Exploring Grandparent/Grandchildren Contact over Distance

- Shared Activities and Time Zone Differences

"Boys don't wanna talk on the telephone"

- Father from 2nd participating Danish/Australian family

"I have never been so much in contact with my grandchildren as now"

– grandfather from 1st participating Danish/Australian family

Master's thesis by René Godsk Vutborg, Informatics, Aalborg University, 2010

Title:
Exploring Grandparent/Grandchildren Contact over Distance
- Shared Activities and Time Zone Differences

Project Period: February-June 2010.

Project group: d606a

Study: Informatics

Supervisor: Jesper Kjeldskov

Number of pages: 35

Project submitted: June, 10th, 2010

Aalborg University
Department of Computer Science
Selma Lagerlöfs Vej 300
DK-9220 Aalborg Øst
Phone (+45) 96 35 80 80
Fax (+45) 98 35 97 98
http://www.cs.aau.dk/

Abstract:
This thesis explores contact between grandparents and grandchildren over distance. This was done by designing, implementing and deploying a technology probe to two families in Australia. Based on this deployment, I elicit and discuss themes important to consider when designing technology for communication between grandparents and grandchildren living apart.

Subsequently the technology probe was deployed to families having grandparents in Australia and grandchildren in Denmark. Based on this deployment, I analysed how their communication was affected by the time zone differences. This was done based on existing theoretical terms on time and events. Finally, I discuss how technology can be designed for communication between grandparents and grandchildren living in different time zones.

_____

René Godsk Vutborg

Preface

This Master's thesis is written as conclusion on the study to become M.Sc. in Informatics at the University of Aalborg. During the thesis writing period, I was a Research Assistant trainee in the Department of Information Systems at the University of Melbourne, Australia in the periods 1/8-2009 – 23/12-2010 and 6/4-2010 – 25/5-2010. While in Melbourne, I was affiliated with the research project "*Socially Oriented Requirements Engineering - Software Engineering meets Ethnography*", funded by the Australian Research Council (DP0880810). Even though the work of this thesis is produced by me, the research grounding this thesis has been conducted in collaboration with employees from the University of Melbourne.

I would like to thank my supervisor Dr. Jesper Kjeldskov for his invaluable support during the last year. I would also like to thank Dr. Sonja Pedell and Dr. Frank Vetere, both employees at the University of Melbourne, for very valuable and giving collaboration. I could not have conducted the field studies with Australian participating families without your help. The families who participated in the field study also deserve my gratitude.

Finally, I would like to thank *F-studienævnet* and *Internationaliseringspuljen* at Aalborg University and also *Knud Højgaards fond* and *Nordea Danmark Fonden* for economical support, making my June-December stay at the University of Melbourne possible.

Contents

Introducing the Research Papers

The main part of this thesis comprises two research papers: [Vutborg; 2010a] and [Vutborg; 2010b]. Each of these is written exclusively on the 10th semester of my study and neither has been submitted as part of the 9th semester project in any way. Furthermore, [Vutborg; 2010a] has been submitted to NordiCHI 2010 in a revised version.

Common for both papers is:

1) that the domain includes children and
2) that what is investigated is contact over distance, i.e. where the child and another person is distributed in space.

Introduction

The majority of modern family households comprise no more than two generations [Williams et al.; 2005]. One or two adults, who might be parent(s) for one or more children. The older generation, the grandparents, lives in their own household. This physical separation between grandparents and their grandchildren almost inevitably makes it harder to develop and maintain a close relationship between the two. Social circumstances such as parents getting divorced can further exacerbate these opportunities. Studies show that a close relationship is important for the well-being of both grandparents and grandchildren [Kornhaber; 1996][Kornhaber et al.; 1981]. The geographical separation and the inadequacy of current mainstream technologies (telephone, webcam) pose a threat to the development of this relationship. Grandparents, or other distant relatives, find it hard to get the child engaged in a conversation over the phone [Ballagas et al.; 2009]. This is the case for most children until they reach 7 or 8 years of age [Ballagas et al.; 2009]. The child is often bored by talking on the phone and will much rather roam the house or play with friends [Ames et al.; 2010].

Shared Activities

Triggered by these issues, I formulated the first research question:

> *How can technology be designed to improve contact between grandparents and grandchildren living apart?*

This research question is explored in [Vutborg; 2010a] by providing shared activities for grandparents and grandchildren distributed in space. This idea was inspired by popular collocated shared activities, as "*Reading books and telling stories together"* [Kennedy; 1992] and *"Talking together about recent events in each other's lives"* [Kennedy; 1992]. I hoped that the contact between grandparents and grandchildren would be better, more giving or more fun if they could engage in such shared activities together.

To provide such shared activities for grandparents and grandchildren living apart, and to collect adequate data to be able to answer the research question, I designed, implemented and deployed a system in a field-study. The system provides three types of shared activity over distance. The grandparent and grandchildren can share oral reading of children's book stories, they can share personal photos taken by

camera phones, and they can draw to each other using coloured pencils. Other types of functionality, listed in Appendix C, were envisioned, but never implemented.

The system was deployed in two Australian families, and whenever it was used, its use was recorded to provide the foundation for the subsequent analysis. The recordings consisted of video and audio, and a log file of use (see Appendix D for an excerpt from the log file).

The field study revealed that the families appreciated the system. The vivid telling of fictional stories, the ability to share personal photos and the creativity shown with the pencils indicates that both grandchildren and grandparents really enjoyed the storytelling sessions and bonded during so, by sharing the same conversational context. The study also showed that parents play an important role as facilitators of contact between their children and the grandparents, making sure the technical setup works, making sure that the children do not fight over control and surfacing ideas for activities. It was also observed that children generally behaved differently depending on the time of day when they used the system. During the day, they would be really active, and later on the day, e.g. after dinner-time, they would want to be told a story. This shows that children's daily rhythms, and how that affects the activity level of the child, must also be given thought when designing technology to be used partly by children. Finally, the grandparent played an important role during the storytelling sessions, as s/he would suggest activities matching the mood of the grandchild, whether that was teasing, playing with photos, or telling stories.

This study also revealed a preference to use the system in the evenings, and it was thus expected that grandparents and grandchildren would face further challenges maintaining or building a relationship when they live in each their part of the world, and thus in each their significantly different time zone.

Time Zone Differences

Triggered by the expected challenges families have by communicating across time zones when children are involved, I formulated the second research question:

> *How do time zone differences between grandchildren and their adult relatives affect their communication and which consequences does this have for design of technology for this domain?*

This research question is explored in [Vutborg; 2010b] by deploying a system in a field study to two families, each of which had grandparents living in Melbourne and grandchildren living in Denmark. The system consisted of the Storytelling component, presented in [Vutborg; 2010a] and developed by me on my 9th semester, and the Collage component, presented in [Vetere et al.; 2009], which was slightly modified for this study.

The results indicate that the time zone differences made communication troublesome and that day time responsibilities can hinder the opportunity for young grandchildren to engage in contact with their adult relatives. The misaligned daily schedules can by itself hinder communication between children and relatives, as children might not even think about communicating with their remote family when they have time for it, for example when it is morning for the children. The time zone differences also makes parents

important for scheduling sessions of contact, a task which the young children in the study did not do themselves.

The study also shows the importance of considering the easiness with which the children can use the technology, when designing technology to be used across time zones. Children may have daily routines which make them get up really early in the morning, before their parents, which may be the only good time to engage in contact with grandparents or other family members living in another time zone. However, this still needs to be balanced against the domestic rules many families have regarding use of technology (computers) by their children [Rode; 2009].

The study also confirmed, in line with [Vutborg; 2010a], that synchronous communication with voice can be really beneficial, when a conversational context is provided. However, the time zone differences somewhat compromised the possibility for such synchronous sessions to be conducted. This makes it important to consider supplementing synchronous interaction forms with asynchronous ones to improve the possibility for some type of contact to arise.

Conclusion

When taking all fours families, who are presented in the two papers, into account, it is clear that the general idea of providing conversation context is working well, whether or not time zone differences are involved. Whether or not it is *better* than a telephone or Skype conversation is not investigated in this study, but other research has confirmed this to be the case [Raffle et al.; 2010].

It is also interesting to note, when looking at the use patterns from the four families, that interaction during Storytelling sessions were different depending on the amount of grandchildren who participated. If only one grandchild participated, with one/two grandparents, interactions were generally more submerged in the activity they conducted, e.g. in the reading aloud of a story. If two grandchildren participated simultaneously, it was generally much more playful and each activity was more quickly replaced by another activity. This finding makes it interesting to investigate if this really is the case, i.e. how interaction changes depending on the amount of concurrent interacting children.

Future work could also involve investigating how communication between children and adult relatives growing up in different countries are influenced by different native languages. If a child grow up in another country than a dear relative, it might induce the risk that the child prefers to speak in his/her own native tongue, and hence only reluctantly will speak in his/her relative's native tongue. However, further studies are needed to investigate if this is a real problem. It could also be interesting to explore how communication between grandchildren and adult relatives is influenced by cultural differences, e.g. if one lives in Europe and the other in China.

References

Ames, M. G., Go, J., Kaye, J. ' and Spasojevic, M. (2010). Making love in the network closet: the benefits and work of family videochat. Proc. CSCW '10. ACM, 145-154.

Ballagas, R., Kaye, J., Ames, M., Go, J. and Raffle, H. (2009). Family communication: phone conversations with children. Proc. IDC '09. ACM, 321-324.

Kennedy, Gregory E. (1992). Shared activities of grandparents and grandchildren. Psychol Rep. 1992, Feb; 70(1):211-27.

Kornhaber, A. (1996). Contemporary Grandparenting. Thousand Oaks, CA: Sage Publications, Inc. ISBN 0-8039-5806-4.

Kornhaber, A., Woodward, K. L. (1981). The grandparents/grandchildren. The vital connection. Garden City, NY: Anchor Press/Doubleday. ISBN 0-3851-5577-8.

Raffle, H., Ballagas, R., Revelle, G., Horii et al. (2010). Family story play: reading with young children (and elmo) over a distance. Proc. CHI '10. ACM, 1583-1592.

Rode, J. A. (2009). Digital parenting: designing children's safety. Proc. British Computer Society Conference on Human-Computer Interaction. British Computer Society, Swinton, UK, 244-251.

Vetere, F., Davis, H., Gibbs, M. et al. (2009). The Magic Box and Collage: Responding to the challenge of distributed intergenerational play. Int. J. Hum.-Comput. Stud. 67, 2 (Feb. 2009), 165-178.

Vutborg, R. (2010a). Providing Shared Activities for Grandparents and young Grandchildren living apart. Department of Computer Science, Aalborg University, Aalborg.

Vutborg, R. (2010b). Supporting young children's communication with adult relatives across time zones. Department of Computer Science, Aalborg University, Aalborg.

Williams, Brian K., Sawyer, Stacey C, Wahlstrom, Carl M. (2005). Marriages, Families & Intimate Relationships. Boston, MA: Pearson. ISBN 0-205-36674-0.

Appendix A – Research Paper I

"Providing Shared Activities
for Grandparents and young Grandchildren living apart"

Providing Shared Activities for Grandparents and young Grandchildren living apart

René Vutborg
Aalborg University
Selma Lagerlöfs Vej 300
9220 Aalborg East, Denmark
rene@vutborg.dk

ABSTRACT

Grandparents feel revitalized when they get a grandchild. However, the physical separation between grandparents and grandchildren that often exists today makes it harder to develop a heart-felt relationship. Current mainstream technologies, as the phone, are inadequate for developing such relationships when children are involved. This paper presents the design, implementation and deployment of a system exploring how technology can be designed to alleviate this problem. Based on the deployment, four important themes for designing technology for distributed intergenerational bonding are elicited and discussed. The four themes are *Conversational Context* (to have something to talk about), *Facilitation* (to be given the opportunity to talk), *Diversified Interaction Forms* (to maintain attention of the child) and *Supporting Grandparent caring for grandchild* (to adapt activity to the mood of the child).

1. INTRODUCTION

In current western-based lifestyle, the majority of family households comprise no more than two generations [18]. One or two adults, who might be parent(s) for one or more children. The older generation, the grandparents, lives in their own household. This physical separation between grandparents and their grandchildren almost inevitably makes it harder to develop and maintain a close relationship between the two. Social circumstances such as parents getting divorced can further exacerbate these opportunities. Studies show that a close relationship is important for the well-being of both grandparents and grandchildren [8, 9]. The geographical separation and the inadequacy of current mainstream technologies (telephone, webcam) pose a threat to the development of this relationship. Grandparents, or other distant relatives, find it hard to get the child engaged in a conversation over the phone [2]. This is the case for most children until they reach 7 or 8 years of age [2]. The child is often bored by talking on the phone and will much rather roam the house or play with friends [1].

Collocated talk between grandparents and grandchildren is often submerged in ongoing activities [5]. By mediating the collocated activity of storytelling, the system presented in this paper provides geographically separated grandparents and grandchildren with shared activities during sessions of synchronous contact. The goal is to explore if children not older than 8 years old can be made interested in engaging in distributed contact with their grandparents if such activities are provided.

Related work concerning the importance of a good grandparent/grandchildren relationship is presented first, followed by an overview of previous research on using technology to facilitate contact between distributed grandparents and grandchildren. The process of designing and implementing the system is then presented, followed by its deployment. Finally, findings from the analysis are presented and discussed by eliciting important themes for designing technology to support distributed intergenerational bonding.

2. RELATED WORK

Kornhaber [8, 9] conducted a 3-year sociology study involving 300 sets of grandparents and grandchildren and found the grandparent/grandchildren relationship to be important for both grandparent and grandchild. Kornhaber et al. found the grandchild-grandparent bond to be second in emotional importance only behind the parent-child bond [9] and that "*Grandparenting provided many elders with meaning and joy in their lives*" [8]. For the grandchildren, a good relationship with their grandparents makes them fell emotionally secure, having them as a "backup" if their parents fall away and provides them almost unconditional love [8]. Kornhaber also found that shared grandparent/grandchild activities build up the child's self-esteem [8]. Thus it is clear that a good grandparent/grandchildren relationship is important for both parties. One potential way such relationship can arise is through shared collocated activities. Kennedy [7] asked in a sociology study 391 young adult grandchildren to write down which shared activities they had with their grandparents. Based on more than 1000 nominations for types of activities, Kennedy generated 29 categories for different types of grandparent/grandchildren shared activity. Examples of such categories are "*attending church together*" and "*spending the night at grandparent's house*".

Current synchronous mainstream technologies that provide contact opportunities for geographically distributed persons use an audio channel or a combined audio and video channel, but these technologies all pose challenges for successful bonding when a child is involved. Ballagas et al. found that "*young children […] have difficulties articulating*

clearly with words alone" and that "*children up to 9 years old had difficulties staying engaged in the phone conversation*" [2]. Ames et al. found that when children were participating in video chat sessions with remote family members, all children they observed had a hard time sitting still in front of the camera. They would much rather roam around in the house, thus making the family members at the other end of the video chat unable to see and hear the child [1].

Previous research has in various ways tried to stimulate children's interest in synchronously communicating with remote relatives using technology. Yarosh et al. [19] built the ShareTable system, aimed at parent/child contact, where a combination of a camera, a projector and special projection surface allowed the child and parent to share viewing of physical artifacts. Evaluation showed that the ShareTable system was well-received by both parents and children and preferred over regular videoconferencing, although some children had a hard time understanding how the system worked. Vetere et al. [17] made the Collage system for exploring intergenerational distributed play. The grandparents and grandchildren could send photos and text messages from a mobile phone to the system, and both could then manipulate these objects on each their touch screen monitor. Manipulation would be synchronous replicated to the other household. Evaluation showed that both grandchildren and grandparents enjoyed the new types of playful activities the system offered. Modlitba [11] developed the GlobeToddler system making the child able to synchronously communicate with a travelling parent. The parent can record audio comments and take pictures and send them to the child (asynchronously), who is supplied with an interactive doll based on a Nintendo Wii remote controller. Whenever the child uses the doll, the parent is notified of this, and can choose to engage in synchronous activity with the child e.g. by making an avatar jump. Evaluation showed that both parent and child really enjoyed the system, but it also showed that the child sometimes found the doll confusing to use and not consistent enough. Raffle et al. [12] created a custom-made device to be used by grandparents and grandchildren for shared reading of physical story books. It included an audio channel and page-censoring technology to make it possible for the grandparent to determine if the child was on the same physical page. Evaluation showed that it made children more engaged in long-distance communication than when they used Skype and that the quality of the intergenerational interactions improved as well. This device, together with the Collage and the GlobeToddler technologies, especially inspired the research presented in this paper as they attempted to provide children and their relatives with distributed activities in a similar way.

3. RESEARCH DESIGN

Previous referred research [11, 19, 17] explored how to facilitate synchronous contact between family members living apart by introducing custom-made technology in the family homes and by interviewing the participants. This paper is the outcome of a similar approach, where a system was designed, implemented and deployed to participating families. The family members were interviewed before and after they had used the system. The pre-use interview centered on challenges of maintaining contact with grandchildren living apart. The system explored distributed intergenerational contact by mediating an existing and collocated shared activity. The post-use interview centered on how the system facilitated distributed contact.

3.1 Case

As grandparents and grandchildren participate in various types of activities when together [7], it was necessary to select a point of foci for exploration. The shared activity *storytelling* was selected because it was judged feasible to mediate over distance (which it probably would be harder to do for Kennedy [7]'s category of "*eating out with grandparent*"). Storytelling is in the context of this paper defined as the *oral activity of telling*, that is, conveying a story from one to another. In the context of this paper, a story is defined as one of two things. A story is either *real*, for example about daily life, mapping to Kennedy [7]'s category of "*Talking together about recent events in each other's lives*" or *fictional* and read out loud, mapping to Kennedy [7]'s category of "*Reading books and telling stories together*". Thus the goal is to mediate both telling of real and fictional stories in the system.

4. THE STORYTELLING SYSTEM

The goal of the storytelling system is to explore if grandparents and grandchildren find it fun, meaningful and possible to share activity over distance and, if this is the case, how they choose to do it. The system had to require no intervention from researchers during use as this potentially would be annoying for the participating families and thus hinder use. The age of the participating family members also had to be taken into consideration. Children could find the system boring and the grandparents could be intimidated by the system, both cases resulting in potential less use. Overall, the system therefore had to be easy to use and contain a few, carefully selected but intriguing features which would be relevant for the household's endeavor to get more in touch.

The system presented in this paper can be considered a technology probe [6]: it has data logging capabilities, it is an early design, and the goal of the subsequent analysis of its use is to explore *how it is used* rather than usability. Regarding data logging, the system was equipped with recording capabilities for making all communication and interaction available for subsequent analysis.

4.1 Conceptual Design

The conceptual design of the system was inspired by Yarosh, who built the ShareTable for shared viewing of *physical* objects [19]. Adapting this to a less physical context, but with the same objective – shared viewing - the system was designed to allow sharing of *virtual* objects, through a *shared display*. Thus the system was made to consist of two LCD monitors and two computers, one set for each house-

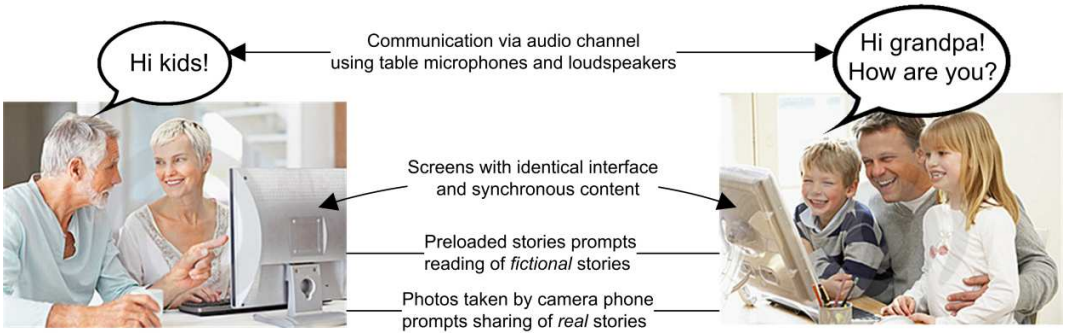

Figure 1: Conceptual overview.

hold. The shared display was implemented by replicating one household's interaction with the system on the monitor in the other household and vice versa, thus following the *What You See Is What I See*-concept [14]. The system was furthermore equipped with an audio channel through which grandparents and grandchildren could talk to each other as on a normal phone. An important part of bonding is getting to trust each other and research shows that "*speech plays a significant role in [the] development*" of trust [5]. Research also shows that trust indeed can develop in a non face-to-face situation [3]. Thus, as the motivation behind the research grounding this paper is to improve bonding between grandparents and grandchildren living apart, an audio channel was deemed necessary. Supplying the system with an audio channel also conveniently solves the potential issue of asking children, just in the process of learning how to read and write, to communicate using a text-only medium. Figure 1 illustrates this conceptual design.

As the system had to be constructed on a limited budget, it was built of mainstream available technologies, both hardware and software-wise, combined in a novel way. Each household was equipped with a table-based microphone and a set of loudspeakers to allow an audio-channel to be opened. This approach was preferred over providing headsets as it would allow multiple people to talk at once in both households, and as children would not have to put on headsets before audio contact could be made.

4.2 Interaction and Interface Design

The visual interface made available to the households comprises two parts: *initiation of storytelling sessions* and *active storytelling sessions*. One household can at any time choose to *invite* the other to participate in a storytelling session, and the other household then have the option to either accept or deny the invitation. Whenever one household invites the other, a telephone sound is played in both households, to draw attention to the system. Upon acceptance of the invitation, the interface for *active* storytelling sessions is shown. Both households can close the session at any time by clicking on the red cross in the top right corner (see Figure 2). To keep the system simple, and to allow grandparents and grandchildren to help each other use the system even over distance, the visual interface is identical in the two households. This interface is illustrated on Figure 2. Supplying both households with the same interface to make it easier for them to help each other is previously shown to be effective in establishing common ground between two distributed persons when the objective is for one to help the other [10].

The interface for active storytelling sessions contains two conceptually different parts. One part is a *shared visual space* [10], where everything shown, and all actions done, is replicated to the other household, hence in effect making it a shared space. Having such a shared space is shown to improve communication between distributed people [10]. The other part is *toolbars*, where the different mediated storytelling activities can be initiated from. This distinction can be seen on Figure 2. The shared visual space was designed with an unlimited amount of empty *slides* (as in PowerPoint) which both households can navigate between as they desire using the left and right arrows. The following describes the different types of objects available in the system for insertion on slides.

Fictional stories

The first type of mediated activity made available concerns telling *fictional* stories. When a fictional book is read aloud in a collocated setting, both the grandparent and grandchild

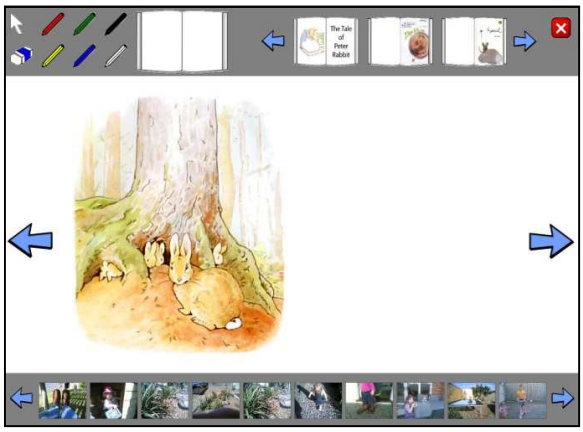

Figure 2: The interface design of an active storytelling session, where the first page from the fictional book "Peter Rabbit" is chosen. The large white area in the middle is the shared visual space. The bottom row is the photo toolbar. The top row toolbar contains the books and the coloured pencils.

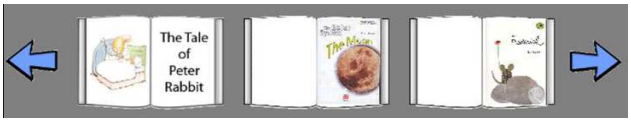

Figure 3: Using the arrows, ten story books can be read.

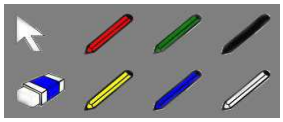

Figure 4: The coloured pencils and eraser-tool.

can touch the book, see the book and influence the choice of book to read. This was mediated in the system by making 10 different children's books available in the toolbar section, as seen on Figure 3. Both grandparents and grandchildren are given the opportunity to select books to read and to navigate the pages in a chosen book by pressing the left- and right-pointing arrows. When a book from the toolbar is selected in one household, the same book is shown on the monitor in the other household. The same is the case when navigating pages. The hope was that these shared books would make grandparents and grandchildren interested in reading aloud stories to each other.

Real stories

The second type of mediated activity made available concerns telling *real* stories. When the grandparent asks their grandchild "*what have you been doing today*?" on the phone, the grandparent expects the grandchild to tell stories about his/her day. With the purpose of making conversation easier around those types of questions, the system was designed with the possibility to share photos. This was done by supplying a designated camera phone for each household to use at their own discretion, whether in the house or "on the run", and then allow the households to share these photos in the shared display. It was hoped that these photos would prove to be a valuable addition to questions as "what have you been doing today" by making it easier for especially children to remember which stories about their daily life they could tell. Figure 5 illustrates how these photos are made available in the bottom toolbar section. Both households have the possibility to drag a photo from this toolbar into the shared visual space. When a photo is taken by one household's mobile phone, it is placed in the photo toolbar in *both* households. The idea behind this decision was to make a scenario possible where the grandparent would drag a photo taken by the grandchild into the shared visual space and ask "what are you doing in this crazy photo?", thus prompting conversation. An unlimited amount of photos can be inserted on the same slide, photos can be moved around and photos can be resized without maintaining proportions.

Sharing books and sharing personal photos serves the goal of exploring if grandparents and grandchildren find it fun, meaningful and possible to tell stories or talk about personal experiences over distance and if this is the case, how they choose to do it. Sharing books and personal photos is well in line with previous research concluding that interfaces for children "*should […] elicit sharing or storytelling*" [2].

Coloured pencils

A series of coloured pencils and an eraser were also added to the toolbar section (see Figure 4). These pencils can be used to draw on top of story books, photos and blank slides and the eraser can be used to erase it again. As every parent knows, children love to paint. It was hoped that children would use these pencils to perhaps make paintings for the grandparent or that grandparents would use these pencils to tease the grandchild, a trend Ballagas et al. found grandparents would use to "*engage the children in the conversation*" [2]. Ballagas et al. also found that children in general are more inclined to express their ideas through action than through words [2], a finding the pencils hopefully support well. Finally, touch-enabled LCD monitors was used. This would allow children to paint with the pencils on the monitor as they would have done on paper. More than one person would also be able to interact with the system simultaneously without having to fight over control of the mouse. However, the mouse would still be visible for use if desired.

4.3 Technical Design

The system was implemented in 1½ month time by a single researcher. The audio channel between the two households was implemented using an existing piece of audio communication software [16]. The interface displayed on Figure 2 was implemented in a C#-based Windows Forms client. It communicates with a Microsoft SQL Server database in real-time to ensure that actions from both households are replicated in the other household. Finally, photos are taken with a Nokia 7610 camera phone, and via MMS sent to an e-mail address. A C#-based console application then extracts these photos from the e-mail address at regular intervals, saves them in the SQL Server database and adds the photos to the photo toolbar in both households. The technical design is illustrated on Figure 6.

5. DEPLOYMENT

The system was deployed in a field study with two participating families. The objective was to get an understanding of how the grandparents and grandchildren used the system to augment their contact. The families received no remuneration but had the costs of their involvement covered.

Figure 5: The photo toolbar. Using the left and right arrows, all photos can be seen and inserted.

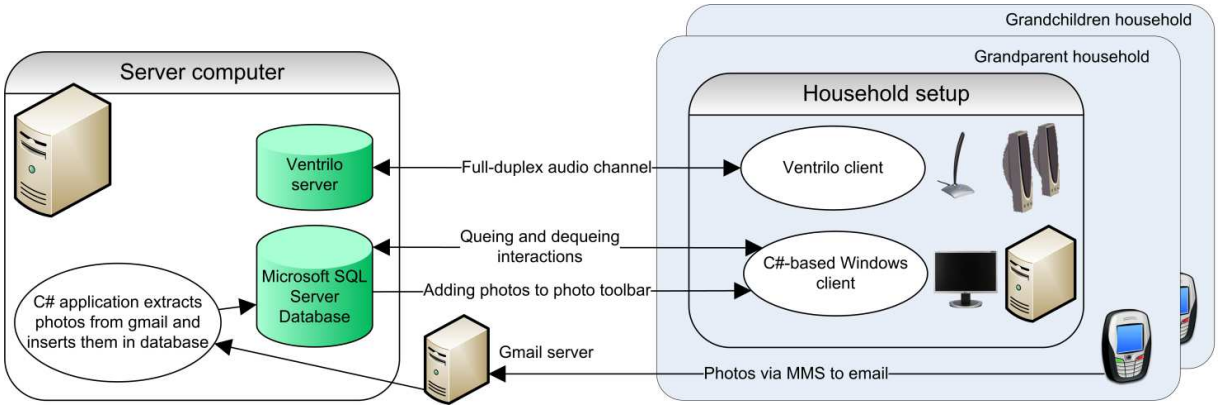

Figure 6: Technical overview of the system.

5.1 Participants

Participating families were recruited through academic staff at the University of Melbourne. Each family had to meet a basic set of requirements to be selected for participation. Both households in the family had to be located in the greater Melbourne area. The parents had to have at least one child aged between 4 and 8, and the grandparents had to live in their own household and require no external care. These requirements were put in place to ensure that the family would, and could, invest the time required to generate useful data. The participating families had complete freedom regarding frequency, content and time of use. Several families volunteered to participate in the study among which the following two families were chosen. Family 1 consisted of two children aged 5 and 6 and two grandparents. They kept in contact using the phone and lived around 30 km. from each other. Recent shared activities between the grandparents and grandchildren included the children having sleepovers at the grandparent household, baking, and going to science museums. Family 2 consisted of three children aged 2, 6 and 8 and two grandparents. They also used the phone to keep in touch, and lived around 20 km. from each other. Recent shared activities include looking at books together, reading stories and painting.

5.2 Method and Data Collection

When a family had agreed to participate in the study, identical set up dates were scheduled with both households to minimize the amount of time one household would have a non-working system. At the scheduled date, two researchers drove to the two households. The following procedure was then followed for both households in both families.

First, a semi-structured interview was conducted. The intention of this interview was both to "break the ice" between the household residents and the researchers but more importantly to achieve a basic understanding of how that household communicated with the other household. Among the questions asked were how they currently stay in contact with the other household and which problems they have experienced with this. Second, the system computer and the 19inch touch screen monitor were installed in the household. To facilitate use, the touch screen was placed in a central, high traffic area in the household, such as on a kitchen table. The computer and the keyboard were hidden away as much as possible. The mouse was kept visible and usable. The computer was wirelessly connected to the household's existing ADSL-based internet connection (all households had that already). The family was informed that they could use the system in whatever way they found suitable or exciting. After having briefly demonstrating the available toolbars, made sure the audio channel worked and instructed the household's residents on how to send photos from the camera phone, the two researchers left the household. While the family had the system installed, the system was monitored remotely and technical problems were solved as quickly as possible. Every time the family used the system, a screen capture program [4] recorded both what was shown on the touch screen and their voice talk. This happened automatically in the background without interfering with the use of the system. This was supplemented by a log file with time stamped entries of every time a household tried to initiate a session, what the response was from the other household ("accept" or "deny") and how long initiated sessions lasted. When the system was collected from the households again, a second semi-structured interview was conducted investigating how they used the system, what they liked and disliked and which tools they used the most. During both the pre- and post-use interview, the most valuable comments came from the grandparents and the parents, as the grandchildren generally had a hard time maintaining focus on the interview.

The system had to be deployed sequentially to the two families for technical reasons. To harvest enough data and ensure that system usage routines developed, the intended duration of a deployment in a family was four weeks. Unfortunately Family 1 only had the system for 14 days as they chose to opt out, presumably caused by lack of time to use the system in the grandchildren household. To compensate this, Family 2 was given the system for an extended period of time, a total of 45 days.

5.3 Data Analysis

Even though storytelling activity was the activity the system was built to facilitate, it would limit the analysis if

storytelling activities were the only area of interest, as the nature of a technology probe is to explore the unknown and as the participants can "*use them [the probes] in unexpected ways*" [6]. Vetere et al. observed grandchildren and grandparents together in collocated playgroups and derived categories for shared collocated play [17]. Among these categories are *instruction* (e.g. how to use an object), *performance* (e.g. singing a song), *game* (e.g. playing with a ball) and *joking* (e.g. telling an obvious lie). Besides storytelling activity, these four categories further worked as inspiration for types of shared activities to look for in the analysis. Using Grounded Theory [15], inductive knowledge was created in the following systematic way. The video recordings of the storytelling sessions, 5½ hours in total, were transcribed in columns. The first column contained a direct transcription of the speech. The second column contained a description of what they did in the shared space (e.g. "Grandparent inserted a photo"). During this process, whenever an interesting event occurred, this was noted in a third column, representing the *properties* in Open Coding. A total of 238 properties were identified, which were subsequently categorized as 47 different *phenomena*. Using Axial Coding, connections were made between these phenomena, resulting in 12 *categories*. Using Selective Coding, these categories were divided among three *themes*, each of which is central to the use of the system and each of which is treated in the next section. This process took 31 hours to complete.

6. FINDINGS

The analysis revealed several instances of successful mediation of collocated shared activity and even instances where existing types of activity were mediated in a novel way. This is supported by video recordings from both families showing the grandparents and grandchildren having a really good time together.

6.1 Observed activities

A total of 17 sessions were conducted, two by Family 1, and 15 by Family 2. Family 1 used the system for a total of 30 minutes, while Family 2 used it for 5 hours and 3 minutes. The average length of a session was 14 minutes with a maximum length of 33 minutes. Most eager to initiate sessions was the grandchildren (59% of all attempts), however an indeterminable amount of these attempts is the mother initiating.

Reading stories aloud

Reading the fictional stories aloud was a popular activity among grandparents and grandchildren. Most often, the grandchild chose the story, which the grandparent then read to the grandchild, adapting his/her voice to the story character. Sometimes the grandchild got really into the story, and did nothing else than turning the page of the book when instructed to by the grandparent. The longest session with a grandchild 100% immersed in story reading lasted close to 17 minutes. This is very similar to the way one of the grandparents reported s/he told stories with collocated grandchildren by sitting with the grandkids, reading a story, letting the grandkids turn the pages and chose the story. Beside these sessions, where the grandchild said nothing for a long period of time, the story books often prompted conversation. The grandparents often explained the meaning of words and asked questions about the story to the grandchild, who eagerly answered. The grandparents also related the story to the real world, e.g. by elaborating on a story item (e.g. explaining where Eucalyptus trees grow because a Eucalyptus tree was present in a story). This is very similar to activities the grandparents reported doing with collocated grandchildren, where they during reading of books explain concepts or elaborate on the story. Other times, the grandchildren were really active during the grandparent's reading out loud. A common action by the grandchildren was to paint on top of story characters, which amused both parties. In one episode, a grandchild painted red spots on top of a story character, which prompted the grandmother to say "*Ohh, he's got measles*", which made the child laugh. Some stories also made the grandparent and grandchild act out specific lines from the story by yelling the line into the microphone, which also amused both parties. The grandparents also often suggested that the child read a book out loud. The child agreed to do this only a few times, and the child's reading aloud lasted only a few pages before the child lost concentration or literally asked the grandparent to read instead. During these attempts of the child to read aloud, the grandparent helped with the reading by pronouncing difficult words to the child, who then repeated the word.

Drawing and sharing personal photos

The photos taken by camera phone turned out to provide opportunities for talk as well. During the time where the system was deployed in the families, family 1 and family 2 took and sent 17 and 77 photos, respectively. In one episode, a photo of a papier mâché dinosaur made by the grandchild was shared, and the grandchild eagerly answered all the grandparent's questions about her/his creation. Other photos induced similar patterns of talk. The ability to resize inserted photos also proved to trigger laughter. In an example, one granddaughter inserted a photo of her older brother, and said "*Then I make it [the photo] biiig [taller] and them I squash him [minimize width dramatically]*". This caused the grandparent to reply "*What does that fell like, squashing your brother? Does that feel good?*" which the grandchild answered with loud laughter and a "*yes*". The coloured pencils were also often used combined with the photos. This is exemplified on Figure 7 (on the next page), which is a screenshot from the video recordings, showing a grandparent and grandchild drawing on top of a photo of the grandparent. The coloured pencils were also used without photos and story books in various ways. They were used for playing games, specifically tic-tac-toe, where the grandparent had one colour, the grandchild another, and the tic-tac-toe board was drawn with a third colour. They were used to write messages, as "Hello", to the other part. They were also used, mainly by the grandchild, to make drawing to the grandparent (e.g. a rainbow). Playing games together,

and drawing pictures, either together or for each other, are activities both participating families reported were also typical in a collocated, non-mediated setting.

Teasing

Several episodes of mutual teasing could also be observed in family 2. At one point, the grandparent said "*This is the tale of Peter Rabbit*", when the grandchild just moments before selected another story, which caused the child to answer "*no, it's not*" and the grandparent to laugh. Later, the grandparent drew a story character blue, and claimed he was unaware who did it, even though the child suspected the grandparent did it. This is a good example of the grandparent teasing the grandchild in a way that would not be possible in a collocated, non-mediated setting. The grandchildren were just as teasing. Over time a pattern emerged where the grandchild, while the grandparent was reading aloud, used the white pencil to overwrite, hence effectively erase the story text the grandparent was reading out loud. While erasing, the grandchild often laughed a lot, and it only got funnier when the grandparent started to tease back by erasing the white spots, hence making the text visible again. Another example of mutual teasing involved switching story books. While the grandparent was reading out loud, the grandchild suddenly selected another story book to tease the grandparent. However, the grandparent chose just to read aloud whatever was shown in front of him, which made the grandchild laugh a lot. This episode of rapidly changing story books went on for several minutes.

Bonding

When the grandparents from family two were interviewed after they had used the system, they interestingly reported that the system provided them with opportunities for bonding that would not be possible in a collocated setting. The grandparents agreed that one of their grandchildren were pretty shy when s/he visited them, but that the same grandchild was "*much more free*" when s/he used the storytelling system over distance, and that the grandchild probably saw especially the grandfather as more relaxed. This example can be related to previous research which found that shy individuals fell less inhibited in an online (distributed in space) setting than in an offline (collocated) setting [13].

6.2 Deviating "one grandparent, one grandchild" use

The most common ways the families used the system was one grandparent interacting with one grandchild. However, the video recordings also reveal examples where one grandchild joined another grandchild in an existing session and examples where multiple grandchildren participated simultaneously for the entire duration of a session.

The examples with more than one simultaneous interacting grandchild varied a lot with respect to both the grandchildren's mood and the types of activities conducted. In one session, a grandparent was reading a fictional story to two grandchildren simultaneously, who both answered his questions about the story but otherwise stayed passive and immersed in the reading aloud. In another session, where the

Figure 7: A screenshot from the video recordings, showing a grandfather and granddaughter having a good time together, painting on top of a picture of the grandfather.

grandparent was reading aloud a story, both grandchildren were having a really good time together with the grandparent. They used the pencils to draw on top of story characters, e.g. to make the character cry, which made both the grandchildren and the grandparent laugh out loud. At one time it was even observed that one grandchild helped the other grandchild use the system, i.e. selecting a tool. However, just at often, the two grandchildren got annoyed at each other. When one grandchild was being read a story by the grandparent, the other grandchild entered the scene, starting to touch the touch screen. This caused great irritation for the first grandchild, exemplified by loud yelling of "*stoooop*" or "*you're keeping it all to yourself*", signaling that one grandchild preferred the other was not touching the touch screen. During the setup in the first family, when the children were given control over the touch screen, not two minutes passed by before one of the children started crying, fighting over control. Interestingly, it only took a few seconds for grandchildren to change their mood during sessions with two simultaneous grandchildren. One second, the two grandchildren really enjoyed each other's interactions, and the next, they were really annoyed at each other. One session had participation of all three grandchildren in the second family, the mother and a grandparent. Two of the grandchildren painted with the pencils, helped by the mother, while the third grandchild played the flute for the grandparent. This illustrates the diversity of the system.

The mother in the two families also proved to play an important role for successful use of the system by the grandchildren. The mother often intervened during active storytelling sessions, and by talking with the grandparents scheduled when the next storytelling session was going to take place. The mother also initiated storytelling sessions and fetched the child or the children only when she had made sure the grandparents were available and had time for a storytelling session. Similarly, she replied to invitations from the grandparent if neither of the children heard the ringing sound and then gathered the children. During sessions, the mother helped the children both to use the system, for example explaining how to enlarge pictures, and suggested activities as "*why don't you [the grandparent]*

read a story to [the grandchild]?". Several times the mother also supplied visual clues to the grandparent about current grandchildren activity. Once, when the child did not immediately answer a question from the grandparent, the mother said "*she has a cookie in her mouth*", thus providing the grandparent with visual clues from the grandchildren household. Finally, the mother educated her children during sessions, warning one grandchild not to yell into the ear of the other grandchild while both were using the system.

6.3 Integrating the system into daily life

The first participating family never managed to integrate the system in their daily life, partly because of technical problems and partly because the mother did not have the energy to facilitate use. However, the second family successfully integrated the system into their daily life to a degree where the children felt down when the system was recollected from their household. Figure 8 shows when on the day most storytelling sessions were conducted, showing a clear preference for evening sessions.

Daily life in the grandchildren household also affected system use. The second family got into a routine where they conducted storytelling sessions in the evening having two grandchildren swapping the use of the system with having a bath. During sessions, it was common for the grandchild interacting with the system to be disturbed by other matters in the household, causing the grandparent to feel insecure if s/he still had the attention of the grandchild. The system also affected the daily life in the grandchildren household, exemplified by the grandchild escaping bed to have a session with the grandparent and disobeying the mother's call to dinner because the system was more exciting.

7. DISCUSSION

7.1 Themes

Four themes are derived from the data and discussed related to how the themes are important for supporting grandparents and grandchildren communicating synchronously over distance and how these themes are important for future attempts to design technology with this goal in mind. Even though these themes are elicited based on empirical data from grandparent/grandchild contact, it is imagined that the same themes are useful to consider when designing technology supporting contact between distributed parents and children, e.g. in the case where one parent travels a lot.

Conversational Context

Ballagas et al. found that children have a hard time staying engaged in a phone conversation [2]. Based on a focus group study, Evjemo et al. concluded that parents appreciate communication technologies that provide conversational context [5]. This paper presents an attempt to provide distributed grandparents and grandchildren with conversational context in a real setting. The telling of fictional stories, the ability to share personal photos and the creativity shown with the pencils indicates that both grandchildren and grandparents really enjoyed the storytelling sessions and bonded during so, by sharing the same conversational

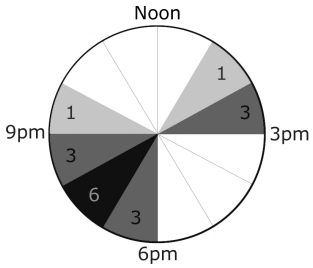

Figure 8: The numbers illustrate how many sessions were initiated at that hour on the day. No sessions were initiated between midnight and noon.

context. This paper thus supports the need of a conversational context found by Evjemo et al. [5]. It also appears the system provided better opportunities for bonding than previous referred research have shown the telephone can do, if it is used alone.

Facilitation

The way the system was used in the families suggests that it is important to consider the role parents play facilitating contact between distributed grandparents and grandchildren. This study shows that parents can greatly increase the amount of bonding contact between the grandparents and grandchildren. The parents are probably more aware of the routines in the grandparent household than the grandchildren are. This makes the parents important for prompting the grandchildren to initiate contact at a time of day where the grandparents have a higher chance of being available. The case of Family 1 shows what can happen if neither parent has the time to facilitate use, as both parents were either not home or very busy at home during the two weeks this family had the system, resulting in very little system use by the grandchildren. During sessions of contact, the parents also play an important role, by supporting the children both technically and conversationally and making sure two concurrent interacting children are not fighting (too much) over control. Thus when designing technology for supporting bonding between distributed grandparents and grandchildren, it is important that the role of the parents is considered as well and that parents are given an opportunity to play a role, as they both can help the children with the technology and have to permit the children to use it.

Diversified Interaction Forms

The use of the system in the two families also revealed the importance of diversified interaction forms when designing for children. Children have, similarly to adults, some form of a daily routine. During the day, they're full of energy, running around, playing and are generally just really active. When using the system, similar behavior was observed with the child interacted wildly, painting fast, and browsing pages fast, thus being active. This is exemplified by one child saying "*I'm gonna make you a rainbow*" (with the coloured pencils), whereupon the child started painting wildly with all the colors. This is contrasted by behavior later on the day. The interviews conducted in the two families before they were given the system revealed that it was

common for the parents to read aloud to the children before they went to bed, or when they were in bed, before they fell asleep. Again, when using the system, similar behavior could be observed when a child said "*Tell me a story*" to the grandparents, and then did nothing for almost 20 minutes but turning the pages when instructed to. This suggests that the various ways the children interacted with the system is influenced by the daily routine of the child, who probably expects to be told a story at bedtime whether by the collocated parent or by the remote grandparent. It is also possible that the general mood of the child affects what the child in the moment finds exciting. If the child has had a very energetic day, the child may be interested in a more passive interaction form in the afternoon. No matter if the child was very active or very passive, both the child and the grandparents appreciated the interaction. This suggests that to optimize the possibility for bonding between distributed grandparents and grandchildren to occur, the technology should encompass a diversity of interaction forms to suit the current activity level of the child.

Supporting Grandparent Caring for Grandchild

When grandparents and grandchildren play together in a collocated setting, the grandparent act as a carer for play, e.g. by selecting playful artifacts, thus ensuring the child is having fun playing [17]. The grandparent can conduct this behavior just by watching the child and the environment. Thus, when the grandparents and grandchildren are given the opportunity to be in contact with each other over distance, this role must be attended to, if shared collocated activity is to be mediated successfully. This study showed that the grandparents did indeed conduct the role of caring by asking questions as "*do you want me to read you a story*?" on the audio channel or dragging personal photos into the shared display, with which the child then played. The video and audio recordings of their interactions also showed that the grandparent adapted his/her activities to the mood of the grandchild. If the grandchild at one point e.g. was not interested in hearing a story, the grandparent immediately suggested other activities. The audio channel alone played an important role in facilitating this, as the grandparent through this got immediate knowledge of the mood of the grandchild, by his/her laughter, voice pitch etc. The grandparent knew s/he had been successful when the child burst out in laughter. These examples show that the grandparent role of caring is important to take into account when designing technologies for improving contact between distributed grandparents and grandchildren. It is also clear that having an audio channel and a shared display provides the grandparent with the possibility to care for the grandchild, thus ensuring the child is having a good time.

7.2 System issues

A common observed issue was that the system lacked information supplying the grandparent with information about what the grandchild were doing. The grandparent would ask, as an example, "*Which photo are you talking about*", and the grandchild would then point on the particular photo and say "*this one!*". As the system did not inform the grandparent where the grandchild was pointing, the grandparent had no way of knowing which photo the grandchildren pointed on. This happened several times and suggests that the child was having a hard time grasping which actions could and which actions could not be seen by the grandparent. This issue would be easy solvable by displaying the current position of the grandchild cursor on the grandparent monitor. However, at one occasion the child by itself figured out to use one of the coloured pencils to paint on top of the photo in question.

The decision to use loudspeakers and table microphones in both households unfortunately proved to be troublesome as this introduced severe acoustic echo in both households. Speech from one household was played back on the loudspeakers in the other household, and therefore also re-recorded in the other household, and then transmitted back to the first household. Especially the grandparents in both families expressed serious irritation over this. The loudspeakers had an important role by playing the telephone sound upon receiving an invitation to participate in a story-telling session to get the attention of the household residents. The table microphones also played an important role as they allowed multiple grandchildren and even multiple parents to chat with the grandparents simultaneously. They furthermore captured everything else going on in the households, which also proved to be a primer for conversation. The problem of acoustic echo could be solved by implementing acoustic echo cancellation, although this is not simple to do. Another way to solve this would be to use headsets instead of table microphones, but this would limit concurrent grandchildren participation to the amount of headphones available and significantly decrease the amount of sound recorded from further away in the household than just in front of the touch screen.

The system also proved to be such a good instrument of play for the grandchildren that it can be interpreted as a barrier for bonding. Once, a grandfather was in the process of telling a story to the grandchild, when the grandchild started to interact wildly with the system, switching the pages fast. While the grandfather often just laughed when the child did this, the observed reaction in this example was different. The grandfather got so annoyed by the grandchild's constant interruptions of his reading that he denied reading anything more that day. A more common observed phenomenon was the grandchild being so immersed in painting with the coloured pencils that questions from the grandparent stayed unanswered despite several attempts by the grandparent to initiate conversation. This suggests that sometimes the grandchild saw the system more as an instrument of individual play than an instrument of shared activity, which does not work towards more contact between distributed grandparents and grandchildren. This could be addressed by giving the grandparents more control over which tools the grandchildren can use at any time, at the risk of losing the child's interest in the system.

7.3 Limitations

During analysis, it was impossible to be absolutely sure of who was using the system at a certain time. This is because the system was often used by several members of the same household concurrently and because the system did not record visual information about who was using the system (this could have been accomplished with a webcam, recording but not broadcasting the video stream to the other household). The household member interacting with the system at a certain point in time was thus often determined by an educated guess based on the audio channel communication and knowledge of previous use patterns of the system. Furthermore, the degree of generalisability of the above presented themes can be questioned as only two families participated in the field study. Usage might differ substantially in other families, potentially leading to discovery of other themes. The presented themes are also not requirements in a traditional way, nor do they constitute a grounded theory. They are merely to be used to trigger design ideas and to be reflected upon when designing technology for distributed bonding when children are involved.

8. CONCLUSION AND FUTURE WORK

This paper has explored how to design technology to improve contact between grandparents and grandchildren living apart. The design, implementation and deployment of a system have been presented and important themes have been elicited. The results indicate that grandparents and grandchildren are keen to stay in contact when a conversational context is provided, e.g. by sharing reading of fictional stories or sharing personal photos. It is also shown that parents play an important role as facilitators of contact between their children and the grandparents. The daily rhythms, and how that affects the activity level of the child, must also be given thought when designing technology to be used partly by children. The study also shows the importance of taking the grandparent's role of carer for play into consideration to allow meaningful and fun sessions of contact to arise. It is hoped these themes will help fellow researchers when designing technology for improving contact between grandparents and grandchildren living apart.

As this study reveals a preference to use the system in the evenings, it is expected that grandparents and grandchildren will face further challenges maintaining or building a relationship when they live in each their part of the world, and thus perhaps in each their different time zone. This is currently being explored by deploying the system presented in this paper together with the Collage system [17] in a field study with two Danish/Australian distributed families. Findings from this will be reported in a subsequent paper.

ACKNOWLEDGEMENTS

The author would like to thank Jesper Kjeldskov, Sonja Pedell and Frank Vetere for very valuable collaboration and the two participating families for their time and interest.

REFERENCES

[1] Ames, M. G., Go, J., Kaye, J. ' and Spasojevic, M. (2010). Making love in the network closet: the benefits and work of family videochat. Proc. CSCW '10. ACM, 145-154.

[2] Ballagas, R., Kaye, J., Ames, M., Go, J. and Raffle, H. (2009). Family communication: phone conversations with children. Proc. IDC '09. ACM, 321-324.

[3] Bos, N., Olson, J., Gergle, D., et al. (2002). Effects of four computer-mediated communications channels on trust development. Proc. CHI '02. ACM, 135-140.

[4] CamStudio. http://www.camstudio.org. Seen on March, 7th, 2010.

[5] Evjemo, B., Svendsen, G. B., et al. (2004). Supporting the distributed family: the need for a conversational context. In Proc. NordiCHI '04, vol. 82. ACM, 309-312.

[6] Hutchinson, H., Mackay, W., et al. (2003). Technology probes: inspiring design for and with families. Proc. CHI '03. ACM, 17-24.

[7] Kennedy, Gregory E. (1992). Shared activities of grandparents and grandchildren. Psychol Rep. 1992, Feb; 70(1):211-27.

[8] Kornhaber, A. (1996). Contemporary Grandparenting. Thousand Oaks, CA: Sage Publications, Inc. ISBN 0-8039-5806-4.

[9] Kornhaber, A., Woodward, K. L. (1981). The grandparents/grandchildren. The vital connection. Garden City, NY: Anchor Press/Doubleday. ISBN 0-3851-5577-8.

[10] Kraut, R. E., Gergle, D, et al. (2002). The use of visual information in shared visual spaces: informing the development of virtual co-presence. Proc. CSCW '02. ACM, 31-40.

[11] Modlitba, P. L. (2008). GlobeToddler: enhancing the experience of remote interaction for preschool children and their traveling parents. Master's Thesis. MIT Media Laboratory. http://web.media.mit.edu/~paulina/portfolio/PaulinaModlitbaMSThesis.pdf

[12] Raffle, H., Ballagas, R., Revelle, G., Horii et al. (2010). Family story play: reading with young children (and elmo) over a distance. Proc. CHI '10. ACM, 1583-1592.

[13] Roberts et al. (2000). "U r a lot bolder on the net": Shyness and internet use. In Crozier, W.R. (Ed.), Shyness: Development, consolidation and change, Routledge, New York. pp. 121-138.

[14] Stefik, M., Bobrow, D. G., Foster, G., et al. (1987). WYSIWIS revised: early experiences with multiuser interfaces. ACM Trans. Inf. Syst. 5, 2 (Apr. 1987), 147-167.

[15] Strauss, A and Corbin, J. (1990). Basics of Qualitative Research, Newbury Park: Sage.

[16] Ventrilo. http://www.ventrilo.com. Seen on March, 13th, 2010.

[17] Vetere, F., Davis, H., Gibbs, M. et al. (2009). The Magic Box and Collage: Responding to the challenge of distributed intergenerational play. Int. J. Hum.-Comput. Stud. 67, 2 (Feb. 2009), 165-178.

[18] Williams, Brian K., Sawyer, Stacey C, Wahlstrom, Carl M. (2005). Marriages, Families & Intimate Relationships. Boston, MA: Pearson. ISBN 0-205-36674-0.

[19] Yarosh, S., Cuzzort, S., Müller, H. and Abowd, G. D. (2009). Developing a media space for remote synchronous parent-child interaction. Proc. IDC '09. ACM, 97-105.

Appendix B – Research Paper II

"Supporting young Children's
Communication with adult relatives across time zones"

Supporting young Children's Communication with adult relatives across time zones

René Vutborg
Aalborg University
Selma Lagerlöfs Vej 300
9220 Aalborg East, Denmark
rene@vutborg.dk

ABSTRACT

The possibility of regular contact between children and their adult relatives can be compromised if they live in each their time zone. They may find it hard to agree on a time to engage in contact. This paper presents a study of the affect of time zone differences on communication between grandparents and grandchildren living in each their time zone. This is accomplished by deploying a system to time zone distributed families and analysing the use based on four existing theoretical terms on time and events: *rigid sequential structures* (that some events cannot occur before others), *fixed durations* (that most events always last the same time), *standard temporal locations* (that events have a standard time when they occur on the day) and *uniform rates of recurrence* (that some events always reoccur at a uniform rate). A discussion of how to design technology for this domain stresses the importance of considering the parents' role in facilitating contact and making the technology easy to use by children themselves. It also illustrates the advantage of concurrent synchronous and asynchronous interaction forms and the need to respect private time.

1. INTRODUCTION

Communication over distance between children and their adult relatives is complicated when a family has to adapt to their children and relatives being in each their time zone. This can be the case for various reasons. One reason is migration, if an adult son or daughter moves abroad and eventually settles in the foreign country permanently with a husband/wife and children. This would cause the children to grow up without easy regular physical contact with his/her grandparents, if contact at all. If this move results in a large geographical distance in an east-west direction, permanent different circadian rhythms will be induced between the two, as one e.g. might be eight hours ahead or behind the other. Another reason that can introduce time zone differences between children and other family members is if the parents get divorced, and one parent moves to another time zone without the child. Introduction of time zone differences can similarly occur on a temporary basis whenever one parent travels, e.g. on a business trip. Whatever the reason, it might be hard to find an appropriate time of day that suits "both worlds" in these situations, as their daily schedules are misaligned because of the time zone difference. Even though children generally can tell time by the age of six [7], it is unclear how they cope with such time zone difference to a dear relative. This work explores such challenges of communication between children and adult relatives across time zones. This is done by deploying a system to families having children in one time zone and adult relatives in another. Subsequently it is analysed how this system support communication between the two.

Related work is presented first, followed by findings deduced partly from interviews with time zone distributed families and partly from those families' use of the system. The modification to the system in an attempt to alleviate the impact of time zone differences is then presented. Finally, it is discussed how time zone differences influenced the communication between the children and their adult relatives and which consequences this have for designing technology for communication between children and adult relatives across time zones.

2. RELATED WORK

In his famous book "Hidden rhythms" from 1985, sociologist Eviatar Zerubavel explores and dissects the concept of time [22]. He also describes the emergence of the international standardization of time, and thus the concept of *time zones*, as a requirement when the world was connected by railway transportation and telegraphic communication [21] for people to have fixed points in time to refer to.

The influence of different time zone on communication has been investigated by many ICT researchers. Modlitba and Schmandt found that parents travelling to other time zones adjust their schedule to suit the bedtime of their children at home [13]. Lottridge et al. found that partners living or staying in different time zones take the time difference into account when predicting the whereabouts and available of the partner [12]. Cao et al. conducted a thorough investigation of current practices and challenges for communication between family members across time zones and found that all families perceive the time zone difference as challenging [5]. Interestingly, they found a trend of preferring synchronous forms of contact over asynchronous because the nature of family contact is more emotional and about catching up on daily life than functional exchange of information. Reddy and Dourish [14] did a study of rhythms in hospitals, and found that rhythms itself provide information for workers in a hospital. An example is that nurses know

"*physicians will be in the unit examining all the patients during a certain time in the day*". They also found conflicting work rhythms to exist in hospitals because different types of hospital staff (nurses, residents, consultants) would commence their shift at different times during the 24-period of a day, which makes the coordination of work activities among them a non-trivial task.

Attempts to share the daily rhythm of distributed family members or friends using technology include the work by Kim et al. [10]. They designed the BuddyClock to enable family members or friends to automatically share information about their sleeping behaviour with other people in the same circle of friends or family. Each participant had a BuddyClock installed in his/her bedroom and had to "tell" the BuddyClock when s/he went to sleep and woke up. Other friends or family members in the same circle could then on their own BuddyClock see if the person was asleep or had woken up. Evaluation showed that the BuddyClock made the participants fell more connected with those who could see their sleeping pattern. One participant explicitly stated that a device as the BuddyClock would be useful in his/her family as the mother lived 13 time zones away and always had to manually calculate if her son/daughter was awake or not.

3. RESEARCH DESIGN

The research presented in this paper is based on the deployment of a system consisting of two existing components, each developed in a previous research project [19 and 20]. Before the system was deployed in a field study, interviews were conducted with families to get an understanding of how they stay in contact across time zones and which challenges they face during this. After the families had used the system, interviews were again conducted to explore how the system supported contact across time zones. During the field study, the system was modified in an attempt to explore some of the challenges experienced by the families. This research design is illustrated on Figure 1.

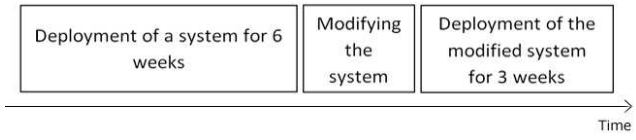

Figure 1: Illustration of the research design.

The system deployed in the field study presented in this paper can be considered a technology probe [9], as it comprise two components each of which is considered a technology probe [19, 20]. This is because the main goal of this study is to explore how the system is used, through extensive data logging, rather than how well it works.

3.1 Case

As the goal of this research is to explore how the time zone difference affects communication between grandchildren and adult relatives, it was important that the case designed involved participants who did not change time zone during the study period, hence lived *permanently* in different time zones. To accommodate this requirement, it was decided to investigate communication between grandchildren and grandparents who lives on each their continent. This also ensured that the time zone difference between them would be significant and not just e.g. one hour.

The system chosen for deployment in the families comprise two components, which are integrated for this study. Each of these components mediates communication between grandparents and grandchildren distributed in space in a novel but different way. Both components contain interaction forms which significantly differ from telephone conversations and having webcam sessions and both components have been shown to make grandparents and grandchildren, who live apart, fell closer to each other [19, 20]. These grandparents and grandchildren lived in the *same* time zone, so it was expected that a deployment of these two components to grandparents and grandchildren living in *different* time zones would reveal interesting challenges related to this specific context. It was expected that these challenges could be generalized to time zone distributed children and parents as well.

4. THE SYSTEM

The system used in this study comprises the Collage component and the Storytelling component. They were chosen for this study as they explore different types of contact between grandparents and grandchildren. The Collage component mediates *play* in both synchronous and asynchronous settings while the Storytelling component mediates *oral storytelling* in a synchronous setting only.

The two components are deployed to the families together and simultaneously, using the same hardware, and thus appear to be one system for the families. This is possible because the two components are very alike. Both components follow the What-You-See-Is-What-I-See approach [16] by providing a *shared visual space* [11] to each of the households, through which the household residents can interact with the system. Interactions from one household are replicated in the other household. Primary interaction in both components happens through touch screen monitors and by using the mouse and neither component involves the use of a keyboard. Both components use a camera phone, which the participating households can use to take photos, which subsequently can be shared on the shared visual space in the households. Finally, both components are technically implemented as client-server solutions, thus enabling the two servers to share information immediately, including the personal photos taken by the camera phones as they are sent off to the system.

4.1 The Collage component

The Collage component is built for "*mediating intergenerational play*" [19] and is meant to be turned on continuously in the household, whenever someone's awake. Personal photos appear from the top and then cascade down the screen simultaneously in both households, as shown on

Figure 2. When a resident from one household moves a photo, this is replicated in the other household. Photos can be moved, resized and rotated. They are randomly selected to be shown cascading down on the monitor, however newer photos are shown larger and more frequently than older ones. Households can send photos from designated camera phones to the component, and these are then shown immediately, accompanied by a "bling" sound played on the loudspeakers. The nature of the component enables both synchronous and asynchronous types of interaction. One household can use the component, for example move photos, without the other household having their component (computer) turned on. With misaligned daily rhythms, where the families are distributed in both time and space, it was expected that the families would appreciate asynchronous possibilities as this. Synchronous interaction is also possible. When both households have their component (computer) turned on, they can watch movement by the other part, which can lead to playful instances of "fight over control" of photos between the participating family members [19]. This is just two examples of possible ways families in another study have used the component [19].

4.2 The Storytelling component

The Storytelling component is built to investigate how synchronous contact between grandparents and grandchildren can be improved by providing them with conversational context in the form of children's books and sharing of personal photos. When a household wishes to use the component, they must invite the other household to participate in a storytelling session. This is done by clicking on a button labeled "*Storytell!*". For this study, this button is placed on top of the Collage component, thus in effect integrating the two components. This can be seen on Figure 2. When one household has sent an invitation, the other household must then actively accept the invitation. Upon agreement between the households to initiate a storytelling session, an audio channel is opened between the two households and the interface illustrated on Figure 3 is shown on the screen on both households. A set of loudspeakers and a table microphone is installed in both households to facilitate the audio channel. This combination of loudspeakers and microphones also makes it possible for multiple residents from the same household to talk simultaneously with the other household. The component plays a telephone sound on the loudspeakers to catch attention when it receives an invitation to start a storytelling session from the other household. In a storytelling session, grandparents and grandchildren can choose to select a story (among 10 preloaded) and subsequently tell it to the other. They can also choose to share a personal photo, taken with a household's designated camera phone, and talk about that photo. These photos can be resized and moved at will. Finally, using a set of coloured pencils, they can draw on top of story pictures or personal photos or just draw on the white space. When they are out of space, they can get a new blank "slide" by pressing the large blue left- and right-pointing arrow. All these activities, including instances of mutual grandparent-grandchildren teasing using e.g. the coloured pencils, were observed when the component was used in an Australian-based field study [20]. It was expected that the families in this study would appreciate these synchronous forms of interactions as well.

4.3 Technical implementation and integration

Figure 4 illustrates the technical setup and the integration between the two components. The Storytelling component is developed in C# using Microsoft SQL Server as database back-end, while the Collage component is developed in Flash using Flash Media Server and the MySQL database as back-end. The only custom-made software developed for this study concerns the personal photos, making every personal photo available in both components without requiring the household to send the photo more than once. This was

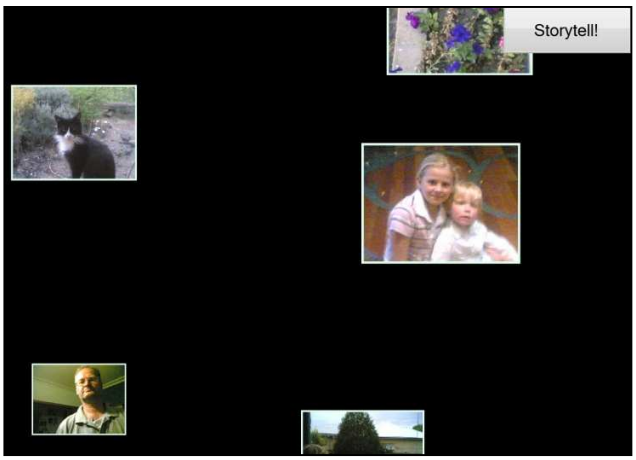

Figure 2: Showing the Collage component running in a household. The Storytelling component can be activated by pressing the "Storytell!" button in the top right corner.

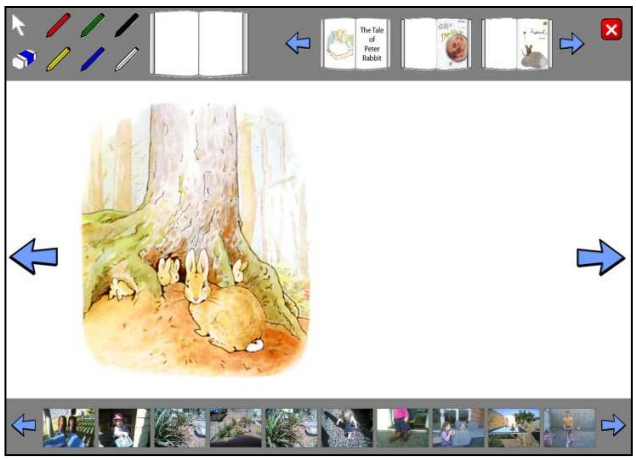

Figure 3: A storytelling session in progress, where a page from a book is shown. The white area is the shared space. The bottom row displays the personal photos taken by camera phone. The top row contains the books and the coloured pencils.

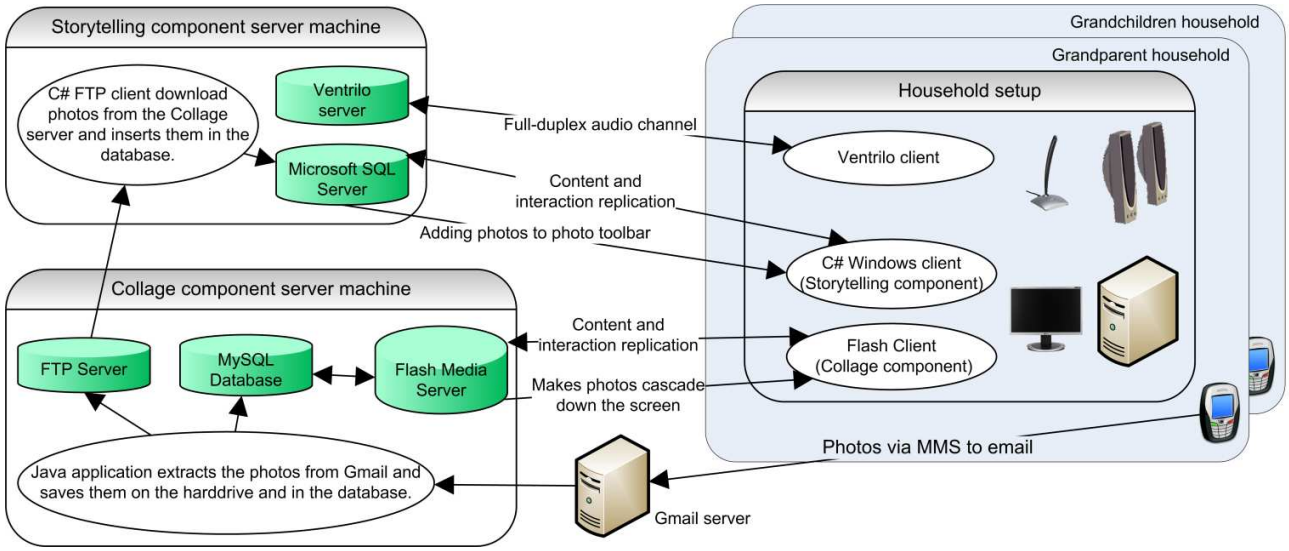

Figure 4: The technical setup of the two components, also illustrating the integration between the two.

accomplished by developing a custom-made FTP client which automatically every 10 seconds downloaded a copy of the personal photo sent to the Collage component and made it available in the Storytelling component. This in effect made the distinction between the two components invisible for the participants. More details of the technical implementation of each of the components can be found in their respective papers ([20] for the Storytelling component, [19] for the Collage component).

5. DEPLOYMENT

The system was deployed in a field study with two participating families. The families received no remuneration but had the costs of their involvement covered.

5.1 Participants

Participating families for the study were recruited through DENMARKhouse, a meeting place for Danes living in Melbourne, Australia. Common for many Danes visiting DENMARKhouse is that they have children in Australia while their parents live in Denmark, thus they were good candidates for the field study. The time zone difference between Denmark and Melbourne is 9 hours, when disregarding Daylight Savings Time (DST). Each family had to meet a basic set of requirements to be selected for participation. The parents had to live in the greater Melbourne area and have at least one child aged between 4 and 8. The grandparents had to live in their own household and require no external care. These requirements were put in place to ensure that the family would, and could, invest the time required to generate useful data. The participating families had complete freedom regarding frequency, content and time of use. Three families volunteered to participate in the study among which the following two families were chosen. Family 1 consists of a grandfather and a step-grandmother living in Esbjerg, Denmark. Both of them have full-time day jobs. The father, mother and three children, aged 6 (boy), 5 (girl) and, 2 lives in Melbourne. Family 2 consists of a grandmother living in Vejle, Denmark. She is retired and the grandfather is deceased. The father, mother and three children, aged 14 (boy), 11 (girl) and 7 (boy), lives in Melbourne. Common for both families is that the grandchildren and grandparents have met physically previous in their lives, and thus have some form of relationship and knowledge of each other even though they now live in each their time zone.

5.2 Method

When a family had agreed to participate in the field study, set up dates were scheduled with both the grandparents in Denmark and the parents (and children) in Melbourne. At the set up in the household, a semi-structured interview was conducted first, giving insight in current challenges of staying in contact with the remote household. Second, the system computer and the touch screen monitor were installed in the household. To facilitate use, it was placed in a central, high traffic area in the household, such as on a kitchen table. The computer and the keyboard were hidden away as much as possible. The mouse was kept visible and usable. The computer was wirelessly connected to the household's existing ADSL-based internet connection (all households had that already). The family was informed that they could use the system in whatever way they found suitable or exciting and the different possibilities in the system were demonstrated. Every time the family used the Storytelling component, a screen capture program [4] recorded both what was shown on the touch screen and their voice talk. This happened automatically in the background without interfering with the use of the system. This was supplemented by a log file with time stamped entries of every time a household tried to initiate a storytelling session, what the response was from the other household ("accept" or "deny") and how long initiated sessions lasted. When a photo was sent to the system, and thus to both components, the sender and the time on the day was logged. When the system was collected from the households again, a second

semi-structured interview was conducted investigating how they used the system, what they liked and disliked and if, and how, the system supported communication with the remote household's residents.

To harvest enough data and ensure that system usage routines developed, the system was deployed in each family for three weeks. The system had to be deployed sequentially to the two families for technical reasons. The time zone difference during the deployment in the first family was 10 hours, because of DST in Australia, where as it was between 8 and 10 hours during deployment in the second family, because DST came into effect in Denmark and ended in Australia.

After Family 2 had had the system deployed for three weeks, their use informed modifications to the system. Family 2 subsequently agreed to have this modified system installed for another three weeks. The modified system was deployed remotely to the households using remote desktop software [17]. After three weeks, the complete system was recollected from the family and another semi-structured interview was conducted exploring if, and how, the modifications impacted how the families used the system.

5.3 Data Analysis

The analysis was conducted using four parameters coined by Zerubavel on the concepts of time and events [22]. The four parameters are *rigid sequential structures* (that some events cannot occur before others), *fixed durations* (that most events always last the same time), *standard temporal locations* (that events have a standard time when they occur on the day) and *uniform rate of recurrence* (that some events always reoccur at a uniform rate). All interviews were transcribed and subsequently examined, looking for instances where the families faced issues related to one of the four parameters or to their misaligned daily rhythms in general while keeping an open mind for other, non-expected issues they faced in their attempt to communicate between the households. The video recordings of all conducted storytelling sessions, 6½ hours in total, were also reviewed with similar objectives.

6. FINDINGS

6.1 Challenges of staying in contact

The interviews conducted in the families before the system were deployed revealed that the grandparents from both families found it difficult to really engage in conversation with children over a regular telephone. This finding is not surprising taken previous research into account [1, 2, 6, 20]. What is interesting is that grandparents from both families had a very pronounced idea that this was the case especially with boys. When enquired on this subject, one of the grandchildren supported this by stating *"I hate it, because it is a waste of time. I am always meant to talk on the phone when I am up to something –some other things"*. The children seldom used email to communicate with their grandparents, and when they did, they were in the background as a parent would write the actual email.

The families also faced challenges specifically related to the time zone difference. Both families reported that the time zone difference made communication more troublesome than communication with family members in the same time zone. This was largely due to the small windows available for communication, because, for example, one would sleep while the other was at work/school. This supports the findings by Cao et al. [5] on family communication across time zones. The time zone difference made Family 1 have telephone conversations only during the weekend, where both households had the time. The families also appeared to have difficulty calculating what the time was in the other household. When conducting the interviews, both grandparents and parents from family 1 was well aware of what the time difference was between the two households (8, 9 or 10 hours). What they continued to struggle at, however, was to remember if they were supposed to subtract or add that amount of hours to their own time, to get the time in the other household. The time zone difference also seemed to make it even harder to find a common subject to talk about across time zones, as stated by one grandparent: *"First you have to think: what are they doing down there? You have to think which time on the day it is"*.

6.2 Facilitating contact by using the system

The system successfully facilitated contact between the grandparents and grandchildren as both families enjoyed using the system and felt they were closer to the remote family members after having used the system. A grandparent from family 1 said: "*We have never had so much contact with them as now*" and a grandparent from family 2 said: "*Our relationship is closer now than before*". According to the father from Family 1, his daughter and his parents "*hardly never spoke on the phone [before], where know she [the daughter] looks forward to [using] it every day pretty much*". Interestingly, this outcome was reached through very different use patterns in the two families. This difference is reflected in the use statistics shown in Table 1.

	Family 1	***Family 2***
Photos sent	142	52
Number of storytelling sessions	10	16
Total duration of storytelling sessions	2 hours, 36 minutes	3 hours, 58 minutes

Table 1: Statistics from three weeks use in each family.

6.3 Preferring the Collage component

Family 1 largely preferred to use the Collage component, hence non-voice contact. The grandparents had the computer turned on almost all the time when they were home, and really enjoyed watching and rearranging the photos that were flowing down in a waterfall-style manner. The grandmother said that *"every time a new [photo] arrived, we just HAD to see it"*. The grandparents often saw new photos as 79 % of the 142 photos taken by this family were

taken by a member of the grand*children* household. Photos they did not recognize would prompt talk and conversation in that household. According to the father, especially the grandson used the Collage component a lot, "*just looking at the photos*". The grandfather also eagerly described one episode, where he was excited to discover photos continuously coming in from the grandchildren showing them walking with their parents on Bondi Beach as part of a vacation in Sydney. This shows that the Collage component provided opportunity to follow the lives of the residents in the other household as events were unfolding. Family 1 did however use the Storytelling component as well. A common pattern detected by analysing the video recordings was that one of the grandchildren started a storytelling session, said "*Hej Bedstefar*" (Hello grandpa), had a short conversation with the grandparent, and then started painting or playing with photos largely without anymore talking with the grandparent. Sometimes they did however speak to each other, often prompted by the parent. The photos also worked as a primer for conversation about daily life a few times. They never told nor used the fictional stories in the Storytelling component. The grandson mainly used the Collage component, because, as his father said, he "*is not into talking*" and thus preferred non-voice contact. The opposite was the case for the granddaughter, who mainly used the Storytelling component. She loved to talk, and actually for the first week thought that her grandfather could see her visually when she was using the storytelling component. According to the father, she "*kept looking behind the screen, "Now you can't see me" and "Now you can", because they told about the same photo so she just couldn't figure out that there wasn't a camera in there*". When not counting weekends, 86 % of the storytelling sessions were conducted in the morning hours for the children, often between 7 and 8 am, which was equivalent to evening time for the grandparents.

6.4 Preferring the Storytelling component

Family 2 largely preferred to use the Storytelling component, hence having voice contact between the two households. Even though the grandmother is retired, she had a busy daily schedule away from home and thus preferred the kind of intense contact with her grandchildren as the Storytelling component could provide. Just playing with the photos in Collage was not enough for her. She only took a few photos with the camera phone, as "*I am not good with technical stuff*". The grandchildren household took the rest of the photos within the first 11 days of the study. As they were not allowed to bring the camera phone to school and to spare time activities, they found that they had no more interesting scenes to capture. The family however enjoyed the storytelling sessions a lot. Even though this study is geared towards children under the age of 9, it was the 11 year old granddaughter who used the Storytelling component the most. She often read entire stories to the grandmother, who would listen and asks questions during the telling, both about the stories and about other matters somehow related to the stories. The stories thus worked as a primer for conversations between grandparents and grandchildren. The majority of oral, fictional storytelling in this family was the grandchildren telling the story to the grandmother. These storytelling sessions were always initiated in the evening hours for the children, between 5pm and 10 pm, which is equivalent to morning time for the grandmother. When the grandmother was not available for storytelling sessions, the children used the Collage component asynchronously, playing with the photos, e.g. by turning them upside down.

7. MODIFYING THE STORYTELLING COMPONENT

Even though both families successfully scheduled and conducted storytelling sessions, the scheduling part was experienced to be cumbersome as two sets of calendars had to be balanced against each other with respect to both local and remote time. This was not made easier by the apparent issues the family members had converting local to remote time. These experiences informed modifications to the Storytelling component in an attempt to overcome this.

In an attempt to make this scheduling part easier, an asynchronous approach was considered, in the form of a direct and easy to use message channel, which the families could use to schedule storytelling sessions. However this idea was not chosen, as another study of family communication across time zones found that family members "*would often […] wait to make a [synchronous] call, rather than opting to send an asynchronous message*" [5]. It was thus decided that the modifications to the system should focus on improving the possibility that unplanned, unscheduled sessions of storytelling sessions would occur and that the family would get a better understanding of the time in the other household. Two modifications were thus implemented to the system in an attempt to address this.

7.1 Implemented modifications

The first modification implemented was to share indication of availability for storytelling sessions between the two households in a family. When a family had the original system deployed, they had no way of knowing if someone from the other household was available for a storytelling session. When they clicked on the "Storytell" button, one of two things happened. If the other household had their system turned on, they were invited to participate in a storytelling session. If the system was turned off, a message saying "*Your [grandparent/grandchild] is not currently ready for storytelling*" was displayed. This meant that a household resident had to press the "Storytell!" button to find out if the other household was available for a storytelling session. The parents from family 2 reported that their children during the day often just pressed the "Storytell!" button to find out if their grandmother was available for a storytelling session. Partly prompted by this idea, and partly prompted by the way Instant Messaging clients as MSN and Yahoo Messenger display a user's status as e.g. *available* or *offline*, an indication of the other household's availability for a storytelling session was implemented. To make sure that it could be seen further away than just in front of the moni-

tor, the indication was implemented as a traffic light, as shown in the top right corner of Figure 5. The traffic light would be green if the other household had their system turned on and red otherwise. Showing information about the other household's availability in a manner like this can be considered an invasion of privacy, albeit an inevitable one, because if "*one person in the media space [is] to have richer awareness, others must necessarily have less privacy*" [8]. Research on communication between distributed family members have also found that privacy was something their participants "*did not seem too concerned about" [18]*, so this was not deemed a major issue here.

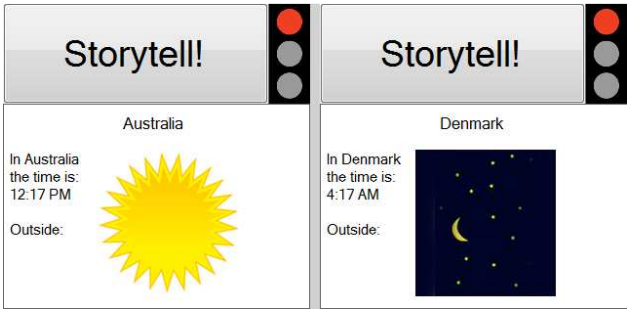

Figure 5: Illustrates the modifications made to the system. The left part is shown in Denmark (grandparents), the right part in Australia (grandchildren).

The second modification implemented was an indication of what the time was in the other household at any time. It was hoped that this would help especially the grandchildren understand when it was night and day for their grandparents. This was implemented by showing a picture of either a sun, representing day time in the other household, or a night with starts, representing night time (see Figure 5). This was to ensure that the children got an indication of the time at the other household even though they possibly could not tell time yet. The time at the other household was also displayed in a digital clock style with AM/PM notation, so a time as 10:00 could not be misinterpreted as 22:00.

7.2 Effects of the modifications

Family 2 conducted eight storytelling sessions lasting a total of two hours during this three week period with the modified system. The indication of availability represented by the traffic lights did not make the family use the Storytelling component outside the time interval where they used it before the modifications were put in effect (late afternoon/evening Australian time). The grandmother speculates that this might be because they continued to schedule when sessions were to take place, and that sessions were always scheduled for around the same time of day. The indication was, even though, well received in the family. The grandmother appreciated it because it showed her if the grandchildren were there or not. The mother actively used the traffic light. She kept an eye on it throughout the day, and when it went green informed her children that "s*he's there*", meaning that the grandmother had her system computer turned on. According to the mother, this made the children hang out around the system less and eliminated some attempts of initiating storytelling sessions that were bound to fail because the grandmother had her computer turned off. The traffic light thus impacted the process of initiating storytelling sessions in a positive way. The interview also revealed that the children thought the sun, indicating day time, meant the sun was actually shining in Denmark. This misinterpretation could potentially have been avoided if another photo was chosen for representing day time. The children also told their grandmother what the weather was like in Denmark when they started a session, so the image of the sun prompted talk about Denmark between the two. The grandmother reported that the sun/night photo and the digital clock did not offer any advantage to her, as she already had a good knowledge of the time zone difference.

8. DISCUSSION

8.1 Influence of time zone differences

The misaligned daily schedules existing between the grandparents and the grandchildren because of time zone differences affected the interaction and communication between the two households in various ways. This is described in the following by relating the findings to the four parameters coined by Zerubavel on the concepts of time and events.

Rigid sequential structures

Events and activities are often bound to happen in a specific sequential order; hence they have what Zerubavel call a *rigid sequential structure* [22], where one event must precede another. An obvious example is that you must find a partner before you can get married. Another example is that when you are sleeping, you must wake up, before you can consciously communicate with other people. Even though this might seem trivial, it presents a challenge when the context is communication across time zones. This is because in any fixed period in time, the residents of one household might be awake when the residents of another household might be asleep, which obviously also was the case for the families who participated in this study as the time zone difference was between 8 and 10 hours.

Fixed Durations of Sleep

Events we engage in or activities we conduct during a day have according to Zerubavel a *fixed duration* [22], caused by either biological or technological reasons or based on conventions. The duration of a plane trip from Bangkok to Melbourne is for technological reasons fixed to close to 11 hours. When we watch a feature length movie, we expect it to last more than 10 minutes based on unwritten conventions for duration of movies. And finally because of biological reasons, we need to be asleep for approximately 8 hours a day to be well functioning in the long run. This final point about sleep is worth stressing in this context. Even though it may appear apparent, it makes it impossible for a household to permanently cut down on the amount of sleep, hence disobeying the biologically determined fixed duration of sleep, to decrease or even eliminate the perceived time zone difference to make communication easier.

This point is confirmed by the use patterns of the components, which shows that never was a photo sent to the system, or a storytelling session conducted, at what was the middle of the night for one of the households.

Standard Temporal Locations out of sync

According to Zerubavel, events and activities have a *standard temporal location* on the day [22]. Lunchtime is usually around noon, dinner time is in the evening and we usually have a standard set of hours during the day when we are at work or in school, i.e. implying that we never, or only very rarely, go to school in the evening. When two households, located in time zones for example 8 hours apart, have to engage in shared activities, their individual perception of what constitutes standard temporal locations of those events are not affected but are, because of the time zone difference, *not synchronous*. The consequence of this is that at a fixed point in time, it is morning in one household and evening in the other. This affects communication between the two households, which was particularly evident in family 1, where the grandparents had day-time jobs and thus only had time for contact when they got home from work in the afternoon/evening, which equaled morning for the children. Even though the grandchildren in this family, according to the father, "*love having told stories"* at bedtime, they were not told a single story during the three weeks they had the system deployed. The children might simply not even think about storytelling in the morning, in the same way it would be "*almost inconceivable […] that an event such as a dance would be scheduled for the morning*" [22]. It is thus clear that the two households are significantly affected by their time zone difference while simultaneously having standard temporal locations that are not synchronous.

Uniform rates of recurrence

Zerubavel presents yet another term appropriate in this context, the *uniform rate of recurrence* [22], describing that events and activities occur with a fairly rigid rhythmicity. He describes the fact that we celebrate Christmas on the 25th of December each year as an example of an event with a *yearly* rigid rhythm. The field study presented in this paper shows the degree of uniformity of recurring *daily* events to be affecting the type of communication they can conduct. The grandparents from family 1 were because of day time jobs unable to modify their daily schedule to encompass synchronous activities with the grandchildren. This made the only possible window for synchronous contact the morning, before the children went to school, a period where probably neither the parents nor the children had time nor energy to participate. This factor made asynchronous contact, supplied by the Collage component, more popular than synchronous contact in family 1. On the contrary, family 2 mainly used the Storytelling component and thus engaged in synchronous contact. This was possible because the grandmother was retired and thus had the ability to adapt her daily schedule to engage in synchronous contact when it was suitable for the other household. This is a contradiction to previous findings on family communication across time zones which found that family members typically will *"not change their own schedule in order to accommodate communication with remote family, except for special occasions such as New Year*" [5]. Using Zerubavel's term, the rate of recurrence of events in the life of the grandmother in family 2 is less uniform than the rate of recurrence of events, that is, work in Family 1.

8.2 Consequences for design of technology

Considering the role of the parents

Previous research found that parents play an important role in facilitating contact between grandparents and grandchildren living apart [20]. This is confirmed by the activity observed by the parents in this study. One example is the parent(s) solving issues of fighting over control between two grandchildren, who simultaneously wanted to use the system. However, the time zone differences existing between the two households in this study, making their standard temporal locations being out of sync, surfaces another interesting role for the parents. During the end of storytelling sessions, the parents often stepped in and scheduled when the next storytelling sessions could happen with the grandparent(s). This involved a rather complicated discussion between the parent and the grandparent, involving sharing their daily schedules with each other while simultaneously calculating local and remote time in an attempt to find a time slot suitable for both households. It is doubtful if children would be able to grasp a similar organizational task, and an adult relative thus become even more important for facilitation of contact between a child and a relative when time zone differences are involved.

Technology being easy to use

Parents from both families expressed that one of their favorite properties of the system was their children's ability to use the system without parental guidance. Children might have a different sleeping pattern than their parents, if they're put to sleep early in the evening, while the parents stay up late, and the children then wake up before the parents in the morning. This situation was experienced at least once in Family 1, who had the system turned on 24/7. One of their children got up really early one morning while the parents were still sleeping and initiated a storytelling session with the grandparents, who just got home from work. The children also gladly interacted with the Collage component without parental guidance or grandparental interaction. These examples demonstrate the advantage of designing the technology to be easy to use by the children single-handedly. If technology is not designed in this way, the small differences in daily rhythms that may exist between parents and children in the same household can limit the children's use of the technology if the parents need to be available to initiate use or help during use. This becomes a more important issue when differences in time zones makes it meaningful for children to have contact with a relative of theirs at a fixed point in time when the child and the relative

is awake and available for communication but cannot be supported by the parents.

Children's use of technology in the home can however potentially be regulated by rules. An example is the children in Family 2, who were only allowed to use computers in the weekend (the parents made an exception for the system deployed in this study). Research shows that it is not unusual for parents to set up rules about their children's use of computers in the home [15]. The ability for children to use technology single-handedly can thus be impacted by domestic rules set up by the parents regarding use of technology in the home. It is thus important that the designed technology either conform to popular rules about use of technology by children in the home or is designed in a way that increases the chance that parents feel comfortable making an exception for this particular piece of technology, as Family 2 did in this study, because it serves the more prominent goal of increasing contact with relatives living or staying in other time zones.

Concurrent synchronous and asynchronous interaction form

Previous research on designing technology for use by grandparents and grandchildren living apart recommended that such technology should be designed to "*encompass a diversity of interaction forms to suit the current activity level of the child*" [20]. The use patterns from the families in this study confirm the need for a diversity of interaction forms but for other reasons than to suit the activity level of the children. Family 2 preferred the Storytelling component to a great extent (hence synchronous forms of communication over asynchronous), because it allowed them to speak directly to each other, engage in shared activities as storytelling, thus having intense contact and undivided attention from each other. The opposite was the case with Family 2, who preferred the Collage component (hence primarily asynchronous forms of contact), because it allowed them to easily follow the life of the residents in the other household in an impulsive manner, without having to put too much effort into the interaction.

Synchronous contact offers immediate advantages over asynchronous forms of contact. One is the possibility to allow the participants to speak to each other as on a telephone. This provides the opportunity for trust to develop or increase between the child and the adult relative [3]. It also allows both parties to know if, and how much, the other party is paying attention to their conversation. The use patterns of Family 1 illustrate that synchronous contact can be cumbersome to conduct in a time zone distributed family, when both households have day time responsibilities (work for parents, school for children) which they cannot re-schedule. Events with a uniform rate of recurrence might thus permanently prevent a family to find an appropriate time slot for synchronous communication. Synchronous contact do however become easier to conduct when one part is not constrained by such day time responsibilities, as was the case with the grandmother in Family 2, who was retired and thus had a much more flexible schedule. Even with only two families participating in this study, it is clear that families have different prerequisites for engaging in contact between children and adult relative across time zones. Technology can thus not solely rely on either synchronous or asynchronous interaction forms, but most incorporate elements of both to accommodate for varying conditions in different families.

Respecting Private and Public time

Zerubavel suggests that the social accessibility of an individual at any given time can be defined based on two hypothetic maxima, *Private Time* and *Public Time [22]*. When an individual is "in" private time, s/he is not interested in engaging in contact with other people, where as if the individual is "in" Public Time, contact with other people is either sought or encouraged. Even though "*neither of them exists in pure form in actuality*" [22], they still provide the foundation for an interesting point to be derived in this study. Family 1 allowed the system to play a continuous role in their daily lives, whereas the grandmother in family 2 used the system much less, but more intense. The use pattern of especially the grandmother in family 2 illustrates how she observed a rather strict distinction between private and public time. Whenever she was home, she turned on the system to indicate that she was ready for communication, but only when she had completed her morning routine. Whenever she left the house, or had visitors, she would turn off the system to indicate private time, at least towards her remote family. Even though family 1 had their system turned on almost continuously, the use patterns derived from the use of the system by the grandmother in family 2 reveals that appropriate care must be paid to families who wish to observe a more strict division between public and private time. The families had the possibility to do that with the deployed system as the families could turn it off and on at will, which suggest this as an important property for technology designed for the domestic domain. This is supported by the father from Family 2 saying, regarding the availability indication implemented as a modification, that if it was to be a permanent solution, "*I would think you should have a button saying: Yes, I would like to be disturbed right now, if anybody wants to talk to me*".

9. CONCLUSION AND FUTURE WORK

This paper has explored how technologies can support young children in communicating with adult relatives, more specifically grandparents, across time zones. This was done by deploying a system in two families, each of which had grandparents living in Melbourne and grandchildren living in Denmark. The results indicate that the time zone differences made communication troublesome and that day time responsibilities can hinder the opportunity for families to engage in synchronous contact. The misaligned daily schedules can by itself hinder communication between children and relatives, as children might not even think about communicating with their remote family when they have time for it, for example when it is morning for the children. The time zone differences thus makes parents important for

scheduling sessions of contact, and it makes it important to consider the easiness with which the children can use the technology on their own. Synchronous communication can be really beneficial, but the study reveals that the misaligned daily rhythms makes it important to consider supplementing this with asynchronous communication, while simultaneously paying appropriate care to the distinction between private and public time.

These presented issues on communication between young children and adult relatives across time zones are not exhaustive. As future work, a study of communication between, for example, children and one parent living permanently in another time zone might reveal other issues. The system deployed also only explores limited types of contact. Other components, for example exploring learning over distance, might similarly reveal different issues.

ACKNOWLEDGEMENTS

The author would like to thank Jesper Kjeldskov, Sonja Pedell and Frank Vetere for very valuable collaboration and the two participating families for their time and interest.

REFERENCES

[1] Ames, M. G., Go, J., et al. (2010). Making love in the network closet: the benefits and work of family videochat. In Proc. CSCW '10. ACM, New York, NY, 145-154.

[2] Ballagas, R., Kaye, J., Ames, M., Go, J. and Raffle, H. (2009). Family communication: phone conversations with children. Proc. IDC '09. ACM, New York, NY, 321-324.

[3] Bos, N., Olson, J., Gergle, D., et al. (2002). Effects of four computer-mediated communications channels on trust development. Proc. CHI '02. ACM, 135-140.

[4] CamStudio. http://www.camstudio.org. Seen on March, 7th, 2010.

[5] Cao, X., Sellen, A., Brush, A. B., Kirk, D., et al. (2010). Understanding family communication across time zones. In Proc. CSCW '10. ACM, New York, NY, 155-158.

[6] Evjemo, B., Svendsen, G. B., Rinde, E., and Johnsen, J. K. (2004). Supporting the distributed family: the need for a conversational context. Proc. NordiCHI '04, vol. 82. ACM, New York, 309-312.

[7] Friedman, William J. and Laycock, Frank (1989). Children's Analog and Digital Clock Knowledge. In Child Development, Vol. 60, No. 2, pp. 357-371.

[8] Hudson, S.E. and Smith, I. (1996). Techniques for addressing fundamental privacy and disruption tradeoffs in awareness support systems. Proc. CSCW '96. ACM, New York, 248–247.

[9] Hutchinson, H., Mackay, W., et al. (2003). Technology probes: inspiring design for and with families. Proc. CHI '03. ACM, New York, NY, 17-24.

[10] Kim, S., Kientz, J. A., Patel, S. N., et al. (2008). Are you sleeping?: sharing portrayed sleeping status within a social network. Proc. CSCW '08. ACM, New York, NY, 619-628.

[11] Kraut, R. E., Gergle, D., and Fussell, S. R. (2002). The use of visual information in shared visual spaces: informing the development of virtual co-presence. Proc. CSCW '02. ACM, New York, 31-40.

[12] Lottridge, D., Masson, N., and Mackay, W. (2009). Sharing empty moments: design for remote couples. Proc. CHI '09. ACM, New York, NY, 2329-2338.

[13] Modlitba, P. L. and Schmandt, C. (2008). Globetoddler: designing for remote interaction between preschoolers and their traveling parents. CHI '08 Extended Abstracts. ACM, New York, NY, 3057-3062.

[14] Reddy, M. and Dourish, P. (2002). A finger on the pulse: temporal rhythms and information seeking in medical work. Proc CSCW '02. ACM, New York, NY, 344-353.

[15] Rode, J. A. (2009). Digital parenting: designing children's safety. Proc. British Computer Society Conference on Human-Computer Interaction. British Computer Society, Swinton, UK, 244-251.

[16] Stefik, M., Bobrow, D. G., Foster, G., et al. (1987). WYSIWIS revised: early experiences with multiuser interfaces. ACM Trans. Inf. Syst. 5, 2 (Apr. 1987), 147-167.

[17] TeamViewer. http://www.teamviewer.com. Seen on the 6th of May, 2010.

[18] Tee, K., Brush, A. B., and Inkpen, K. M. 2009. Exploring communication and sharing between extended families. *Int. J. Hum.-Comput. Stud.* 67, 2 (Feb. 2009), 128-138.

[19] Vetere, F., Davis, H., Gibbs, M. et al. (2009). The Magic Box and Collage: Responding to the challenge of distributed intergenerational play. Int. J. Hum.-Comput. Stud. 67, 2 (Feb. 2009), 165-178.

[20] Vutborg, R. (2010). Providing Shared Activities for Grandparents and young Grandchildren living apart. Aalborg University, Aalborg.

[21] Zerubavel, E. (1982). The Standardization of Time: A Sociohistorical Perspective. In The American Journal of Sociology, Vol. 88, No. 1 (Jul., 1982), pp. 1-23. The University of Chicago Press.

[22] Zerubavel, E. (1985). Hidden Rhythms. Schedules and Calendars in Social Life. University of California Press.

Appendix C – Ideas for Storytelling System

This list of ideas gives an overview of the ideas for functionality to implement in the storytelling system. The ideas were generated over a two month period before implementation began and illustrates what the Storytelling system could have evolved into with more time spent on the implementation phase.

Idea	**Imple-mented**
Allowing them to tell premade stories to each other. The premade stories would be scanned in versions of popular books for children. Each story would be presented on a number of slides, as PowerPoint slides, each of which contains text and images. These slides can then be navigated in linear order by both the grandparents and the grandchildren.	Yes
Allowing them to draw on top of any slide, no matter what it contains, using a basic drawing palette.	Yes
Allowing them to choose “an empty story”. This would consist of an unlimited number of purely blank slides, which can be used for whatever purpose the participants find meaningful.	Yes
Allowing them to insert their own pictures on any slide, no matter its contents. The pictures are to be taken using the same mobile phones as the Collage probe use.	Yes
Allow both parties to manipulate any inserted image. Manipulations would include moving and enlarging images	Yes
Allowing them to insert non-story related or non-personal related images to any slide. Such an image could be a nice car or a frightening bear. The idea was that such images would promote discussion on the voice channel.	No
Giving both parties the opportunity to see what the other part is doing at any time. For example if the grandchild clicks on the top left corner of a story, this would be shown on the grandparent touch screen as a large green hand at the same spot.	No
Allowing the grandparent to put on a piece of music during a storytelling session as to calm the child down.	No
Giving the grandparent opportunities to tease the grandchild by allowing the grandparent to navigate to one or more “false slides” that would contain e.g. story text or images that would make no sense in the context of the current chosen story.	No
In between storytelling sessions, allow the grandchild to play back a previous conducted storytelling session that is already recorded on video. This would happen asynchronously as an activity the grandchild could chose to do no matter if the grandparent is available at the current time or not. No interaction would be possible while playing the video back, other than basic video play back functionality as start, stop, go to beginning, etc.	No
Supplying grayscale version of all stories, so the grandparent can ask the grandchild to colour in the grayscale images using the drawing palette.	No

Appendix D – Example log file from use of the Storytelling system

This log illustrates how the log file, used for analysis, looks like after one random day of usage of the Storytelling system.

Client	Event	Date
Grandparent	WantsToBegin	2009-12-15 14:30:16.243
Grandchild	InvitationAccepted	2009-12-15 14:31:29.667
Grandchild	Abrubt ending because other part lost connection	2009-12-15 14:32:27.043
Grandparent	Abrubt ending because other part lost connection	2009-12-15 14:32:45.390
Grandchild	Camstudio file. Creation time: 15/12/2009 2:32:40 PM. Size:11.41211 Mb	2009-12-15 14:32:45.537
Grandparent	Camstudio file. Creation time: 14/12/2009 4:41:47 PM. Size:34.71729 Mb	2009-12-15 14:33:01.380
Grandparent	WantsToBegin	2009-12-15 14:46:08.907
Grandchild	InvitationAccepted	2009-12-15 14:46:14.983
Grandchild	ClosedSession	2009-12-15 14:53:48.040
Grandchild	Camstudio file. Creation time: 15/12/2009 2:32:40 PM. Size:11.41211 Mb	2009-12-15 14:53:54.147
Grandparent	ClosedSession	2009-12-15 14:54:33.400
Grandchild	Camstudio file. Creation time: 15/12/2009 2:53:58 PM. Size:80.28369 Mb	2009-12-15 14:54:39.100
Grandparent	Camstudio file. Creation time: 15/12/2009 2:54:22 PM. Size:7.380859 Mb	2009-12-15 14:54:42.473
Grandchild	WantsToBegin	2009-12-15 15:46:38.760
Grandchild	InvitationCancelledAfterTimeout	2009-12-15 15:48:20.530
Grandchild	WantsToBegin	2009-12-15 15:49:04.140
Grandchild	InvitationCancelledAfterTimeout	2009-12-15 15:50:45.613
Grandparent	WantsToBegin	2009-12-15 16:17:07.087
Grandchild	InvitationAccepted	2009-12-15 16:17:19.047
Grandchild	ClosedSession	2009-12-15 16:19:51.717
Grandparent	Camstudio file. Creation time: 15/12/2009 2:54:22 PM. Size:88.78613 Mb	2009-12-15 16:20:02.473
Grandchild	Camstudio file. Creation time: 15/12/2009 4:19:59 PM. Size:26.66846 Mb	2009-12-15 16:20:09.957
Grandchild	WantsToBegin	2009-12-15 21:02:36.743
Grandparent	InvitationAccepted	2009-12-15 21:02:44.173
Grandparent	ClosedSession	2009-12-15 21:27:17.747
Grandchild	Camstudio file. Creation time: 15/12/2009 4:19:59 PM. Size:26.66846 Mb	2009-12-15 21:27:27.147
Grandparent	Camstudio file. Creation time: 15/12/2009 2:54:22 PM. Size:88.78613 Mb	2009-12-15 21:27:27.180

Appendix E – Summary

This thesis investigates contact between grandchildren and their adult relatives over distance. The motivation for this research is that previous research has found that it is hard to get children engaged in telephone conversations. Thus, when grandchildren and e.g. parents or grandparents do not live together, it can be hard to develop or maintain a good relationship between the child and the adult relative. The thesis is based on two research papers, each of which explores a single research question.

Research Question I: *How can technology be designed to improve contact between grandparents and grandchildren living apart?*

This research question is explored by providing shared activities for grandparents and grandchildren distributed in space. This idea was inspired by popular collocated shared activities as reading books and telling stories together and talking together about recent events in each other's lives. It was hoped that the contact between grandparents and grandchildren would be better, more giving or more fun if they could engage in such shared activities together.

To provide such shared activities for grandparents and grandchildren living apart, and to collect adequate data to be able to answer the research question, a system was designed, implemented and evaluated in a field-study. The system provides three types of shared activity over distance. The grandparent and grandchildren can share oral reading of children book stories, they can share personal photos taken by camera phones, and they can draw to each other using coloured pencils.

The system was deployed in two Australian families, and whenever it was used, its use was recorded to provide the foundation for the subsequent analysis. The recordings consisted of video and audio, and a log file of use.

The field study revealed that the families appreciated the system. The vivid telling of fictional stories, the ability to share personal photos and the creativity shown with the pencils indicates that both grandchildren and grandparents really enjoyed the storytelling sessions and bonded during so, by sharing the same conversational context. The study also showed that parents play an important role as facilitators of contact between their children and the grandparents, making sure the technical setup works, making sure that the children do not fight over control and prompting ideas for activities. It was also observed that children generally behaved differently depending on the time of day when they used the system. During the day, they would be really active, and later on the day, e.g. after dinner-time, they would want to be told a story. This shows that children's daily rhythms, and how that affects the activity level of the child, must also be given thought when designing technology to be used partly by children. Finally, the grandparent played an important role during the storytelling sessions, as s/he would suggest activities matching the mood of the grandchild, whether that was teasing, playing with photos, or telling stories.

This study also revealed a preference to use the storytelling system in the evenings, and it was thus expected that grandparents and grandchildren would face further challenges maintaining or building a relationship when they live in each their part of the world, and thus in each their significantly different time zone. This fostered the second research question:

Research Question II: *How do time zone differences between grandchildren and their adult relatives affect their communication and which consequences does this have for design of technology for this domain?*

This research question is explored by deploying a system in two families, each of which had grandparents living in Melbourne and grandchildren living in Denmark. The system consisted of the Storytelling component, presented above and developed by me on my 9th semester, and the Collage system.

The results indicate that the time zone differences made communication troublesome and that day time responsibilities can hinder the opportunity for young grandchildren to engage in contact with their adult relatives. The misaligned daily schedules can by itself hinder communication between children and relatives, as children might not even think about communicating with their remote family when they have time for it, for example when it is morning for the children. The time zone differences also makes parents important for scheduling sessions of contact, a task which the young children in the study did not do themselves.

The study also shows the importance of considering the easiness with which the children can use the technology, when designing technology to be used across time zones. Children may have daily routines which make them get up really early in the morning, before their parents, which may be the only good time to engage in contact with grandparents or other family members living in another time zone. However, this still needs to be balanced against the domestic rules many families have regarding use of technology (computers) by their children.

The study also confirmed that synchronous communication with voice can be really beneficial, when a conversational context is provided. However, the time zone differences somewhat compromised the possibility for such synchronous sessions to be conducted. This makes it important to consider supplementing synchronous interaction forms with asynchronous ones to improve the possibility for some type of contact to arise.