the best side, but also failures and weak points, because there is a loving trust within the relationship.

A challenge for most of the grandparents was the managing of the technologies itself. Uncovering this kind of weakness is an intimate act in itself. Problems dealing with the electronic Magic Box were often communicated in a humorous way or loaded with self-irony making the technology handling a shared episode itself. A nice example was one grandmother sending this message:

"Dear Andrea, in trying to send this photo to you I burnt my steak I am having for dinner, yuk!!!"

After this she took a photo of her burned frying pan as well and sent it:

"When I tried to send this message Thursday the machine told me to try again, so here I am. This is the pan I burned while trying to enter the project!!!"

We only tend to show our failures to people we trust and love. Therefore, to the researchers, this grandmother assured in the interview that the pan was "all clean again" and that she had no more disasters. In a similar way one grandmother sent a photograph of her messy desk:

"This is my messy desk. I am trying to catch up with office work."

The granddaughter took it up immediately as something funny and kept saying in one of the interviews:

"Granny you are messy as well — you sent me this photograph of your desk."

That the grandparents admit to weaknesses being adults and "should know better" was received as something special by the grandchildren.

Share grief: The electronic Magic Box was particularly well suited in mediated shared emotions. There was sometimes an urge to transfer something important and emotional. One example was when the granddaughter's dog got

really sick and died. The granddaughter wrote her Nanna accompanied with a really sad picture of herself:

"I really miss Sam — really really!"

Her granny answered:

"I have been thinking of her too, but she was very sick & you wouldn't want her to suffer, would you?"

The electronic Magic Box was also used for more complex emotions or situations that required context information in the sense that they were exceeding a simple state of a relationship, but telling longer stories with the aim to be comforted or understood.

5.5 New quality goal *build up confidence*

While we were interested to group the sub-qualities to our existing quality goals, in order to substantiate them with our field data, we permitted new main quality goals emerge, and hence allow changes to our overall goal model. As part of the method, in the event important activities or themes evolve for which we cannot find a home, we define new quality goals. Qualities emerging that we could not group with our existing quality goals were themes surrounding the technology use itself still being close connected to positive feelings - often explicitly described as fun. The new quality goal that emerge is *build up confidence*, shown in Figure 5.

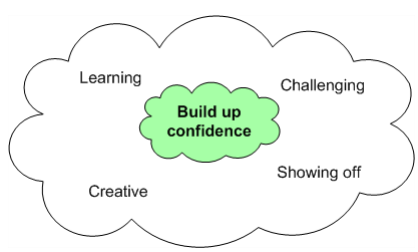

Fig. 5. Quality cloud for "build up confidence".

Learning: One important aspect was being able to continuously improve managing the technology:

"It is quite interesting to see where we started: 'I didn't find a photo, but here is the text'. [an early message from the grandparent]. Next time I was able to send the text as well. It is a bit of fun." [grandparent during an interview].

"I guess I have to get into email now with some kicking and screaming I am enough of a dinosaur. I think I am ready." [grandparent during an interview].

One grandchild could not get enough of the kangaroo magically jumping out of the box and could not figure out how this had happened; the grandmother was proud that she was able to do something unexpected with the technology what links in with building up confidence.

Showing off: Showing the application to people like neighbours, friends and other family members with a feeling of pride.

This theme is a clear sign that confidence indeed had been built up and another example or measure for validating the success of the application that is closely tied to a complex quality goal and not to a certain piece of functionality. One mother said about her daughter:

"Showing them something cool: 'this is what I've got this is mine' — this is my phone and I can send pictures." [parent during an interview].

The showing off effect was in particular interesting with the grandparents. There was a new role the grandparents suddenly had among their peers. They became advocates for new technologies, while they would have never anticipated themselves as champions of new technologies. They found confidence in the technology in a way that we had not planned.

6 Discussion

The quality representations of the field data helped to formulate high-level requirements for a design of a more complex and refined technology concept for grandparents-grandchildren interactions that we are currently building. These requirements are to a large extent influenced by the new quality cloud *build up confidence*. Building confidence is part of the intergenerational interaction and it has implications on how the technology should be designed: not put everything in an application at once, because it scares the grandparents away. We now maintain simple screen views and a layered application instead of a packed one with functionality.

Aiming for simplicity is not only based on the lack of confidence of many grandparents to deal with complex technology, but is suggested in the nature of strong-tie relationships themselves. In the sub-themes becomes apparent that these technologies rely on an existing rich and loving relationship. A lot is carried by these strong tie relationships that we can observe in the home. To support the long-term interactions between grandparents and grandchildren with technology, it is not necessary to build complex technologies. The technologies serve as a mediator of these subtle and complex relationships in the family context and routines

Another important insight was discovering "the other side of fun". Certain value sets have so far been marginalised to date such as disclosing weaknesses or failure — and laughing about them — or the demonstration of grief and openly dealing with it. The grandmother does not try to brush the grief away with some happy comment, but she honestly acknowledges that the loss of the loved dog indeed is sad. According to our results, the dealing with these kinds of emotions is just as important for a strong tie relationship as demonstrating love, play together and laugh about a joke. It is no contradiction that technologies for intergenerational fun also allow and even aim for activities that deal with aspects we would normally avoid to show openly.

In this sense the quality goals represent the essence of an intergenerational relationship independent of a specific implementation or even technology use at all. The motivation model tells us something more general about the values between grandparents and grandchildren. While we have chosen the domestic domain as a challenging example for demonstrating our approach, we believe that this approach could also be relevant for defining and substantiating the main quality goals and values important for communities. The AOSE models are able to represent the values and desired outcomes of social life and can serve as a shared source of discussion and decision making in community and government led projects.

7 Conclusion

As social ICTs become more, and more relevant for the home and families, software engineering needs processes to cater for and understand these complex and sensitive social goals. We propose a replicable process of interleaving motivational models and lightweight technologies to be able to analyse, substantiate and evaluate quality goals in the light of these mutually influenced artefacts. We based our exploration of family life on field data and advanced our understanding about the intended social outcomes (quality goals) in using a technology probe. This approach allowed us firstly the novel use of agent-based methods in building a bridge between ethnographers and software engineers and secondly to show how the notion of goal-oriented analysis, in particular the notion of quality goals, can be useful for the interpretation of ethnographic data.

Quality goals allow a focus on understanding the reasons why people do things or the essence of a relationship rather than describing a state of the world or an action. With quality clouds, we were creating a set of new testing artefacts for lightweight evaluation. They were useful in the process to validate associations between activities and high-level goals and evaluate the degree of the match between the two. The proposed method helped us to substantiate quality goals for social interactions for the development of meaningful domestic technologies, helping us to bridge the gap between the agent-oriented models, and the ethnographic data.

Traditional quantitative evaluation methods do not apply for the evaluation of socio-technical systems and require new approaches. We proposed a time intensive user study to ensure that users' evaluation of the system is based on real social experiences with the system. We made use of an iterative and qualitative evaluation process as we do not see a way to use traditional software engineering metrics to measure having fun mediated by a system. Our evaluation is engineered in the sense that we evaluated applications comparing and evaluating them against the original agent-based model. In our future research we aim to look more closely into finding a more formal, less descriptive, and less time intensive evaluation process for social quality goals. While we have chosen the domestic domain to evaluate our appoach, we believe that this approach is applicable for defining and substantiating quality goals in other domains.

References

1. R. Ballagas, J.J. Kaye, M. Ames, J. Go, and H. Raffle. Family communication: phone conversations with children. In *Proceedings of the 8th international Conference on Interaction Design and Children*, pages 321–324. ACM, 2009.
2. K. Blakemore. *Social Policy: an Introduction*. Open University Press, 1998.
3. L. Chung, B.A. Nixon, E. Yu, and J. Mylopoulos. Non-functional requirements in software engineering. 2000.
4. B. Evjemo, G.B. Svendsen, E. Rinde, and J.A.K. Johnsen. Supporting the distributed family: the need for a conversational context. In *Proceedings of the NordiCHI'04*, pages 309–312. ACM, 2004.
5. A. Garcia and N. Medinilla. The ambiguity criterion in software design. In *International Workshop on Living with Uncertainties (IWLU'07)*. ACM, 2007.
6. D. Gause. User driven design – the luxury that has become a necessity, a workshop in full life-cycle requirements management. In *ICRE 2000, Tutorial T7*, 2000.
7. R. Guizzardi and A. Perini. Analyzing requirements of knowledge management systems with the support of agent organizations. *Journal of the Brazilian Computer Society*, 11(1):51–62, 2005.
8. S. Howard, J. Kjeldskov, and M.B. Skov. Pervasive computing in the domestic space. *Personal and Ubiquitous Computing*, 11(5):329–333, 2007.
9. H. Hutchinson, B. Westerlund, B.B. Bederson, A. Druin, M. Beaudouin-Lafon, H. Evans, and N. Roussel. Technology probes: inspiring design for and with families. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 17–24. ACM New York, 2003.
10. R. Iqbal, A. James, and R. Gatward. Designing with ethnography: An integrative approach to CSCW design. *Advanced Engineering Informatics*, 19(2):81–92, 2005.
11. I. Jureta and S. Faulkner. Clarifying goal models. In J. Grundy et al., editor, *Proceedings of ER*, volume 83 of *CRPIT*, pages 139–144, 2007.
12. C. Leonardi, C. Mennecozzi, et al. Knocking on elders' door: investigating the functional and emotional geography of their domestic space. In *Proceedings of OZCHI'09*, pages 1703–1712. ACM, 2009.
13. J. Paay, L. Sterling, F. Vetere, S. Howard, and A. Boettcher. Engineering the social: The role of shared artifacts. *International Journal of Human-Computer Studies*, 67(5):437–454, 2009.
14. M.Q. Patton. *Qualitative research and evaluation methods*. Sage Publications, Thousand Oaks California, 2002.
15. J. Pavón, M. Arroyo, S. Hassan, and C. Sansores. Agent-based modelling and simulation for the analysis of social patterns. *Pattern Recognition Letters*, 29(8):1039–1048, 2008.
16. N. Romero, P. Markopoulos, J. Baren, B. Ruyter, W. Ijsselsteijn, and B. Farshchian. Connecting the family with awareness systems. *Personal and Ubiquitous Computing*, 11(4):312, 2007.
17. L. Sterling and K. Taveter. *The Art of Agent-Oriented Modelling*. MIT Press, 2009.
18. S. Viller and I. Sommerville. Ethnographically informed analysis for software engineers. *International Journal of Human-Computer Studies*, 53(1):169–196, 2000.
19. A. Zafiroglu and M. Chang. Digital homes on wheels: designing for the unimagined home. *Personal and Ubiquitous Computing*, 11(5):395–402, 2007.