Globetoddler: Enhancing the experience of remote interaction for preschool children and their traveling parents

by

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Abstract

In recent decades, families in the Western world have become more geographically distributed. Business traveling - the kind of traveling that tends to separate family members - is still a very common phenomenon and keeps making it difficult for family members to maintain a feeling of connectedness. Different time zones and contexts are some of many factors that make "being together" more challenging when physically apart. Modern communication technologies, such as phones and IM clients, improve communication, but seldom achieve the same level of connectedness and awareness that face-to-face communication does. In addition, when it comes to young children, these communication technologies may not even be an option. This thesis presents a theoretical and practical design project that addresses these travel-related issues. The overall goal of the project has been to (1) define a set of design principles for this type of interaction by studying existing psychology and technology research and literature, as well as by interviewing families, to (2) develop a system that, on the basis of the defined principles, makes remote communication and sharing of experiences easier and more meaningful to preschool children and their traveling parents, and to (3) evaluate the system with real end-users in order to improve the user experience. The outcome of the project is "Globetoddler", a mobile-tangible communication platform, designed explicitly to reconcile differences in both location and time, without compromising the specific needs of the individual users.

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The following people served as readers for this thesis:

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It is creative apperception more than anything else that makes the individual feel that life is worth living. Contrasted with this is a relationship to external reality which is one of compliance, the world and its details being recognized but only as something to be fitted in with or demanding adaptation... In a tantalizing way many individuals have experienced just enough of creative living to recognize that for most of their time they are living uncreatively, as if caught up in the creativity of someone else, or of a machine.

D. W. Winnicott, "Playing and Reality" [63]

There is an Indian story... about an Englishman who, having been told that the world rested on a platform which rested on the back of an elephant which rested in turn on the back of a turtle, asked...what did the turtle rest on? Another turtle. And that turtle? "Ah, Sahib, after that it is turtles all the way down." Such, indeed, is the condition of things.

Clifford Geertz, "The Interpretation of Cultures: Selected Essays" [31]

Chapter 1

Introduction

Several years back, my advisor Chris one day decided to try out something new. In an effort to engage his then three-year-old son Ben in an upcoming business trip to an important trial in Richmond, VA, Chris came up with the wonderful idea of bringing a *Ty Inc. Beanie Baby Kitten* (a stuffed toy) along on the trip. He then captured photographs of the toy kitten in various places and contexts, in the court room and in the hotel lobby flower pot among other places, and emailed them to his wife, for Ben to see. Needless to say, Ben loved this spontaneous adventure. Every day, after returning home from daycare, the first thing he wanted to do was to turn on the computer to see if there were any new photographs of "Trial Kitty" waiting for him. When Chris called home, Ben requested to talk to Trial Kitty instead of his dad. Consequently, Chris had no other choice but to distort his voice and pretend to be Trial Kitty.

My advisor Chris' story is not unique. Traveling toys, as well as other embodied toy interfaces, have been used in many different contexts, from educational projects (*Flat Stanley*), to movies (*Amelie*), and commercials (*at&t*). A fairly new project is *Daddy Dolls*; dolls that have been designed especially for children of duty military

personnel. The Daddy dolls are fairly simple doll-shaped pillows with a whole-body image print of the remote parent and a personalized recorded audio message that is replayed when the child squeezes the doll. What these projects all have in common, is that they use embodied interfaces as an incentive for the child to connect, or in some cases to create a sense of connectedness. The object functions as a common platform for communication, and, unlike many other communication technologies and methods, uses the notion of storytelling and imagination to take the focus of the communication act that in many cases does not make sense to a young child. In many ways these objects function as transitional objects [62], a term used in the field of child psychology to refer to comforting objects, such as blankets or teddy bears that young children cherish, because they remind the children of their parents. These objects, in the long term, help the children make the transition from complete dependence (on the parent) to independence.

The vision of this thesis is partly rooted in the concept of transitional objects and uses it in order to develop a novel remote communication platform that makes sense from a young child's point-of-view. The goal of the thesis has been to partly replace conventional technologies that force children to adjust to grown-up ways of interacting, with rich user experiences that draw on storytelling, game play, tangibility, and reciprocity to create more immersive and meaningful interactions.

1.1 Thesis roadmap

This section will present a brief outline of the contents and structure of this thesis. The thesis consists of three main chapters: chapter two provides an extensive account of the theoretical background and motivation for the underlying concept of this thesis, including a description of an initial interview study; chapter three describes *Globetoddler*, a system that has been developed based on the theoretical conclusions

and ideas; chapter four discusses a final user evaluation of Globetoddler, and explores possibilities for future implementations and improvements. This thesis also includes an appendix that describes the technologies implemented in this research, as well as questions used in interviews, evaluations, and surveys.

A note about terminology: The term "Globetoddler" refers to the entire system implemented, including the physical object, networking infrastructure, and visual application. The Globetoddler system is referred to as both a "system" and a "platform". In this thesis the terms are used as synonyms, unless otherwise specified.

1.1.1 Background and Motivation

Chapter two will review the theoretical rationale that this thesis has been motivated by and built on. The chapter contains both academic and non-academic work, as well as an initial interview study and a survey study. The content of the chapter suggests how the rationale can be used to derive design principles for family-oriented communication technology in general, and for remote parent-child communication in particular. This chapter will also discuss related work, ranging from mobile-based content-sharing applications to large-scale awareness systems.

1.1.2 Design

Based on the theoretical framework explained in chapter two, a useful parent-child communication platform for remote interaction should address, among other things, the following needs:

- The system should support caring, playing and the expression of emotions and intimacy. More specifically, the system should allow the parent to make the child feel safer and taken care of. On the child's side, the application should be

focused on rich interactions and storytelling in order to make it more engaging and meaningful.

- Communication between a parent and a child is often asymmetrical; many times the parent is more interested in communicating with the child than vice versa. Therefore the system should help seed conversations.

- The system should be easy to access and use, whenever the users have time to or want to interact, and should support frequent and spontaneous use.

- When it comes to (preschool) children, interfaces that are familiar and tangible, such as toys, as well as game-based features, have the potential of creating more engaging and comprehensible user experiences and interactions.

Chapter three will explain the design of Globetoddler in terms of these requirements. Additionaly, this explanation will discuss the design process, and how decisions were made to support the conceptual and practical needs of a fully realized communication platform.

1.1.3 Evaluation

The Globetoddler system was subject to an experience-focused user evaluation. This chapter describes both the theoretical and practical aspects of the evaluation study.

First, theories that have influenced the evaluation study in different ways are described. These theories all have in common, the suggestion that humans and their experiences, actions and relations have to be studied from a wider, contextual point-of-view. Accordingly, evaluations of user experiences in HCI require full contextualized descriptions, rather than detailed, quantitative descriptions of discrete tasks.

Second, this chapter will explain the user evaluation setup in detail, as well as

its results. These results suggest a set of features that would better serve a future implementation of the Globetoddler system.

1.1.4 Appendix

The appendix will discuss the backend technology and network structure of Globetoddler in more depth. This part has been placed in the appendix since the main novelty and contribution of the system lies in the combination of technologies, as well as the user interface and interactions, rather than in the technology itself.

In addition, the appendix contains lists of questions used in the surveys and interviews that were used in this thesis project.

Chapter 2

Background and motivation

The topic of this thesis was originally inspired by a conversation that I had with a friend a while ago. My friend, who has a four-year-old daughter, travels frequently and is away for rather long periods of time. She explained to me that for her personally the fact that her daughter is not comfortable with talking over the phone makes being away from home a lot more difficult; their interaction level drops from continuous to non-existent overnight. Charlie Hudson [35], author of the book *The parent's guide to business travel*, has had experiences similar to my friend's:

> *The ability to grasp the concept of "trip" is easier in these years [age 3-5], although understanding the passage of time will probably be limited... Forging and maintaining a strong communication link during absence is important and can span from low-tech to the latest electronic gadgets... [The] challenge was keeping in touch with my son and, while I called on a regular basis, a preschooler doesn't have a lot to say during a phone conversation. I would send him cute postcards or greeting cards with a sentence or two, although that first summer I wasn't aware of how meaningful those cards were to him... My son was too young to care what I wrote, and the messages [on the cards] were essentially all the same, but it didn't matter - he was getting "mail" from me that he could*

hold in his hand, and that was the important thing for him... This is also the age when it may be difficult to distinguish between imagination and reality, and a child may become fearful of something that doesn't occur to you. For example, if you have taken a trip to Arizona, but your child doesn't know where or even what Arizona is, he or she may conjure up disturbing images of you in a terrible place.

I find these testimonies intriguing for several reasons. First, when we think of parent-child awareness we tend to see it from the parents' point-of-view. Parents want to monitor their children and make sure that they are safe, but what about the children? Do they feel a similar need to be aware of and feel connected to their parents? Second, what is it that makes my friend's daughter reluctant to use the phone? Is she angry? Could it be that she doesn't find the phone conversation fun or rewarding enough? Does she have problems relating to or imagining the remote location of her mother? I believe that it is crucial to not assume that children enjoy and benefit from using the same kinds of systems and applications as adults do.

2.1 Initial interview study

In order to find answers to my questions, I decided to (1) conduct an initial user study with families who have regular experiences of remote interaction and (2) carry out interviews with experts in the field of child communication. An overview of the results is presented in this section.

2.1.1 Methodology

An initial interview study was conducted with a total of five families (five mothers, three fathers, and six children age 4-10). The interviews were carried out as 30-

minute semi-structured interviews with each participant, meaning that although a rough script was designed prior to the interview, the order of the questions was not fixed. In addition, new questions and topics could be added during the interview. Although the overall topic was the same for all participants, the scripts were adjusted to the role of the participant: (1) traveling parent, (2) non-traveling parent, and (3) child. The questions span over a wide range of areas, from general communication habits and routines, to more specific technology-related matters, to emotions and relationships. Examples of questions asked are:

Child:

- Do you miss [your mum/dad] when [he/she] travels? Do you think about [him/her] a lot?
- Is there anything special that you like telling your parents about when they are away? Your school day? Football?
- Is there something that makes you feel angry or sad when your parents are away?
- What do you so to stay in touch when they are gone? Do you call? Talk on the computer? Do you use a webcam?
- If you could make your own machine to stay in touch with your family or friends, what would it look like? How would it work? (Feel free to draw if you want).

Traveling parent:

- How do the members of your family stay in touch when you are at home? Which channels and what technology? Do you have any routines? Do you communicate in the same way with all kids?
- Are you happy with the way you communicate when you are gone? If yes, what

aspects do you like? If not, what aspects do you dislike? Is there anything in particular that frustrates you?

- What aspects of your interactions do you cherish the most? Which aspects do you think are most valuable for staying in touch and feel a connection?
- Do you ever/usually initiate the conversation with your children when you are away or do they? Would you like to change the way it is?

Non-traveling parent:

- Do you normally make special family life arrangement before your partner travels? If yes, what kind of arrangements?
- Do you tell your children where your partner is going and what you are doing there? Are they usually interested?
- Do you continuously talk about your partner's trip? Do your children ask?

For a full description of the interview scripts and questionnaires, see section B.

Each family decided which family members were to participate in the study. However, the minimum requirement for participation was one parent and one child. The child or children were interviewed separately only if the parents approved. In the set of five families, only one family did not approve individual interviews. In addition to the formal interviews, a number of traveling parents at the MIT Media Laboratory were consulted in a more informal manner.

2.1.2 Results

Naturally, each family's story is unique; some families are early adopters of emerging technologies, others are fine with using a regular phone. Also, children vary due to

Table 2.1: Demographics of parents and children. Interviewed children are boldfaced in the table.

Demographics of parents and children				
Family #:	**Gender:**	**Children (age/gender):**	**Traveling parent:**	**Technologies used:**
1	Male	2.5 (girl) and **6 (girl)**	Yes	Maps, calendars, emails, video conferencing, photos (via emails or website).
1	Female	See previous row.	Mostly no	See previous row.
2	Female	3 (girl) and **5 (girl)**	Yes	Video conferencing, emails.
3	Male	**9 (girl)**	No	Written stories about the destination and purpose of trip, photos, notes, phone calls.
3	Female	See previous row.	Yes	See previous row.
4	Female	3 (girl), **5 (girl)** and **6 (girl)**	Yes	Phone calls.
5	Female	1 (boy) and **6 (girl)**	Yes	Phone calls.

both different personality traits and age. However, despite many differences, a number of mutual experiences and key concepts could be identified. The results have been divided into two subcategories: (1) communication- and technology-related aspects, and (2) emotional and social aspects.

Communication and technology

- **Routines:** Maintaining family routines, even when a parent is on the road, is very important. Naturally, this is a bigger challenge when the main caregiver is traveling. At least two of the interviewed parents write or record lists of tasks for their children and/or partner before leaving.

- **Time differences:** For many families, being in different time zones was per-

ceived as the most limiting factor. In most cases, the traveling parent adjusts to the routines of the family at home. Bedtime is the most cherished time of the day in all families; an intimate routine that most parents do not want to miss out on:

> *If it is several days of travel then it is usually in a different time zone. Then it is difficult for us to use chat. Three hours time difference makes a huge difference. When they come back, I am still busy at work and when I come back from the conference to the hotel, they are already in bed. So we just use phone.*

- **Busy schedules:** All families mentioned tight schedules as another crucial limitation. Some traveling parents deliberately squeeze in as much as possible in their schedules in order to shorten their trips. However, in many cases the children seem to be just as busy as their parents, for example daycare, after-school, homework, and extracurricular activities.

> *[The kids] are so busy. Their school ends at 5:55 or 6... So when they come home it is like 6:30 or even close to 7. We don't have enough time to talk or share our experiences...and they are very tired after all day in school. It is even worse when I am away.*

- **Media:** Most families use the phone to communicate remotely, which seemed to work fine for the older children (age 5-10). However, the children who use video chat, usually with the help of a parent, all described that they prefer seeing the face of the person they talk to. In the case in which the parent takes photos during the trip, the children prefer viewing the photos after the parent comes home in order to hear the parent describe the captured event. At least two of the children regularly use the computer to look at old pictures. One mother said:

When he is in Europe or Asia, that's actually why we got Skype and that helped. Because I can actually talk to him. Now, when we have the video hooked up it is even nicer. You know, it is a little more fun for the kids... I think they are more likely to sit and talk to him... I think they value the video aspect of it more...since they can't read. So the email part is not even an option for them.

The daughter in the same family explained how photos are being used:

I can look at pictures of them so that I miss them less. On the computer or in photo albums of course... One time my dad [sent photos] and he put arrows on it to show what he was talking about... I look at them when he is not talking to us.

- **Dependency:** Another important factor is that of dependency; partly due to complicated technologies, the children need help from their non-traveling caregiver in order to initiate interaction with their traveling parent. One mother said the following about her daughter's interaction with her traveling father:

  [My daughter] doesn't really have the asynchronous communication. If I could remember to show [the photos that my husband sends] to her then that would be great. Sometimes that doesn't happen for days. I think she likes the pictures...but I don't think she is able to understand them until he is here to explain them to her.

- **Frequency:** All families try to talk at least once per day when a parent is traveling.

Emotional, psychological, and social aspects

- **Separation anxiety:** Saying goodbye before a trip is, in many cases, the hardest and most crucial part, both for the child and the parent. The families used,

for example, notes, detailed itineraries, maps, stories, and toys to talk about the upcoming journey and the moment of separation:

> *[My daughter] used to get really upset when I go away... The night before would be horrible. A couple of nights before. She gets really agitated and weepy. She is getting better at that...but she still gets upset the day before I am leaving.*

- **Concept of time:** Once separated from their traveling parent, the main concern for most of the young children seems to be: "When are you coming home?" Two of the interviewed families used calendars to make the concept of duration more comprehensible:

> *We draw stuff on the calendar...that's our way of communicating with the kids about certain things, like ice cream day and the day that I bring home the muffins...so that they can tell by the little pictures I draw what's going on. And then we cross the days off so that they know what day it is...*

- **Routines:** Maintaining family routines is also important from an emotional point-of-view. Establishing and maintaining routines plays a crucial role in helping especially the youngest children feel safe and comfortable. A business trip disrupts those routines and it is therefore important to try to maintain the established routines, as well as maintain that feeling of safety and familiarity:

> *Usually, when they go to bed, I stay with them for five to ten minutes... Then they are relaxed...[and] start talking. That's what I really miss when I am away. [I] actually [call] twice. Just after they come home and just before they go to bed... I pray for them...we have these routines.*

- **Trust:** At least in a family where separation is new or uncommon, business traveling may jeopardize the trust that the child has invested in the relationship: "Why does mum leave me all the time?", "Will dad ever come home again?"

After a while, many children seem to get used to the fact that their parent travels every now and then and learn that the parent always comes back home again. Still, investing time and effort in connecting with the child on a regular basis may be one way of making sure that the parent-child trust is maintained.

- **Demystification:** Making an upcoming trip more tangible and understandable to the child by talking about it is another important aspect. In one of the families, the mother writes letters to explain and illustrate details and facts related to the trip. The non-traveling father explains:

  > *She always leaves [our daughter] a letter. She usually leaves early in the morning before [our daughter] gets up. So there is always a letter for [her] on the counter. Usually with a map of where she's going, and a letter about where she is going, what she is going to be doing and then reminders for [her]...*

2.2 Online survey

2.2.1 Setup

In addition to the initial interview study, a small online survey was carried out in order to collect more general information about remote interaction in families with preschool children. A total of 13 responses were collected in the study, of which eight were submitted by parents who are the only business traveling parent in the family. One of the participants never travels for business.

2.2.2 Results

A majority (61.5%) of the respondents had one child in the target group (ages 3-6) and travel in average 1-4 nights 1-10 times per year. While apart, most of the families tend to communicate every day or every other day, mainly on the phone. All of the respondents use at least their cell phone to call home, but overall the technology used for connecting depends on, among other things, the infrastructure, schedules and time differences. 7 of the 13 respondents exchange media content, such as photos and videos, with their children when they are on the road. Of these seven respondents, a vast majority only send photos.

The respondents were almost equally divided into "often" (46.2%) and "rarely" (38.5%) having a guilty conscience when traveling. When it comes to (the parent's perception of) the child's attitude to the parent's traveling, most respondents answered that their preschooler(s) seems to miss them most of the time when they are apart, but that the children's attitude normally varies with the length of the trip. One traveling mother wrote:

> *It's actually not the first day - it's the moment of separation...once I'm out of the door she's totally fine. NOTE this does not happen with her dad. She is fine with her dad traveling.*

61.5% of the respondents find business traveling problematic from a family communication point-of-view. The most limiting factors are: (1) the traveling parent rarely has time to interact with those at home, (2) the technology available is too complicated for the children to use, and (3) the technology available currently doesn't support the things the family members would like to be able to do. One of the respondents wrote:

> *For instance, it would be great if my daughter can set up whatever tech on her own without have to rely on grandparent (or whoever else she is with) to take*

the initiative and set her up...

Other interesting comments are:

[The children] don't feel like talking when I do and vice versa, they may want to talk to me when I am busy. Also, phone calls are not the same as a hug, cuddling. They are not at all comforting to a small child.

phone is too abstract, and it is the most authentic. video would help, but it's not an option on the road. skype is too complicated.

They don't want to sit still in front of a static camera, and the sound quality in both directions is not great if they run around the room.

My spouse thinks technology is not friendly enough.

[The technology is] not ubiquitous...cell phones are great because you just pop them out and phone, whereas set up time with skype is higher (need headset, need internet connection, need computer - or use skype out, which we haven't tried yet).

2.2.3 Summary

The results of the survey study to a large extent confirm the results of the interview study. When it comes to technology aspects, it is clear that although video communication is considered more fun and rich, cell phones are used most of the time since they are fast and easy to setup and use, and therefore suit the traveling parent well. However, it is also clear that talking on the phone is not the ideal method of communication for the user on the other side of the communication channel - the child.

A more detailed presentation of the questions and results can be found in section

B [1].

2.3 Literature studies of previous work

The potential to use technology to connect geographically distributed individuals has been recognized and studied for many years. In 1993, Bly et al. [19] presented the concept of *media spaces* - systems designed to use audio, video, and other media to create shared spaces in which distributed work groups can operate continuously and conveniently. Since then the academic field of remote interaction has been extended from formal work and office milieus into home environments [51]. As in the case of work-oriented systems for remote communication, domestic systems address a wide range of needs and activities, both practical and socio-emotional. To date, a large number of projects have addressed the problem of connecting distributed family members - all with unique approaches and conclusions [21, 22, 27, 33, 36, 41, 47, 50, 57]. However, despite their disparate solutions, they all seem to agree that using technology to make dispersed families feel more connected is a good idea, if not a necessity. Today, probably more than ever, family members spend a lot of time apart, due to, among other things, growing workloads and traveling. Business traveling - the kind of traveling that tends to separate family members - is a very common phenomenon, despite emerging technologies for remote communication. In 2005, approximately one quarter of all domestic traveling in the US was business-related. Not to forget, currently about 1.2 million American children belong to families with active duty military personnel. Additionally, in contemporary families, the grown-ups are not the only ones to spend less time at home. Modern children often attend after-school and other extracurricular activities, in addition to school. Thus, overall, the time spent together with the family, doing things together, has come to decrease and makes it hard for families to

[1] A *complete* summary can be found at http://web.media.mit.edu/ paulina/gt/survey/Survey-Summary.html

maintain a feeling of intimacy and connectedness [24, 67].

Research on remote interaction between children and their traveling parents is not as extensive as one would expect considering the large number of traveling parents. According to the *Travel Industry Association*, business traveling increased by 14% between 1994 and 2001 and is projected to continue to rise [12]. Many of the existing family-oriented communication projects not only fail to address the need for mobility, but, more importantly, also fail to address the asymmetry of needs that occurs when users of various ages use the system. Below are short descriptions of previous academic and non-academic work in the field of remote communication in general and remote communication between family members in particular. A number of projects that share one or several of the following characteristics with the Globetoddler system are also described briefly: (1) family-oriented interaction, (2) perception and understanding of remote places, and (3) mobility.

2.3.1 Parent-child interaction theories and academic research

Winnicott's Transitional objects

At the beginning of the 20th century, D. W. Winnicott introduced the concepts of *transitional objects* and *transitional experience* in reference to a particular human developmental sequence in toddlers. Winnicott uses the word transition to describe the gap between psychic and external reality that toddlers normally experience when they become old enough to separate between *me* and *not-me*, which at least initially is the main caregiver. According to Winnicott, the transitional objects, for example a blanket or a doll, are used by the child to bridge that gap, and, thus, create a sense of comfort by replacing the seemingly more distant parent [63, 62].

Today, Winnicott's theory is established in both theoretical [53, 54, 43] and

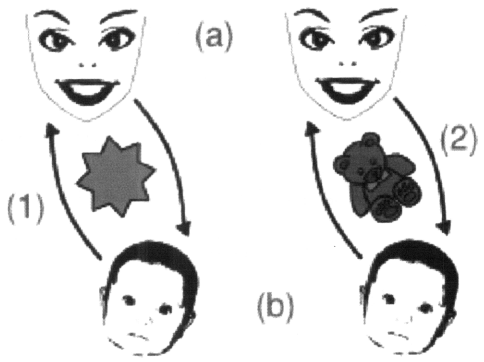


Figure 2-1: (a) mother, (b) child, (1) illusion, (2) transitional object

practical psychology [23, 52] and social studies. Singer and Singer [54] describe the concept in the following way:

> *One possible route to the beginnings of the creation of miniaturized virtual realities by the very young may emerge in the course of older babies' or toddlers' manifestations of what the psychoanalyst, Winnicott (1971), termed involvement with "transitional objects." Early on many children become attached to a soft cloth or to some combination of an old crib blanket and a "plush" toy, a cloth bunny rabbit, bear, or lamb. Such behavior generally meets those criteria of play developed in the research of Smith and Vollstedt (1985), nonliteralness and associated positive affect. Actually, one might propose that the tenacity with which children cling to these objects even as they fade in color, shrink or become ragged, may reflect the very beginnings of an experience of autonomy ("my blankie") and personal ownership, a primordial expression of our nearly universal adult sense of private property upon which whole societies and legal systems are constructed.*

Klein's Psychoanalysis of children

In *The Psychoanalysis of Children* [42], Melanie Klein, an Austrian-born British psychoanalyst who devised novel therapeutic techniques for children in the 20th century, introduced her observations and theory of child analysis. Klein believed children's play with toys to be a symbolic way of controlling anxiety and thus observed free play with toys as a means of determining the psychological impulses and ideas associated with the early years of life. She wrote that in their play,

> *...children represent symbolically phantasies, wishes and their experiences. Here they are employing the same language, the same archaic, phylogenetically acquired mode of expression as we are familiar with in dreams. We can only fully understand it if we approach it by the method Freud has evolved for unravelling dreams.*

Supporting long-distance parent-child intimacy

Dalsgaard et al. [24] used *cultural probes* [29] and contextual interviews to study the concept of mediated intimacy between children and parents, and compare this particular type of intimacy to other intimate *string-tie* relationships. The results were presented using a schematic view of *themes of intimacy*, developed by Vetere et al [59]. According to Vetere et al. acts of intimacy can be divided into three categories: (1) themes that precede the experience (*antecedents*); (2) themes that comprise the act (*constituents*); and (3) themes that are seen as the result of the act (*yields*). Dalsgaard et al. found themes that were unique to both parent-child intimacy and to other strong-tie relationships, as well as common features. Among other things, they found no evidence for reciprocal binding in parent-child intimacy:

> *The acts of intimacy were typically not reciprocated or expected in the parent-child interactions partly due to the unequal relationship between parents and*

children. On the other hand, we did find that parents occasionally expressed needs or desires for extra reciprocity from the children. Furthermore, the lack of reciprocity sometimes leads to less parental assurance and [to] worries.

Some of the themes that, according to Dalsgaard et al., are unique to parent-child intimacy are (1) settings (*antecedents*): the people involved, in this case mostly the parents, deliberately choose to involve and adjust themselves in order to be able to meet the other person on common grounds; (2) unity (*antecedents*): a sense of affiliation to a group with shared interests; (3) play (*constituents*): childish immersion into an imaginary world or setting; and (4) warm & safe (*yields*): the unequal relationship between parent and child manifests itself in a constant and continuous effort, from the parents point-of-view, to make the children feel "warm and safe". The children seek this safety and unity, and need to be protected by the parents:

Opposed to [other] strong-tie relationships, we found that parent-child relationships are unequally balanced, as the parents are also the children's protectors or guardians. In strong-tie relations, the equality of the individuals is fundamental for the relationship. Thus, trust is slightly different from strong-tie relations as security and routines become important... The unequal relationship that characterizes the relationship between parents and children need different kind of information in the acts of intimacy... On the other hand, the lack of reciprocity raises a question of whether to neglect this aspect or to design for added support of reciprocity in parent-child intimacy.

Remote interaction in divorced families

Svetlana Yarosh, at the Georgia Institute of Technology (Georgia Tech), has for several years conducted research on parent-child interaction in divorced families. Yarosh conducted a series of 15 semi-structured interviews with divorced families and concluded that [65]:

- The telephone is widely used, but not efficient.
- Video conferencing is seen as a better alternative to the telephone, but usually only used in situations of longer separation.
- Asymmetric access to infrastructure often reduces the technology used to the lowest common denominator.
- The child may not be motivated to stay in touch.
- Seeding communication is difficult.
- Shared interests or scaffolds aid in seeding conversations.
- There is a lack of access to multiple modalities.

In addition, similarly to Dalsgaard et al. [24], Yarosh states that, from the parents' point-of-view, there is a desire for greater contact with the child. One way in which parents tend to respond to this desire is by trying to maximize the quality of the time that is spent together with the child. Overall, Yarosh identifies three core requirements when it comes to technology that supports parent-child interaction: (1) seeding conversations, (2) staying aware and (3) spontaneous sharing.

2.3.2 Products and prototypes for supporting interaction in families

Davis et al. [26] have developed a system called *Virtual Box* in an attempt to support remote mediated family intimacy. The system was designed based on a set of concepts: (1) *settings*: parents often facilitate the intimate interactions of their children; (2) *play*: children immerse themselves into imaginary worlds and settings which constitutes a large part of their lives; (3) *reciprocity*: the parents expressed a desire for

more reciprocal interactions with their children: and (4) *expression*: the expressions of intimacy are very diverse and there is an inequality between expressions of parents and those of their children. In short, the application developed is a distributed Hide-and-Seek environment that supports the hiding of virtual items and media content objects; the parent or grandparent first hides the virtual object somewhere in the child's home by using a map of the house or apartment. The child then tries to "locate" it by moving in the house with a PDA that provides visual feedback and displays the virtual content once it has been correctly located. Although Davis et al. claim to design for reciprocity, they also chose to implement asymmetry in the interaction. As the authors themselves eventually realized, these two characteristics are hard to combine, since they counteract each other to some extent. More specifically, the asymmetrical design came to limit the interaction possibilities for both the (grand)parents and the children.

The Human-Centered Computing Group at the Georgia Institute of Technology (Georgia Tech) has developed a number of applications and systems for remote communication between children and parents who have been separated due to a separation or divorce. *eMutts* [66] is a series of wearable sensor toys that have been designed to motivate children to interact with and share content with their remote parent. An online game is used to motivate the child to wear and actively interact with the toys, as well as to actively upload and share the collected content with the parent. The parent then uses a web-based application to see information about the child's daily activities. *ShareTable* [66] is a collaborative tabletop surface for synchronous, long-distance activities between parents and children. Each system consists of a table, a projector, a camera, and a video-conferencing system and supports, among other things, collaborative drawing, face-to-face video communication, and board game playing.

The Feather, Scent, and Shaker application [57] was developed to support "simple" emotional communication and intimacy by evoking the human senses via a set of

Figure 2-2: A boy wearing an eMutt on his shoulder.

objects: (1) a floating white feather that represents the thoughts and awareness of the remote person; (2) a container of essential oil that uses scent to evoke emotions; and (3) a more playful tangible "shaker" that uses tactile feedback as the main language. Not only does this framework of awareness applications explore novel sensory and interaction possibilities, but, unlike many other awareness systems, it uses ambiguity explicitly as a way to increase user engagement.

Contextual Asynchronous System (CASY) [67] is a system that uses audio and video messaging, asynchronous communication and context-based delivery in order to help distributed family members feel connected. *CASY* enables family members to send asynchronous video snippets, saying 'good morning' and 'good night', into a shared family database. The recipient then views the snippets in the right context - when going to sleep or waking up. The context-based delivery aspect of CASY is very interesting, since studies of parent-child intimacy show that routines play an important role in the relationship. As described in section 2.1, the traveling parent often tries to maintain and respect these routines by calling home at their child's bedtime.

PlayPals [20] are a set of wireless dolls, designed by Bonanni et al. that are supposed to be used for playful communication, sharing of multimedia experiences and virtual co-presence, between remote locations. The dolls were initially designed for children aged 5-8. According to the designers, embedding digital communication into existing play patterns and objects enhances both remote play and communication.

Gustbowl [41] is a system that, similarly to *CASY*, attempts to support remote awareness in particular situations. The system was designed as a way for mothers to keep in touch with their sons who no longer live at home. Gustbowl consists of a bowl into which the son can throw keys and other objects when he comes home, at the same time as he announces his presence by saying, for example, "I'm home Mom!" The mother's Gustbowl then shakes in response and shows images of the object(s) in the son's bowl.

The Huggable [56, 55] is a full-body "sensitive skin" robotic Teddy bear being developed in the *Personal Robots Group* at the MIT Media Laboratory for healthcare, education, and social communication applications. The Huggable has been designed to function as a social companion, with aspects such as affect and relational touch in focus, and functions as a complement to traditional therapy methods, rather than as a replacement for them. According to the researchers, the form factor of the Huggable was chosen based on the fact that the Teddy bear is a universal symbol of comfort across many different cultures and age groups.

Other similar projects are IDEO's *Kiss Communicator* [17], *Digital Family Portraits* [47], *LumiTouch* [21], *Virtual Intimate Object* (VIO) [39], *Lover's cups* [22], and the *ASTRA Awareness System* [45].

Figure 2-3: IDEO's kiss communicator device.

2.3.3 Systems for encouraging awareness of unfamiliar locations and viewpoints

Plane Tracker [30] is a project developed at the Goldsmiths College in London as a part of their *Curious Home* project. The Plane Tracker is intended to give people a feeling of connection with distant parts of the world via the planes that physically pass by overhead. Transponder data from passing aircrafts is collected, decoded and used for displaying the apparent virtual flight on a display. Although this application encourages people to learn more about remote locations, it does not take social aspects and human-to-human interaction into account.

Glogger [6] is a web service and mobile application that allows people to automatically broadcast live content from their camera phones, or manually from their digital camera, to any of their social networking sites, blogs, or personal pages. In addition to broadcasting photos, Glogger allows the users to create storyboards with narratives. The concept originates in MIT Media Laboratory alumn Steve Mann's research and work on wearable cameras and information sharing, as seen from a cyborg point-of-view.

2.3.4 Mobile application for awareness and shared experiences

Regarding mobile systems for remote awareness and media sharing, a number of novel applications have been designed and evaluated [32, 37, 64]. One particularly interesting aspect of these evaluation studies is that they advocate mobile applications that not only capture and store media content for the sharing of experiences, but also play an active role in the construction of those experiences. Thus, the mobile device is not only a tool, but also a participant in the process of creating and sharing experiences [37].

Monkey-To-Go [7], a system developed in the *Speech + Mobility Group* at the MIT Media Laboratory, is a predecessor to the work presented in this thesis. The system is a mobile extension of *Monkey Business* [46], a tangible awareness system, which consists of a network of animatronic stuffed toy monkeys that communicate information about their users with gestures and sounds. As the name reveals, *Monkey-To-Go*, takes this approach one step further, by making it mobile; whenever a user is away from his or her physical agent, a mobile application that supports the same set of features can be used as a replacement in order to connect to the network. Instead of physical gestures, animated images are used to convey information about occurring events and activities.

2.3.5 Non-academic projects, products and services

A large number of non-academic books and projects address the issue of remote interaction with children [5, 4, 25, 34, 35, 58]. Author and mother Charlie Hudson emphasizes the importance of reducing the preschooler's "fear of the unknown". Hudson claims that there will always be separation issues, rooted in a feeling of abandonment, and one way to reduce that anxiety is to "communicate why [you are leaving]" and "involving [the children] in the preparation of leaving" [8].

Figure 2-4: The Monkey-To-Go interface.

The Flat Stanley Project [5, 4] is a successful educational initiative, which was started in 1995 by a Canadian third-grade schoolteacher, Dale Hubert. The Flat Stanley project uses this concept of "letter traveling" in order to provide an opportunity for students to make connections with peers in other schools. The students begin by making personal Flat Stanley paper dolls and keeping a journal for a few days, documenting the places where Flat Stanley goes and the activities in which he is involved (see figure 2-5). The Flat Stanley paper doll and the journal are then mailed to students in other parts of the country who are asked to treat the figure as a visiting guest and add to his journal. After a period of time, they mail both Flat Stanley and the journal back to the original school.

According to Dale Hubert, several factors have contributed to the success of the Flat Stanley project. First, the project helps to make abstract, remote tasks and interactions more meaningful and comprehensible. Second, it allows you to have a mutual friend with other people, and thus gives the children a feeling of being a part of a global community. Third, the Flat Stanley Project enables "proxy journeys", which are particularly beneficial for children who are not able to travel in real life [9]. *The Traveling Gnome Prank* [13], a similar activity for adults in which "mysterious"

Figure 2-5: Flat Stanley on one of his trips.

garden gnomes are documented across the world, was popularized by the French movie *Amlie* [2]. The Flat Stanley Project and Traveling Gnome Prank both link back to Winnicott's concept of transitional objects (see section 2.3.1), that is, using physical objects as comforting and shielding intermediaries.

WebKinz [15] is an example of an online community for children. The Webkinz business is built around a set of stuffed animals, each of which come with a unique code that lets the child enter a web-based virtual *Webkinz World* and play with a virtual version of the animal. After the code has been entered, the physical stuffed animal has fulfilled its role; the main activity and goal is to develop and explore the animal's virtual Webkinz home by buying things and playing games in the virtual world. There are no specific aspects of child-parent interaction implemented in Webkinz; it does however allow children to interact with friends who are also part of the community. *Build-a-Bearville* [3] and *Adopt Me* [1] are similar online communities for children. Adopt Me is, however, purely virtual and seems to target a slightly older age group. *The Tamagotchi* [11] is a small and simple egg-shaped computational toy that "contains" a digital pet. Similarly to many other avatar-based games and services, the Tamagotchi is based on the concept of care giving; the virtual avatar has to be fed and activated in order to stay happy. More recent versions of the Tamagotchi can communicate with other Tamagotchi devices for games and breeding.

2.4 Summary

The findings presented in this chapter suggest a large number of design principles and requirements, of which the following have been identified as particularly significant:

2.4.1 Initial interview study

- The system should either adapt to daily routines, or (even better) help the family members maintain their routines.
- Both parents and children prefer using video chat, rather than talking on the phone, but tend not to use video since it is too complicated to set up and use.
- Most traveling parents communicate with the rest of the family at least once per day; usually at the same time of day to respect domestic routines.
- Children to a large extent depend on their non-trevling parent when it comes to communicating with the traveling parent, partly because the technology is complicated to use.
- "Demystifying" the upcoming trip by, for example, talking about the trip is usually a good approach for making the trip and the moment of separation less dramatic and hard.

2.4.2 Online survey

- Existing communication technologies are not ubiquitous enough. They should be easily accessible and flexible.

- Phone calls are usually too abstract for young children and is not ideal for expressing emotions or for comforting.

- Communication technologies should be more mobile, since children normally do not sit still for very long.

2.4.3 Academic work

- The system should take into account the unequal, partly non-reciprocal, relationship between a parent and a child. It should also consider the fact that many parents wish that the communication pattern could be more balanced and reciprocal [24].

- Communication between a parent and a child is often asymmetrical; many times the parent is more interested in communicating with the child than vice versa. Therefore the system should help seed conversations [65].

- The system should support caring, playing and the expression of emotions and intimacy. More specifically, the system should allow the parent to make the child feel safer and taken care of [24].

- The system should be easy to access and use, whenever the users have time to or want to interact, and should support frequent and spontaneous use [24, 65].

2.4.4 Non-academic work

- The system should aim to make the unknown ("Where is mum and what is she doing? Why did she leave me?") more understandable to the child.

- When it comes to (preschool) children, using interfaces that are familiar and

tangible, such as toys, as well as game-based features, have the potential of creating more engaging and comprehensible user experiences and interactions [5, 18, 20, 65].

Chapter 3

Globetoddler

This chapter describes the second phase of the thesis project: the practical implementation of a number of the theoretical principles presented in the previous chapter. The result of this work is *Globetoddler*, a multimodal, mobile-tangible mediated communication platform for parent-child interaction. The chapter begins with a design statement; that is, a detailed description of how the theoretical platform was translated into design guidelines, as well as why some principles were considered more important than others. The chapter also presented a user scenario that describes the main features and interactions envisioned for the Globetoddler system. The rest of the chapter covers the design of Globetoddler, describing the various design decisions that went into each part of the multifaceted system in more detail. This description is framed with three sections: (1) the overall design, (2) the interactive and tangible interface on the child's side, and (3) the mobile application on the parent's side.

3.1 Establishing a system design

3.1.1 Design statement

The principles and conclusions presented in section 2.4 leave room for many different implementations, depending on which aspects you choose to focus on. For example, a system for remote communication between parent and child could be built around the concept of traveling. Location-based data, maps and geographic data could provide enough data to realize an application that helps the parent create stories about his or her business trip. In many ways, traveling parents already do this, but in a less high-tech fashion [8, 25]. However, only one of the families that participated in the interview study described in section 2.1 reported that the children in the family were interested in and actively taking part in their parent's business trips. Another family testified that the only thing the children were interested in regarding the traveling parent's trips was the food. In fact, the majority of reports suggest that the main focus during a trip is either (1) from the child's point-of-view: on the return ("When is mum coming home? Is she bringing gifts?") or (2) from the parent's point-of-view: on increasing the possibilities to connect and enhancing the experience during interaction. As a result, in the construction part of this thesis project, the core project statement was defined as follows:

> *I aim to build a system that (1) maximizes the possibilities for traveling parents to connect with their preschool children in real-time and helps them maximize the quality of the interactions by implementing immersive and child-friendly elements that seed communication and interaction, as well as (2) provide a set of asynchronous features that help the parent and child feel connected even when it is not possible to interact in real-time.*

Another important design consideration is that of inequality and asymmetry in the relation between a parent and a child. For example, it is fairly easy to see that interactions supported by the geography explorer application briefly described in the beginning of this section easily could become one-sided; the parent generates stories and content that the child then "consumes". The *Virtual Box* project [26] addresses this issue. Now, this may be a good approach, considering that the parent generally is more eager to connect and therefore also may be more likely to participate actively. However, as the conclusions in section 2.4 testify, providing the children with information in order to make the "unknown more known" is just one of many aspects of remote parent-child communication and intimacy. It is equally important for parents to get feedback and to be reassured: What did my child do in school today? How did she react to that postcard I sent to her last week? Why haven't I heard from him in two days? In addition, although research shows that young children tend to be more egocentric and "in their own world" [60], there is, as far as I know, no proof that children do not enjoy sharing and doing things together with and for their parents. On the contrary, as seen in the case of interaction between co-located parents and children, storytelling and other shared activities is a fundamental part of the relationship. However, it is very important to provide and support the right circumstances for these interactions [24], for example by allocating time, adjusting to the current mindset of the child, as well as by providing the right context, for example while taking a bath, lying in bed, or at bed time. A core assumption in this thesis is that parent-child communication should not be made more unbalanced that it already is. Thus, the following lines were added to the project statement:

> *In addition, the interactions supported by the system should be as symmetrical and equal as possible, but should still acknowledge the fact that the abilities and needs of the parent and child are different. Thus, although the parent's interface and the child's interface need to be different, they should support the same set of features.*

3.1.2 Design translation and realization

Based on the design statement above, a prototype of a toy-to-mobile always-on multimedia experience intermediary was designed. On the child's end, an embodied interface (doll) functions as the main user interface - a "portal" that leads straight to the parent. The traveling parent can use his or her mobile phone to, among other things, record audio comments, capture photos and video, and send them to the child. The next time the child plays with the doll, he or she is notified of the new content and is encouraged by the system to take a look at it on a nearby computer or TV screen. If the child chooses to do so, the parent is discretely notified of the activity, and is, in addition, able to see what content the child is currently looking at. Thus, this approach enables the parent to (1) if available, barge in, in order to chat with the child and comment on the content in real-time (synchronous interaction), (2) if busy, leave a comment later (asynchronous communication), and (3) dynamically learn what the child is interested in and possibly adapt future interactions to those interests. In a similar manner, the child can use the doll to record video and capture photos, or send photo requests ("I want to see what you are doing right now, mum.") to the parent. The interaction on the child's side is guided by an avatar. Thus, the doll and interface, used by the child, function both as the affordance for interaction, as well as an agent that helps the child work its way around the content.

3.1.3 Design hypothesis

To conclude, the main contribution of the Globetoddler system is to (1) increase the overall opportunity for synchronous communication by implementing alerts, (2) allow the parent to know when the child may be receptive to communication, (3) make it easier for the child to initiate interaction by enabling the child to interact with the software, as well as to send interaction requests, and (4) increase the chances

for asynchronous communication, for example by recording sound and/or video when the kid plays with the toy. The system has been designed around the hypothesis that a system that succeeds in making children feel more connected to their parents, and does so in an exciting fashion, will (1) reduce the separation anxiety that many children experience before a trip, and (2) reduce the time-related anxiety ("Will mum ever come back home again?").

3.2 Scenario

Figure 3-1: 1. Sarah is saying farewell to her mother Kate.

This is Sarah and Sarah's mum Kate (figure 3-1). Sarah is four years old and attends pre-school. On her spare time Sarah loves playing with her dolls and sometimes she plays video games with her older brother Jake. Kate works as a manager at *Coca Cola* and travels a lot for business. Normally, Kate is only away for two to three days each time, but she travels at least once per month. This time Kate is going on a business trip to Atlanta, where she will be instructing new managers for a week. Sarah usually gets anxious and upset at least a couple of days before Kate leaves, so Kate finds it really important to take time to talk about the upcoming trip with Sarah. Sometimes they use a map of America and while Kate shows Sarah where she is going, they talk about what it is like there and why she has to leave. Kate emphasizes that she

will be back home very soon and that Sarah's father will be taking care of Sarah while she is away. While on the road, Kate normally tries to call home every night at bedtime by using her personal mobile handset; a *Nokia N95* smart phone. Depending on the infrastructure available, she sometimes uses *Skype*, but since video conferencing requires more preparation in order to connect, she prefers using the handset. A few times Kate has tried to send photos to her husband Ian and ask him to show them to Sarah and Jake, but since Ian always tends to forget to show the children the photos, she stopped sending them.

A few weeks ago Kate decided to invest in a new device: a new system called *Globetoddler* that several of her colleagues recommended to her. Kate really appreciates the fact that, unlike many other technologies, Globetoddler enables her to communicate with Sarah directly: she has a simple mobile application running on her handset and Sarah has a stuffed toy, called *Abima*, which is wirelessly connected to an interactive virtual world on the TV screen, similarly to their *Nintendio Wii* video game. As a result, Kate no longer has to call Ian's mobile phone or ask him to set up Skype in advance; the Globetoddler system is always on and is so easy to use that Sarah is able to use it on her own. Furthermore, Globetoddler doesn't just support phone calls. It supports a large variety of activities, both for asynchronous and synchronous use, and, on top of it all, the system is fun to use. Sarah and Jake both seem to love Globetoddler and Kate sometimes wishes that she would have an excuse to use it too.

One day, when Kate is in Atlanta, she decides to go out for lunch. On her way back to the office she sees a monkey and thinks of Sarah, who loves monkeys in all shapes, colors and forms (figure 3-2). She picks up her handset and captures a photo of the monkey. After processing the image, the mobile application encourages Kate to record an audio message to go with the photo. Kate records a short message: "Hi Sarah. I just saw this monkey here in Atlanta. It's big, isn't it?! The monkey looked

Figure 3-2: 2. Kate takes a photo of a monkey, while Sarah is in school.

at me and smiled when I walked by. What do you think his name is?" Kate then sends the photo. Shortly after the photo is sent, it is received by the Globetoddler server running at home and stored safely. At the same time, an array of lights on Sarah's doll starts flashings to show that there is a new photo waiting for her.

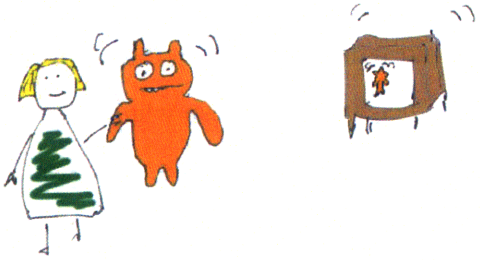


Figure 3-3: 3. Sarah plays with Abima and sees the monkey photo that Kate sent to her.

At the same time, in another part of the country, Sarah is in school and is unaware of what is happening, but as soon as Sarah gets home and starts playing with Abima in front of the TV screen, the virtual version of Abima on the TV screen starts talking: "Hi Sarah! You have a new photo waiting for you! Let's take a look!"', after which it automatically brings Sarah to the virtual photo album (figure 3-3). The photo that Kate sent earlier that day is displayed on the screen and when Sarah squeezes Abima's belly, the audio message is played back. The Abima avatar then helps Sarah record

a video response: "Hi mum! I think the monkey is called Jake, 'cause he looks just like Jake!" The video is then stored locally on the server and a notification is sent to Kate's handset.

Figure 3-4: 4. Kate can see on the screen of her phone that Sarah is playing with Abima.

Luckily, Kate happens to be on an afternoon coffee break at the same time as Sarah is viewing the photos. When Kate activates the mobile application, she receives a "new video" notification and can easily tell that Sarah is using the system, since a green avatar is displayed on her handset screen whenever the system at home is active (figure 3-4). Kate decides to "barge in". She calls the system and then chooses to enter the "shared photo view mode" that allows her to see the photo that Sarah is currently looking at. They then look at the photos together and talk about them.

Figure 3-5: 5. Sarah and Kate play with their avatars.

After a while, Sarah wants to play with Kate, so Kate simply uses the mobile appli-

cation to enter the "play section" and to add her own green avatar next to Sarah's red avatar (figure 3-5). In this particular game Sarah can move her avatar by shaking her physical toy, and Kate can control her avatar through the mobile application. At one point Kate presses the "kiss command" that temporarily takes control over the two avatars and makes them kiss.

After Kate has logged out, Sarah continues to play on her own for a while. Her favorite game is Hide-And-Seek, where she can hide her avatar for Kate to find. The next time Kate initiates her mobile application, she will get a notification saying: "Your child has hidden Abima. You should play Hide-And-Seek!" When Kate enters the Hide-And-Seek game on her handset, she is instructed to click on any of the seven places where Abima could be hiding. After four clicks, Kate finally finds Abima and receives four points. Thereafter, Kate hides her own avatar, Bop. At this point, Sarah is already fast asleep in her bed and is so far unaware of the pleasant surprise that is waiting for her when she wakes up the next day.

3.3 System architecture

The Globetoddler system consists of three core parts: (1a) a stuffed toy connected to a (1b) Flash-based interactive application on the child's side (hereafter referred to as the *FlashClient*), (2) a Java-based mobile application on the parent's side (hereafter referred to as the *MobileClient*), and (3) a Java-based server that functions as the hub (hereafter referred to as the *MainAgent*). The *MainAgent* orchestrates the data flow between the *FlashClient* and the *MobileClient*, and stores the media files that are created at each end for future sharing. In this section, each part will be described in detail. The *FlashClient* and *MobileClient* will be described from a user interface design point-of-view, whereas the *MainAgent* will be described from a technical angle. For more information regarding the technical details of the complete system, see section

A.

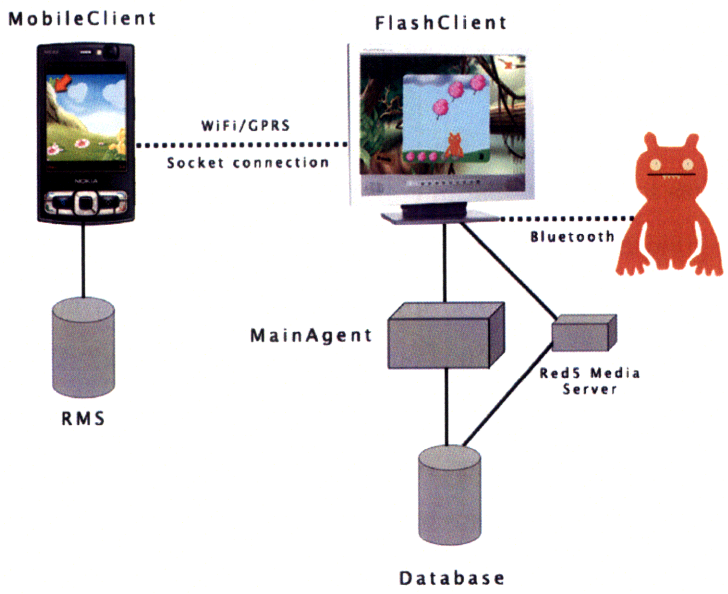


Figure 3-6: The Globetoddler system design.

3.3.1 The FlashClient

To put it shortly, the interface on the child's side consists of a sensor-equipped physical toy interface and a complementary interactive Flash interface. The toy interface functions as a motion-based remote controller for the interactive interface. The graphical interface supports a fairly large number of activities, both for single-user interaction (child only) and multi-user interaction (parent and child). This chapter describes the graphical user interface (GUI) in detail. Special attention is paid to features that are considered particularly important or profound.

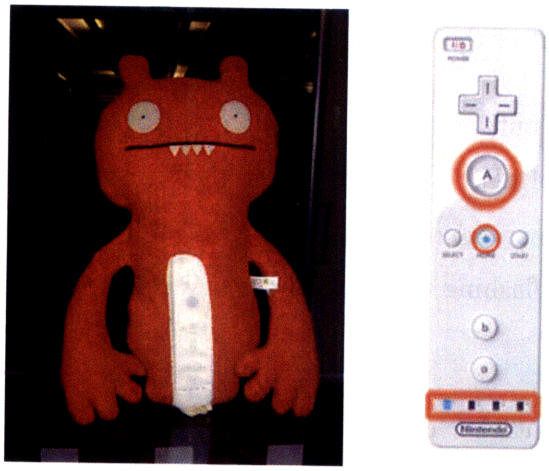


Figure 3-7: (1) The toy (Abima) with a Wii controller belly. (2) The Wii remote controller with active buttons and LED's marked in red.

The tangible Globetoddler toy interface

For this thesis project, *Ugly Dolls* [14] were used for the tangible interface. The dolls were chosen merely for their playful, original and likeable appearance. No assumptions were made regarding the dolls' influence on the users or on the interactions the dolls support. Each doll contains a *Wii* remote controller [1] and uses the accelerometer of the remote controller to sense motion. The remote controller is safely stored in a transparent "pouch", placed with the buttons facing upwards in order to make them visible. As a way to make the interface as simple as possible, only two of the controller's buttons are being used. The large center button (marked with a large orange circle in image 3-7) is being used as the main "execution" button. The small "home" button (the button has a house icon on it), just below the main button, is being used for returning to the previous section. The accelerometer in the controller is used both explicitly and implicitly. In general, the avatar can be moved by tilting the toy to the left or right, whenever the virtual avatar is allowed to move in the GUI. In addition, as soon as a motion event is sensed, a notification is sent to the parent's

[1] A Bluetooth-enabled accelerometer circuit was designed for this project, but turned out to be too unreliable, vulnerable, and power-consuming to be usable in the long run.

side to inform the parent of the fact that the toy is active and being used.

When it comes to output events, the only controller output that currently is supported is the array of LED's below the buttons on the remote controller [2] (figure 3-7). When a new photo or video file has been received by the *MainAgent*, the LED's start flashing and keep flashing until the photo or video section of the interface has been visited.

The *Wii* remote controller communicates wirelessly with the *MainAgent's* Java interface via Bluetooth, and the incoming events are read and parsed by a Java-based *EventHandler* that runs under the *MainAgent*.

The Globetoddler GUI

The interactive virtual Flash interface, the *FlashClient*, which was developed in Action Script 2.0, consists of 13 main sections; each designed to support a specific activity.

In accordance with the design specification and statement (see section 3.1.1), the activities have been designed to support both (1) single-user (child) interaction/multi-user (parent-child) interaction, and (2) asynchronous interaction/synchronous interaction.

The avatars A pair of avatars, *Abima* and *Bop*, are used in the Globetoddler system. The avatars play a key role, especially in the child's interface. First, they are an important part of the storyline upon which the Globetoddler interface is built. Second, the avatars are used for enabling and encouraging more equal and reciprocal

[2]The initial plan was to use the built-in speaker in order to use audio to prompt the child. However, not surprisingly, the low-quality 8-bit PCM sound at 2000Hz turned out to be useless for this purpose.

Table 3.1: Globetoddler sections

Globetoddler sections		
Section name:	**Features:**	**Subsection to:**
SectionStart	Introduction; start application.	(*MainGUI*)
SectionMenu	Navigate between options by walking.	*SectionStart*
SectionGeo	View a map of the parent's and your own (the child's) current geographic location.	*SectionMenu*
SectionMedia	A sub menu that allows you to choose between four media-related activities.	*SectionMenu*
SectionGames	A sub menu that allows you to choose between three game-related activities.	*SectionMenu*
SectionNewPhoto	A "photo album" that allows you to view new photos (and listen to the accompanying audio message), sent from your parent, starting with the most recent one.	*SectionMedia*
SectionNewVideo	A "TV studio" that allows you to view new videos, sent from your parent, starting with the most recent one.	*SectionMedia*
SectionCapturePhoto	A "photo studio" where you can capture your own snapshots, for your parent to download.	*SectionMedia*
SectionRecordVideo	A "video recording studio" where you can capture your own snapshots, for your parent to download.	*SectionMedia*
SectionPlay	A general play environment where the child's and the parent's avatars can meet, jump around, and kiss.	*SectionGames*
SectionHideAndSeek	A game that allows the child to play Hide-and-Seek (mostly) asynchronously with the parent. The MobileClient runs a similar game application.	*SectionGames*
SectionCatchCandy	A single-player game where the child uses the physical Abima toy to move the avatar on the screen in order to collect falling candy.	*SectionGames*
SectionPhotoDisplay	An independent photo display section, which only can be displayed/initiated remotely from the *MobileClient*. This is used by the parent when he or she wants to display specific photos remotely.	(*MainGUI*)

interactions between the parent and the child; in the interactive virtual world, Abima and Bop are friends and meet and play on equal terms.

Table 3.2: Globetoddler features

Globetoddler features		
Feature:	**Interaction model:**	**Users:**
Capture photo/video	Asynchronous	Single-user
View photos/videos	Asynchronous	Single-user
View map	Asynchronous	Single-user
Play Catch Cotton Candy	Asynchronous	Single-user
Play with avatars	Synchronous	Multi-user
Play Hide-and-Seek	Asynchronous	Multi-user
Shared photo view	Synchronous	Multi-user

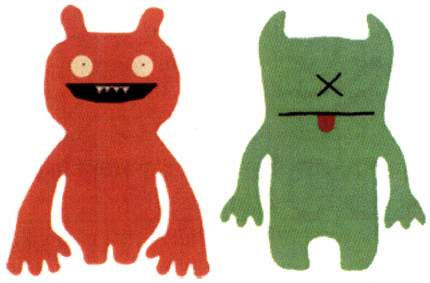


Figure 3-8: The two main characters: Abima and Bop

Abima, the red avatar to the left in figure 3-8, is the child's avatar and exists both as a virtual avatar and a physical toy. The two representations of Abima are tightly coupled; the physical toy is used to control the avatar. On a more abstract, symbolic level, the Abima avatar functions as both a virtual representation of the child and a "guide". The avatar helps the child understand the interactive interface better by explaining the different features and sections. Bop, the green avatar to the right in figure 3-8, is the "traveling" avatar and, correspondingly, a virtual representation of the parent. Thus, Bop is present, for example, in photos that the parent has sent from the handset, as a way to stage and emphasize that Bop is remote and traveling, just like the parent.

The approached described here is partly similar to that of multi-user virtual communities and computer games, such as *Second Life* [10] and *World of Warcraft* [16]; the avatars function as (temporarily) co-located virtual proxies for geographically

distributed individuals. *Webkinz* [15] and *Build-a-Bearville* [3] (see section 2.3.5), which specifically target children, have, similarly to many other child-oriented online services, been designed either for (1) single use, or for (2) child-child communication. Few applications support interaction between children and their parents; even fewer support *remote* parent-child interaction. In addition, many of these communities have a very strong commercial focus, where encouraging the users to spend money by buying both virtual and real objects seems to be the main driving force, rather than supporting rich interactions.

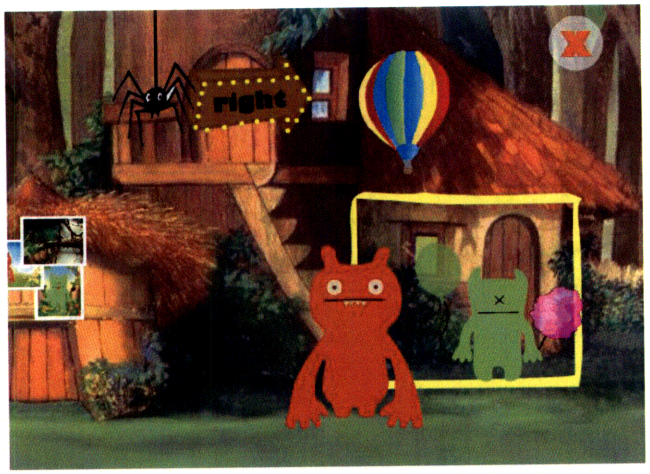


Figure 3-9: SectionMenu

SectionMenu *SectionMenu* is the main menu; a virtual town from where you can reach almost all of the features that the Globetoddler *FlashClient* offers. Image 3-9 shows only parts of the town, since it is wider than the screen. The edges can be reached by moving the avatar to the left or to the right. The virtual avatar is controlled by tilting the physical toy left or right. The yellow frame that surrounds the entrance of the house in the image indicates which option, of *SectionGeo*, *SectionMedia*, or *SectionGames* (represented by the green avatar with a balloon in the image), currently

is pre-selected. Once a section is pre-selected, the child can enter the section by pressing the main button on the toy's belly. In addition to the three sections, the menu contains a camera option that allows the child to send a "remote photography request" to the parent. If the parent enters a specific photo display mode on the handset upon receiving the child's request, the child can remote control the handset camera in order to capture photos; a fairly simple way of getting a "sneak view" of the parent's daily life. A happy, playful background tune is played when the avatar is not speaking.

Figure 3-10: SectionMedia

SectionMedia *SectionMedia* and *SectionGames* are sub sections that contain the specific options, and look the same apart from the actual options. As image 3-10 shows, the menu consists of a "wheel of fortune" that can be rotated. In the case of *SectionMedia*, the options are: *SectionRecordVideo* (yellow quarter with a video camera icon), *SectionCapturePhoto* (brown quarter with a photo camera icon), *SectionNewVideo* (red quarter with a TV icon), and *SectionNewPhoto* (green quarter with a photo icon). The wheel can currently only be rotated clockwise. This is achieved by

tilting the physical toy to the right. Once a quarter is pre-selected, it can, similarly to *SectionMenu*, be initiated by pressing the main button on the toy's belly. In both *SectionMedia* and *SectionGames*, a background tune is played when the avatar is not speaking.

Figure 3-11: SectionNewPhoto

SectionNewPhoto As the name reveals, *SectionNewPhoto* is used for displaying photos that the *MainAgent* has received from the *MobileClient* (parent). The child is automatically directed to this section if new photos have been received. After the child has finished looking at the photos and exits the section, he or she is, again, automatically directed to *SectionCapturePhoto* to capture his or her own photo for the parent (the same goes for videos). The orange arrows to the left and right of the photo are displayed only if there are older or newer photos available. The child picks either the left or the right arrow by tilting the physical toy to the left or right. When an arrow is pre-selected, a black ring is displayed around it, as shown in image 3-11. Once the arrow is pre-selected, the child proceeds to the previous or next photo by clicking on the main button on the toy's belly. The parent's green avatar is superimposed on

the photos as a way to leverage and establish the concept of virtual selves; the parent and the child each have an avatar, and the parent's avatar is traveling just like the parent.

If the parent chose to attach an audio message to the photo before sending it to the server, the audio message is played back automatically when the photo is displayed and can be replayed by pressing the main button.

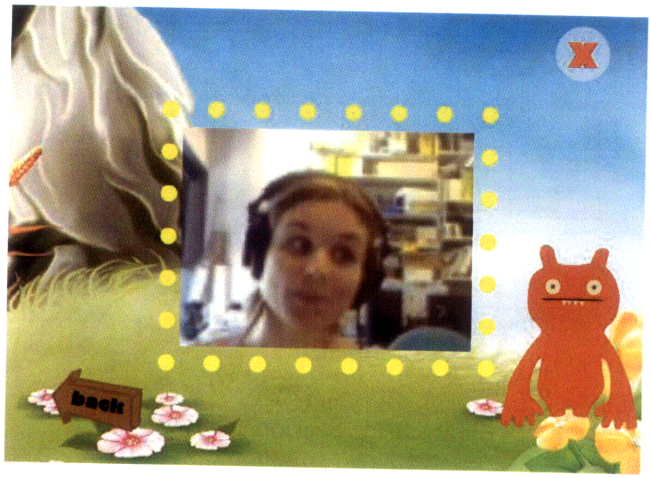


Figure 3-12: SectionRecordVideo

SectionRecordVideo *SectionRecordVideo* allows the child to record his or her own video. The frame of yellow lights in image 3-12 indicate that a video is being recorded. A recording is initiated by pressing the main button on the toy's belly. The same button is used for stopping the recording. After 20 seconds, the video recording is automatically stopped as a means to prevent large video files; the main reason being that the video files currently are sent to the handset before playback, rather than being streamed from the server. When a recording is stopped, the file is automatically stored by the server and the name of the file is added to the list of video files that are available for downloading. A notification is displayed by the *MobileClient* application, either

immediately if the application is running, or right after startup if the application is not running. The video file is not sent to the *MobileClient* until the parent explicitly chooses to download the file from the *MainAgent* application.

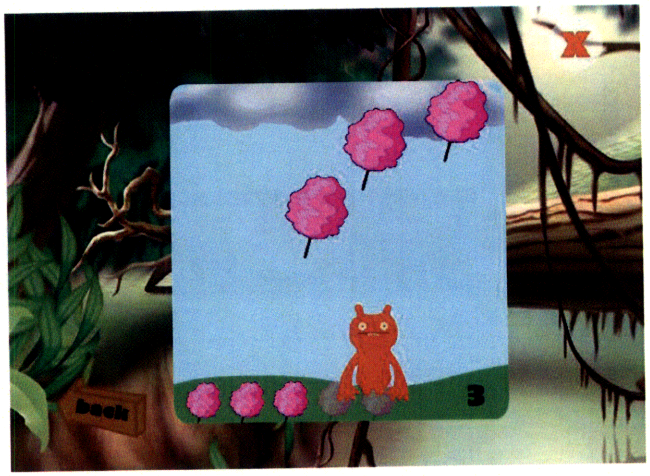


Figure 3-13: SectionCatchCandy

SectionCatchCandy *SectionCatchCandy* is an independent game application in which the child is encouraged to actively use the physical toy as a controller. The goal is to catch five falling cotton candy sticks in order to collect points and proceed to the next, more challenging, level. The game avatar that catches the falling sticks roughly follows the tilt of the physical toy; if the toy is tilted to the left, the avatar slowly moves to the left, and if it is tilted to the right, the avatar moves to the right. The game includes three levels.

SectionHideAndSeek *SectionHideAndSeek* is another independent game activity. However, contrary to the *Catch Cotton Candy game*, *Hide-And-Seek* is a multi-player game that can be played by both the child and the parent. A corresponding application has been designed for the *MobileClient*. The game consists of two activities:

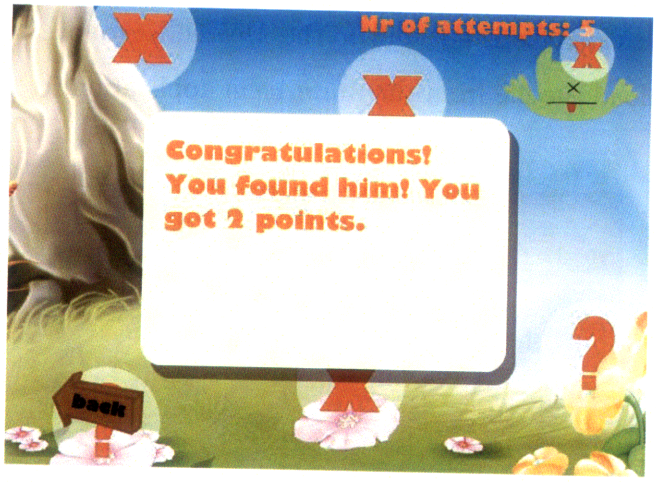


Figure 3-14: SectionHideAndSeek

(1) hiding your avatar for the other person to find, and (2) finding the other user's hidden avatar, if the user has hidden it. The game has been designed for asynchronous use, meaning that it doesn't require the user at the other end to be available while playing. In the case of the *FlashClient*, a notification is sent to the *MobileClient* after hiding the avatar, either immediately if the application is running, or right after startup if the application is not running. If the parent has hidden his or her avatar, the child is automatically directed to the "search mode" after selecting *SectionHideAndSeek*.

SectionPlay *SectionPlay* allows the parent and child to play in real-time. If the child has entered the section, the option "Add avatar" show up in the mobile application. The option allows the parent to add his own avatar (the green avatar in figure 3-15). Once added, the parent can control the avatar remotely from the handset. Currently, the only options supported are to (1) make the avatar jump, (2) stop the avatar, (3) remove the avatar, and (4) kiss, which temporarily takes control over both avatars and makes them "kiss". A kissing sound is played back when the avatars meet.

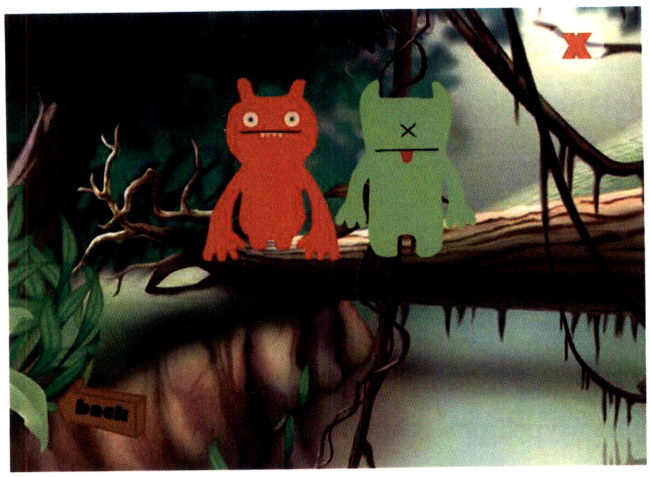


Figure 3-15: SectionPlay

Figure 3-16: SectionPhotoDisplay

SectionPhotoDisplay *SectionPhotoDisplay* is used specifically for viewing images together, in real-time. The section can be accessed only remotely from the *MobileClient*. Once initiated, the parent can choose which of the photos that have been stored on the handset should be displayed in the frame on the child's side. As in the

case of *SectionNewPhoto*, a green avatar is superimposed on the photo. Alternatively, the parent can set the application to display the photo that the child is currently looking at in *SectionNewPhoto*.

3.3.2 The MobileClient

When it comes to the traveling parent, the main requirements were to (1) support mobility, (2) support asynchronous and irregular use, and (3) use available and easily accessible technology. A relatively simple mobile application was developed to meet these requirements. The user interface consists of four main sections: (1) *MainCanvas*, the default screen that shows whether the child's toy is active (moving) or not, (2) the *PhotoMenu*, (3) the *VideoMenu*, and (4) the *ActionMenu*. This section describes the design of the *MobileClient* in general, and the content of the four sections in particular. The focus is on the user interface. For a more detailed description of the technical aspects of the client, see section A.

Hardware

Nokia smart phones (GSM), model *N95 8GB*, were used as the developing platform for the *MobileClient*, since they support Bluetooth, WiFi and GPS, as well as capturing of both images and video. In addition, the N95 handsets have relatively large screens. The Globetoddler mobile application requires either WiFi or GPRS to send and receive text and media data. For this project, *T-Mobile's Full Internet Plan* was used to enable GPRS. However, since WiFi normally is significantly faster than GPRS, GPRS was only used when WiFi was not available. Bluetooth is currently only used for updating the software. GPS is used when the parent chooses to explicitly send location data to the *FlashClient's* map section, *SectionGeo*.

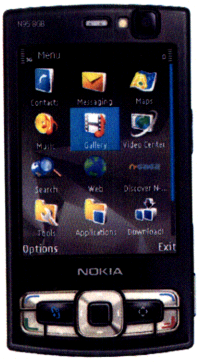


Figure 3-17: The Nokia N95 8Gb handset.

MainCanvas

Figure 3-18: (1) The child's toy is not "active"; (2) The child's toy is "active".

The *MainCanvas* contains the main parts of the mobile GUI: a *FlashClient* status icon, a static image of either a red or a green avatar, which informs the parent of when the toy is being used and a menu, containing the four submenus: *Photos*, *Videos*, *Actions*, and *Change Server [IP] Address*. The status icon changes almost immediately after the child's physical toy has been picked up or put down.

Photo menu

The photo menu options are presented in table 3.3.

Table 3.3: PhotoMenu

PhotoMenu	
Option:	**Function:**
Capture photo	Enter photo mode in order to be able to capture a photo. After capturing a photo, the parent is asked if he or she wants to add an audio message to the photo. Currently, only the image file can be saved.
View your photos	View your own saved photos (figure 3-19).
View child photos	View child photos (captured with Flash) that the parent have saved on the phone.
Download new child photos	Download a list of new child photos (stored on the *MainAgent* server) in order to choose which ones to download and save.
Let child share photos	Tell the *MainAgent* to send the photo that the child is currently looking at (in the *FlashClient section SectionNewPhoto*) to the handset. Photos are sent until the parent exits the shared view mode or the child stops viewing photos and exits *SectionNewPhoto.*
Share photos with child	Display photos remotely in the *FlashClient* section *SectionPhotoDisplay*; a section that can only be accessed by the parent from the handset menu. (*SectionPhotoDisplay* has to be initialized manually prior to sharing photos.)

Video menu

The video menu options are presented in table 3.4.

Table 3.4: VideoMenu

VideoMenu	
Option:	**Function:**
Record video	Similar to "Capture photo" (see Table 3.3).
View your videos	Similar to "View your photos".
View child videos	Similar to "View child photos".
Download new child videos	Similar to "Download new child photos".

Actions

The action menu options are presented in table 3.5.

Table 3.5: Actions

Actions	
Option:	**Function:**
Play Hide and Seek	Hide *Bop* (the parent's avatar) or (2) look for *Abima* (the child's avatar) if your child has hidden her (figure 3-19.
Call child	Establish a phone connection with the *MainAgent* in order to talk to the child. The handset simply calls a *SkypeIn* [3] number that is associated with the *Skype* account running on the server side.
Hide/Show	"Hide" removes the green avatar that indicates that the *MobileClient* is connected from the Flash interface. "Show" displays the avatar and is only added to the menu after the avatar has been hidden.
Navigate in Flash interface	Displays a list of all the sections in the child's Flash interface and lets the parent choose sections remotely.
Send your location (GPS)	Send GPS data directly to the *MaintAgent*, which forwards the data to the *FlashClient*. The location data is used only when the child enters *SecionGeo* to view the world map.
Delete all saved files	Deletes all saved media files from the handset's local memory.
Add/move/stop/remove/kiss avatar	"Add avatar" show up only when the child is in *SectionPlay*. Lets the parent add his or her own avatar to the child's virtual Flash interface. Currently, no visual feedback is displayed on the handset screen. After the avatar has been added, options "Start avatar", "Remove avatar" and "Kiss" are added to the menu options. "Start avatar" triggers the avatar to jump around until "Stop avatar" or "Remove avatar" is selected. "Kiss avatar" temporarily takes control over both the child's and the parent's avatars and makes them "kiss".

3.3.3 The MainAgent

This section contains only a general overview of the *MainAgent* structure, since it is not a core part of this thesis. For a more detailed description, see section A. The *MainAgent* (server) is built on top of the TCP communication protocol and thus uses sockets to connect to and communicate with the *MobileClient* and *FlashClient*. In addition to the *MainAgent*, a *Red5 Media Server* is used for encoding and storing Flash video files, recorded by the child, to the local hard drive in real-time. The *MainAgent* and *Red5 Media Server* currently do not communicate directly, but communicate

Figure 3-19: (1) The Hide-and-Seek screen; (2) The Image Display screen.

through the *FlashClient*, which they are both connected to (see figure 3-6), to notify when a new video has been recorded and stored. The video file is then automatically copied from the default *Red5* file directory to the *MainAgent* file directory. *Red5* is normally used for sharing Flash video files online. In this case, however, it is used merely due to the fact that it makes Flash video encoding and storing significantly easier and faster.

An important feature of the *MainAgent* is that, as a server, it does not initiate any connections. Instead, the *MainAgent* constantly listens for connection requests from the *FlashClient*, *MobileClient*, and *Wii* remote controller. It is crucial that the *MainAgent* can function even when one or several of the other components (clients) are not connected. It is particularly important that the *FlashClient* can be used independently of the *MobileClient*, since it has been designed to log in and out on a regular basis and most likely will drop the connection every now and then (unlike the *FlashClient* that has been designed to always be on and connected). When the *FlashClient* or the *MobileClient* connects to the server, the server provides it with initial information regarding the current state of the rest of the system components, such as whether the client on the other side is connected and active, as well as if any new photos or videos have been recorded and stored since the last time the client was connected.

The communication protocol of the Globetoddler system is, apart from the Red5 media streaming connection, based on simple socket communication. First of all, two ports are reserved for communication with the *MobileClient* in order to enable synchronous bi-directional communication. The server listens for connecting mobile clients and registers the client's IP address, once an ingoing socket connection has been established. Thereafter, an outgoing socket connection is initiated based on the identified IP address. Similarly, the *MainAgent* listens for a connection request from the *FlashClient*. The Wii remote controller connects to the Globetoddler system via the computer's Bluetooth protocol stack. Thus, the controller has to be connected manually to the computer before starting the *MainAgent*; a rather cumbersome solution that is forced by limitations in both the Windows operating system and the open-source *WiiUseJ* Java API used for communicating with the remote controller.

The *MainAgent* in turn connects to a small, external data logging server, *DataLogger*, which is used merely for logging the commands and events that pass through the *MainAgent*. The *DataLogger* was first and foremost developed for the user studies of this thesis project in order to enable remote monitoring of significant events. Primarily due to privacy concerns, the log messages are very sparse and reveal no information regarding the content of the media data that is sent. Examples of log messages are:

May 26, 2008 6:54:42 PM SpeechFrameWork.Globetoddler.MainAgent.DataLogger saveInfoToLogFile INFO: MainAgent started.

May 27, 2008 2:04:14 PM SpeechFrameWork.Globetoddler.MainAgent.DataLogger saveInfoToLogFile INFO: Flash client connects.

Jun 12, 2008 3:14:00 PM SpeechFrameWork.Globetoddler.MainAgent.DataLogger saveInfoToLogFile INFO: Flash client enters menu section.

May 28, 2008 3:58:17 PM SpeechFrameWork.Globetoddler.MainAgent.DataLogger

saveInfoToLogFile INFO: Client wants to share photo view with server.

May 28, 2008 4:06:35 PM SpeechFrameWork.Globetoddler.MainAgent.DataLogger saveInfoToLogFile INFO: Sending image file from server to client.

In the user study, the event log was used for both supervising the performance of the system, and for evaluating how the Globetoddler system was used, for example which features were used most often, as well as the reciprocity of the interaction. This quantitative data was primarily used as a complement to the qualitative data.

3.3.4 Design evolution and decisions

Many design considerations and decisions were made during the design process. It should be pointed out that, partly due to the fact that the system underwent only one design and evaluation iteration, a majority of these decisions were based on inspiration and (naive) assumptions, rather than on rationale. A second design iteration would enable the results of this thesis (see section 4.1.4) to be fed back into the design process in order to improve the design.

General concept

When it comes to the general setup of the Globetoddler system, the initial idea was to use an approach similar to that of the *Flat Stanley Project* [5] by using a self-contained doll that travels with the parent and sends information and content related to the remote location and activities back to the child. However, a number of factors suggested against such an approach: (1) a majority of the consulted adults expressed a strong unwillingness to travel and be seen with a doll, (2) very few of the interviewed children seemed to be interested in the remote location of their traveling parent, (3) the doll would not be with the person who is most likely to appreciate it: the child.

Thus, a number of other projects for children were explored in order to generate new ideas. Among other projects, *The Webkinz* [15] and *Build-a-Bearville* [3] came to inspire this thesis work quite significantly; the current version of Globetoddler uses a similar approach of combining a physical toy with a similar-looking virtual avatar. However, contrary to both Webkinz and Build-a-Bearville, Globetoddler uses both the virtual and the physical parts of the system actively. Another important source of inspiration was previous work on embodied interfaces conducted in the *Speech + Mobility Group* at the MIT Media Laboratory. *Monkey-To-Go* [7] explored the concept of connecting different platforms to support seamless remote interaction: an animatronic toy monkey on one side and a mobile phone on the other.

The parent's interface

The mobile application on the parent's side was unfortunately not extensively evaluated or questioned during the design process. To some extent, the parent's end of the Globetoddler system was even partly neglected, since the child's side required significant amounts of time and effort. The desicion to use a mobile application was based on three factors: (1) a majority of the consulted business traveling parents use their mobile phones to stay in touch with their remote family members (see sections 4.1.4 and B), (2) the mobile phone is a mobile, fairly affordable, and ubiquitous device, and (3) the Globetoddler system was developed as an extension of the Monkey-To-Go system [7], which uses mobile phones.

The child's interface

The child's interface consists of two main parts: (1) the doll and (2) the interactive Flash interface.

The doll As described in section 3.3.1, Ugly Dolls [14] were chosen merely for their colorful and cute appearance. Another important factor is the fact that they come across as less conventional and gender-biased than many other toys.

The interactive interface Contrary to many other remote interaction and awareness systems, which focus on simplicity [57, 39], the interface of Globetoddler was designed to contain a large number of features and parts. At least two factors influenced this decision: (1) one of the core goals of this thesis project was to increase the possibilities for the parent and the child to connect by motivating the child to use the system more than he or she uses conventional communication technologies. Implementing several different, engaging features should decrease the risk of making the child feel under-stimulated and bored, (2) Globetoddler was developed partly for exploring the users' requirements and preferences. Providing a "smorgasbord" of features is one way of learning which aspects of the system the users like more. The three games implemented in the Globetoddler system were used for learning more about the child's preferences in particular; *Hide-and-Seek* is an asynchronous multi-player game, *Catch Cotton Candy* is a singleplayer game, and *SectionPlay* is a synchronous multiplayer activity.

The interactive interface of Globetoddler was given the form of a happy, colorful interactive town, in which each house contains a "wheel of fortune"-like menu of games and other activities (see section 3.3.1). Contrary to the Webkinz World [15], which contains significant amounts of text and information, the child interface of Globetoddler was designed to be fully controllable by preschoolers. Although text is used in some parts of the interface, all commands and instructions are read out loud by the virtual avatar. The physical doll was partly used to enable a more straightforward interaction model that does not involve regular computer keyboards or other more complex input devices.

Music is used in several sections in the Globetoddeler interface as a way to increase the feeling of playfulness.

3.3.5 Challenges

This section describes some of the most significant problems that were encountered during the system developing part of the thesis project.

Encountered hardware concerns

When it comes to hardware, one of the most significant problems encountered was the difficulty to establish a connection between the Wii remote controller and the *MainAgent*. As described earlier in this thesis, current versions of the Java-based Wii API, *WiiRemoteJ*, does not come with its own Java-based Bluetooth stack and thus requires the user to use an external Bluetooth stack, such as *Widcomm* or *BlueSoleil*. This approach makes it rather cumbersome to re-establish the connection between the remote controller and the *MainAgent* if the connection is lost. On Linux machines, the connection is established automatically when the application has been initiated. A newly released version of *WiiUseJ* supports automatic recovering of the connection between the remote controller and application. However, this approach still requires the lower-level physical connection to be intact or recovered manually.

Encountered software concerns

A majority of the most significant software problems are related to the task of "stitching together" the software components that constitute the Globetoddler system (*MainAgent*, *FlashClient*, and *MobileClient*). Using generic socket connections to connect the components makes the task significantly easier. However, monitoring

the status of the connections, synchronizing events and data transmission, as well as making sure that each component works independently, yet, connects to (and disconnects from) the rest of the system in a seamless manner, is a difficult assignment. On of the most challenging problems turned out to be that of handling media files. Java, J2ME (mobile Java), and Flash all support different file formats and resolutions. Thus, *ffmpeg* [4], a free-ware file encoding application, had to be implemented in order to convert audio and video files to the right format before playback.

Another significant problem is the fact that J2ME does not always throw exceptions when a connection is interrupted or dropped. For example, the only way to find out if the TCP socket connection between the *MobileClient* and the *MainAgent* still is active is by trying to send data over the connection, since an exception is thrown if the data transmission fails. Another related problem is the fact that if the *MobileClient* tries to connect to the wrong server IP address, for example because the MainAgent's IP address accidentally has been changed, no exceptions are thrown until the mobile operating system throws a Symbian connection timeout error after several minutes. Needless to say, these problems jeopardize the usability of the mobile application.

[4]For more information, see http://ffmpeg.mplayerhq.hu/.

Chapter 4

Evaluating Globetoddler

4.1 Method

The Globetoddler system was subject to three different kinds of evaluation studies: (1) a long-term realistic setup in which the system was installed in the participants' home and the parent was traveling, (2) a long-term setup in which the system was installed in the participants' home but the parent was not traveling, and (3) a short-term session in which the child and parent were interacting with the interface for 30-60 minutes while "thinking aloud". The initial goal of the evaluation sessions was to conduct as many long-term realistic studies (1) as possible. However, due to the fact that it was difficult to find participants who fitted the profile and were willing to commit to the study, in combination with the fact that the system prototype turned out to be too flaky and cumbersome to be fully usable, other evaluation methods were used as well (2 and 3).

The main goal of the evaluation studies was to evaluate how well the Globetoddler system meets the initial design goals, as defined in section 3.1.1. *Does Globetoddler*

make it easier and more fun for pre-school children and their parents to interact? Does Globetoddler encourage children to interact with their remote parents? The goal was also to further explore the notion of remote parent-child interaction and intimacy. However, limitations and inconsistencies in the user interface got in the way of these high-level questions. Thus, the insights and conclusions presented here to a large extent have come to concern more low-level, UI-related issues.

Lessons learned from the evaluations are also included in this chapter, both in terms of general insights regarding remote parent-child interaction, as well as specific issues with the general design of Globetoddler. These insights, in combination with general insights, suggest a number of possibilities for future work.

4.1.1 Evaluation theory

Experience-based evaluation and thick descriptions

In his book *The interpretation of cultures*, social anthropologist Clifford Geertz writes about Gilbert Ryle's notion of *thick descriptions*:

> *Consider, he says, two boys rapidly contracting the eyelids of their right eyes. In one, this is an involuntary twitch; in the other, a conspiratorial signal to a friend. The two movements are, as movements, identical; from an I-am-a-camera, "phenomenalistic" observation of them alone, one could not tell which was twitch or wink. Yet, the differences, however unphotographable, between a twitch and a wink is vast.*

Geertz uses the concept of *thin descriptions* ("the boy is rapidly contracting his eyes") and *thick descriptions* ("faking a wink to deceive an innocent into thinking a conspiracy is in motion") to explain the work of an anthropologist. According to Geertz, it is only the thick description of the complex and intertwined entities that constitute

our context and culture that lets us understand the role of our actions and relations. Geertz explains:

> *Cultural analysis is intrinsically incomplete. And, worse than that, the more deeply it goes the less complete it is... There are a number of ways to escape this - turning culture into folklore and collecting it, turning it into traits and counting it, turning it into institutions and classifying it, turning it into structures and toying with it.* ***But they are escapes.***[1]

These ideas can, naturally, be applied to (ethnographic) studies of human-computer interaction (HCI). When it comes to HCI and design of new technologies, it may sometimes in fact be beneficial to replace "small" questions (What is the user doing? How often is he doing it? How fast did he do it?) with "deeper" questions (Why is the user doing it? What kind of emotions does that action evoke? How do the user's actions influence people around him?). HCI has developed various methods for evaluating usability, and has helped us build better technologies. However, most of these evaluation methods are designed for evaluation of specific tasks, rather than the full experience of using the technology - the level at which we actually use a technology. Human-centered design is, per definition, about focusing on the human user, and as such it implies studying the user and his or her context from a wider, more complex, point-of-view. The communication and the communicators (users) are just as important as the communication technologies, or as Kaye et al. [40] describe it:

> *The technology is not a passive actor in the equation, any more than the end user passively uses technology in the way that was intended by the designer. Rather, the technology when used can change the individual, and the individual can change the technology in use. So to understand the technology we must understand the user and the network between and around the user and the*

[1] My boldface.

technology, and by understanding the technology we can understand more about ourselves as individuals and groups and societies.

Thus, in design projects like the one presented in this thesis, the most relevant and interesting questions can not be answered with numbers and statistics; the projects are not about efficiency or other quantitative measurements. In fact, they are not about the task at all. Rather, these design projects are about novelty, pleasant and fun user experiences, and rethinking conventional technological approaches and solutions. How does one evaluate abstract factors like these? How does one create rich descriptions of the use of a novel communication platform like the Globetoddler system?

In their paper *Your place or mine*, Dourish et al [28] present a framework for evaluation of (long-term) use of *media spaces*, based on the following three assumptions:

- Face-to-face communicative behavior in the real world is not always an appropriate baseline for the evaluation of mediated communication. To use the real-world baseline is to miss the point, since the "*media space world is the real world; it is a place where real people in real working relationships, engage in real interactions.*"

- Certain practices, influenced by the nature of the system, arise over time as familiarity with the system increases. Therefore, these practices and interactions must be studied in real, long-term use.

- The use and influence of such technology extend beyond its most direct users. It extends beyond their social context and environment.

The framework consists of four main perspectives: (1) *individual* (person-to-system), (2) *interactional* (person-to-person), (3) *communal* (direct users and proximate individuals and groups) and (4) *societal* (larger social group).

4.1.2 Evaluation statement

The Globetoddler system evaluation was partly inspired by the theories described above. The first and most important requirement was to evaluate the system in a realistic setting where Globetoddler is used by "real people" who "engage in real interactions" [28]; in this case, a preschool child and his or her traveling parent. Unfortunately the fairly tight schedule of this thesis strictly limited the scope of the user study. Ten days were assigned to each family, which by no means make a proper long-term study. However, the realistic setting of the study to some extent may have compensated for this drawback. The second requirement was to choose experience-focused evaluation techniques over task-focused techniques. The Globetoddler system has primarily been designed to enable and encourage new ways for children and their parents to communicate. As stated earlier, the overall goal of this thesis project was to "*develop a system that...makes remote communication and sharing of experiences easier and more meaningful to preschool children and their traveling parents*". Thus, the goal of this study was not to compare the system to a specific baseline in order to evaluate its technical qualities, but to learn more about the nature and context of parent-child interaction and how Globetoddler can be used to support and influence that interaction.

4.1.3 Procedure and participants

The evaluation procedure of this evaluation study partly resembles that of Kaye et al.'s in the papers *I Just Clicked To Say I Love You: Rich Evaluations of Minimal Communication* [38] and *Communicating Intimacy One Bit at a Time* [39]. Strongly inspired by Gaver et al.'s work on *Cultural probes* [29], Kaye et al. developed an evaluation method where the participants were given a logbook in which they were told to answer a set of questions each day of the evaluation study. In the logbook, Kaye

et al. asked three kinds of open-ended questions: (1) questions about the technology itself, (2) questions about the relationship the technology was meant to affect, and (3) questions about the survey itself. According to the authors [38] each category :

> *...was designed to unpack a different aspect of this otherwise simple communication. Within each of those categories, the majority of [the] questions fell into three areas: questions about the context of use, questions about metaphors for use, and requests for value judgments - things they liked, things they hated.*

Logbooks and other so called self-reporting evaluation techniques have the advantage of, at least partly, removing the investigator from the evaluation process. Studies show that interview responses are subject to a number of response biases. Often, participants adjust their responses to existing social norms or to what they think the interviewer wants to hear [48, 61]. In addition, in self-reported diary and logbook studies the participants are instructed to write down specific information or thoughts at regular intervals. This enables the participants to reflect on their experiences and activities soon after they occur, rather than afterwards, before the memories deteriorate or get tainted.

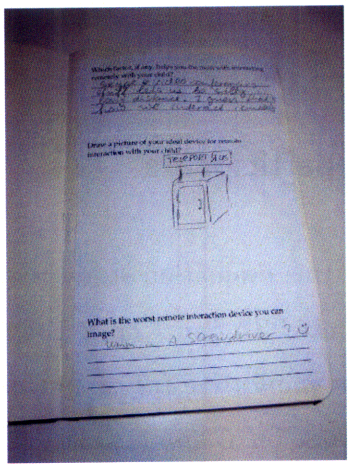


Figure 4-1: One of the traveling parent's logbook.

Long-term domestic study

Initially, two families with a traveling parent were recruited for the evaluation session. However, one of the traveling parents ended up cancelling the trip shortly before the trip was scheduled and therefore withdrew from the study. In addition, in the case of the second family, network problems were encountered in the beginning of the evaluation session. As a result, the system could not be used properly until two days before the traveling parent returned home. The study session was extended with three "non-traveling" days to partly compensate for the loss.

In addition to the geographically distributed families, one "non-traveling" family was recruited. The involved family members were instructed to try to interact with the Globetoddler system "as if they were apart", for example by sending photos from the grocery store. The system was installed in the family's home for a period of four days.

In the case of the traveling parent, a logbook with questions was provided (see figure 4-1). The logbook covered both initial general questions regarding remote parent-child communication and business traveling, as well as daily questions regarding the user experience and other reflections. For a complete list of the question in the logbook, see section B.

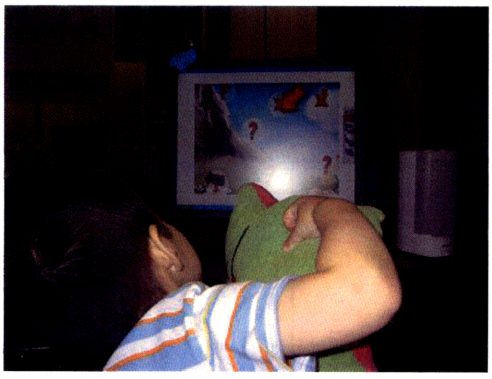


Figure 4-2: One of the child participants playing with Globetoddler.

Short-term study

In addition to the long-term studies, three children and their parents were invited to play with the Globetoddler system at the MIT Media Laboratory. The evaluation sessions lasted for 30-60 minutes each and were carried out as fairly unstructured observational think-aloud sessions. First, the investigator [2] showed the child how to navigate in the interface, as well as some of the features the application supports. Then, the child was encouraged to explore the options freely on his or her own. The parent was then encouraged to used the mobile application to interact with the child.

4.1.4 Results

Ubiquitous-ish communication

One of the most appreciated features of the Globetoddler system was the fact that it is relatively easily accessible; once the system has been installed and set up, it runs continously and does not require any additional start-up procedures. Each user can use the system individually, when he or she wants to use it. One traveling parent said:

> *I think [Globetoddler] is a great idea. It was so cool to stand on the top of a mountain and know that [I can capture a photo that] actually gets to my kids. [I press] one button and then it is in the livingroom!*

This aspect of the system was appreciated by both parents and children.

[2] In this case the author.

Ownership and independence

Another related, and equally valued, aspect is that of "ownership"; the children were happy to have their own device that they could control and manage on their own. In addition, they knew that the incoming content, such as photos and videos, had been captured for them personally, which seemed to make the whole experience more meaningful:

> *[S] liked [looking at the photos and video] because she knew it was for* her. *It was* her *thing. [She] would record funny faces and send them back to me.*

Being together is what makes interaction special

Although the real-time games implemented in Globetoddler were highly appreciated by the children as individual activities, they are not quite sufficient from a social point-of-view. Several of the parents pointed out that parent-child interaction seldom is about the actual activity, but more about the fact that you do something together:

> *I don't play games to win. I play for the experience; to hang out with her and hear her laugh.*

The parents' testimonies suggest that parent-child interaction normally does not require complex, pre-defined features. As long as the parent is willing to make the interactions and user experience more interesting, the child is likely to participate and contribute to those interactions. Even more importantly, less defined and controlled interactions have the potential of being more unpredictable and interesting, since they to a large extent depend on the personalities and current mood of the individuals involved.

Technology changes the way we view the world

One of the parents described that using Globetoddler partially changed the way he viewed his environment, as well as his actions:

> *When I go on business trips I always wish [my family] could go on the trip with me and share my experiences. Globetoddler made me more social. [Instead of sitting in my hotel room], I would go to things that [my family] would want to see and take photos of them.*

The quote above highlights the great value of sharing experiences with others. Exploration becomes more exciting when you know you can share the events with peers who will appreciate hearing about them.

Confusingly tangible

Although the children seemed to like the appearance of the doll *per se*, most of them had a hard time grasping its role. They pretty quickly understood that there is a connection between the physical doll and the avatar, but thought it was hard to use the doll as a control. Tilting the doll to the left and right in order to move the avatar in the corresponding direction was not intuitive. Yet, once that motion-based mapping had been learned, the children were bothered by the fact that the mapping was not complete. For example, they expected the avatar to jump when they made the doll jump, especially since it is possible to make the avatar jump in one of the sections, SectionPlay (see section 3.3.1), and wanted the avatar to walk faster when they tilted the doll more actively. In addition, the children assumed that the avatar could be moved whenever visible; in the photo and video capturing and viewing sections the Abima avatar stands still next to the photo and video screen and can not be moved. In general, children seem to be particularly sensitive to inconsistent behavior, which makes them really valuable as system evaluators; if the interaction logic is broken,

the children quickly lose patience with the interface.

Some of the child participants seemed to feel that the toy was "in the way", since it did not directly enrich the interaction [3]. In one family, the child pulled the Wii remote controller out of the doll and used the controller to interact with the interface. In another family, the children quickly figured out that the laptop keyboard could be used for controlling the interface and stopped using the Wii remote controller altogether.

It is clear that, nowadays, children are more technology savvy than ever. Even the youngest child participants, age 3-4, are playing computer and video games, and have rather advanced interactive toys. As a result, many of them were visibly disappointed with the Globetoddler system.

Broken and inconsistent mappings and analogies

The physical (doll) to virtual (avatar) mapping of the Globetoddler system is currently inadequate and confuses the users. The underlying analogy of the two avatars - Abima is a virtual representation of the child and Bop is a virtual representation of the traveling parent - is too vague since it hasn't been incorporated into the application very well. The Globetoddler system sometimes even contradicts the analogy; for example in the case of the mobile application, in which both Abima and Bop are used in parallel to indicate whether the toy is moving or not (see figure 3-18).

In addition, two very central concepts were lost in the design process. First, the use of two avatars contradicts the central concept of transitional objects [63, 62]. In fact, it is not even clear whether the use of one avatar actually would play the same role as a transitional object. The user studies show that, in the case of Globetoddler,

[3] In some cases it even made the interaction more difficult. It was, for example, really hard for the youngest children to push the button on the toy in order to capture a photo, since they had to look into the camera rather than on the toy.

the approach of using avatars as virtual representations of the users is not intuitive enough to enhance the parent-child interactions.

Second, the concept of a "traveling object" (see section 2.3.5), has not been fully implemented in the system. Although the underlying story is that the parent's green avatar is traveling, just like the parent, and thus is superimposed on the parent's photos, the use of two avatars takes the focus of any one avatar. Thus, unlike Flat Stanley [5], the traveling avatar is not in the center of attention [4]. In addition, the general storyline is currently too vague to make sense to the users.

The more the merrier

A majority of the children thought that the Globetoddler system was not social enough. For example, one of the children asked how many dolls there are, since he wanted to share the experience with his father, just like with the Wii video game that he has at home. He seemed to have a hard time understanding the fact that his parent could interact with the interface as well, by using the cell phone instead of a doll. Similarly, another child participant asked if there was a second doll for her older sister.

There is not such thing as too much interaction

A majority of the parents mentioned that they want Globetoddler to be more interactive than it currently is, and focus on supporting fun real-time activities. Overall, both the children and the parents enjoyed playing games the most. The participants appreciated the asynchronous *Hide-and-Seek* game, but again thought that the game should be even more interactive. According to the parents, the act of playing games with

[4] At this point, it is questionable whether Globetoddler is a suitable name for the system.

children is usually focused around providing support and guidance, as well as around making the game more exciting by saying comments like *"It's getting warmer..."*, *"That was close but not quite right"*, or *"Wow, you are too smart for this. You got it right the first time!"* One of the parents pointed out that the game therefore should either (1) be played in real-time while talking over the phone, or (2) somehow enable the parent to record encouraging comments in advance:

> *You can be interactive without being synchronous. Currently you can't tell the difference between playing with a computer and a child.*

Presence is crucial

Presence and interaction go hand-in-hand. In its current form, the Globetoddler system is not extensive or well-designed enough to make the users feel the remote person's presence; not even in real-time interactions when the other person is actually on the other end. One of the participants pointed out that, to him, voice communication is key when it comes to rich interactions and presence, and he therefore thinks that voice should be "default" for real-time interaction, rather than a separate feature that has to be initiated explicitly (see table 3.5).

Media requires context

Creating and sharing media content are social activities. One of the parents said: *"I don't want to* see *a photo; I want you to* show *me a photo"*. For him, photos and videos are static and uninteresting unless you hear somebody tell you about them. Although the Globetoddler system allows the parent to record and attach audio comments to the photos, interaction with children requires more. Therefore, Globetoddler should make it possible to create whole storylines with a context, rather than short discrete comments. Another participant pointed out that the photos should be used

for emphasizing the notion of "being together" by for example displaying photos of the child and the parent next to each other. Currently, no interactive feedback is provided after a photo or video has been sent unless the parent explicitly initiates a conversation around that photo or video. Thus, the children may not even understand the underlying purpose of capturing and sending the photo and video files. In fact, most of the children loved the simple photo capturing feature (see table 3.1), but seemed not to pay attention to the social aspect of the feature, i.e. the fact that the photo was captured for mum or dad. Rather, the photo feature was used as a fun "thing" that allows them to immortalize their smiles, funny faces and missing teeth. Recording video was, at least initially, perceived as more complicated than taking photos; partly because the children seemed shy and did not know what to say.

Children like to move

When it comes to preschoolers, one of the main problems with conventional voice- and video based communication technologies is that they require the user to be still. Most of the parents involved in the evaluation study testified that their preschoolers have a very limited attention span; after fifteen minutes they are already somewhere else. One parent explained that when his four-year-old son is in China with his mother (the informant's wife), he normally does not get to talk to his son for more than a couple of minutes at a time. In most cases, his wife simply carries their son to the computer, holds him in front of the video camera, and says: *"There you go. Now you have seen him;"* and before she has finished the sentence, their son is gone again, on the search for new adventures. These testimonies suggest that the child's side of the Globetoddler system should be mobile rather than stationary. Although fun games and interactions may encourage the child to stay longer in front of the screen, it is important to remember that the core goal of this thesis project is to develop a system that adjusts to the preferences of the user.

4.2 General insights

This section covers general critical thoughts regarding the Globetoddler system. Some of these insights are not directly related to the official user studies in this section, but emerged in demo sessions and more informal evaluation sessions with friends and colleagues. John Maeda's ten *Laws of Simplicity* [44] are used as a framework for this section.

Reduce *The simplest way to achieve simplicity is through thoughtful reduction.*

In its current form, the Globetoddler system functions as a showcase ("proof-of-concept") for possible features for remote parent-child communication than a user-friendly ready-to-use application. Seen from a usability viewpoint, a more successful approach would have been to respect the fact that sometimes "less is more" by focusing on one or a few key ("killer") features. Currently, none of the features in the Globetoddler system are meaningful or exciting enough to engage the user in the long run.

Organize *Organization makes a system of many appear fewer.*

Both the *MobileClient* and the *FlashClient* in the Globetoddler system provide a large number of features. Currently, the features have been divided rather simplistically, based on the category of activities or actions they support. In the *MobileClient*, for example, there are three main categories: *Photos*, *Videos*, and *Actions*. In the *FlashClient* there are: *SectionGeo*, *SectionMedia*, and *SectionGames*. The category-based structure seemed to make sense when the interface was first design, but, especially in the case of the *MobileClient*, the structure has over time proven to be unintuitive. One of the main problems is that a strictly functionality-based interface layout does not take the "interaction flow" into account, such as the order in which the users tend

to use the supported features, or which features are more important to the user.

Time *Savings in time feel like simplicity.*

The notion of time is almost completely absent in the Globetoddler system, which, considering the fact that time is a central aspect of remote parent-child interaction (see section 2.1.2), is a significant drawback. The system supports both asynchronous and synchronous interaction as an attempt to provide a sense of continuity, but does apart from that not address time in any way. For instance, the system does not explicitly help the child understand when the traveling parent is planning to return home. In addition, when it comes to more user interface-related factors, the Globetoddler system does not provide enough feedback regarding the time and duration of ongoing and previous activities, for example: *When was a certain photo sent? How long did my child look at a certain video? How long ago did my mum log in the last time? How long will it take for this video to be sent?* As a result, the system feels overly complex, unexplained, unreliable, and slow.

Learn *Knowledge makes everything simpler.*

Like most other applications, the Globetoddler system requires initial learning and training; in particular the child's interface, which consists of a novel physical interface and interaction model. Still, by learning more about how end-users reason about the user interface, the features and interactions it supports, the learning threshold can be lowered. Currently, the learning threshold of the Globetoddler system is too high, among other things due to an overly complex system structure and a large number of supported features.

Differences *Simplicity and complexity need each other.*

Without the counterpoint of complexity, we could not recognize simplicity when we see it, writes Maeda [44]. As pointed out above, one of the main goals of this thesis project was to design a system that, especially from the child's point-of-view, makes it easier for geographically distributed parents and children to stay in touch. The core concept is that children should not have to rely on other adults to initiate and realize rich interactions with their remote parents. Therefore Globetoddler should consist of a set of rich and meaningful, maybe even complex, features, disguised in a simple interface. Although the current system already enables the child to initiate communication in a fairly simple manner, a lot has to be done to improve both the complexity of the underlying structure and the simplicity of the user interface.

Context *What lies in the periphery of simplicity is definitely not peripheral.*

One of the most difficult tasks in the Globetoddler design process was to determine and achieve the right level of user independence. Particularly when it comes to young children, it is important to guide the user through interactions in order to avoid confusion and frustration. Still, too much control can make the user feel equally frustrated. In the Globetoddler system, the child's interactive interface is a virtual world, in which the child is encouraged to explore different options and features. A very simple story line, narrated and orchestrated by a virtual avatar, is used for creating a sense of meaning and continuity. The storyline should be improved and extended in order to provide truly engaging and fun user experiences. The same goes for the parent's mobile application; although the narration will have a different look and structure.

Emotion *More emotions are better than less.*

Like any relationship, parent-child relationships are emotional in one way or another. One of the main drawbacks of being geographically distributed is the fact that physical

distance makes it hard to express and exchange emotions. Thus, one of the most important roles of the Globetoddler system is to encourage and support affective expression. However, in its current state, Globetoddler only implements the notions of emotions to a small extent: in videos and photos, as well as in the Flash section *SectionPlay* where the child and parent's avatars can meet and "kiss" (see table 3.5). The parent's mobile interface in particular, lacks feedback in general and affective feedback in particular.

Trust *In simplicity we trust.*

Like trust in people, in order for an application or a system to gain trust it has to prove itself deserving by, among other things, make the user feel confident and "taken care of". Globetoddler is still too flaky and incomplete to come across as trustworthy. Insufficient error correction is one major drawback: when something goes wrong in the Globetoddler system, the user is rarely told why the error occurred or how to recover from the error. It is particularly important to maintain the child's trust and to avoid giving the child a false sense of control and availability. If the child feels as though mum or dad "never responds" or "never is available", he or she will most likely stop believing in the usability and capabilities of the system, as well as in the engagement and interest of the parent.

Failure *Some things can never be made simple.*

Attempting to make remote parent-child interaction easier is a reasonable and important, yet complex, task. Although Globetoddler, in its current form, enables children to send media content to their parents more easily, it is still not simple and well-designed enough to be useful; at least not in the long run. To the Globetoddler system's advantage, Maeda points out that there is always a *Return on Failure* [44]: if you fail and take the time to find out why, you have at least learned a great lesson

that you can feed back into the design process. So, to conclude, you have either made something simpler, or you have knowledge to do so in the future. Suggested future improvements of the Globetoddler system are covered in section 4.4.

The one *Simplicity is about subtracting the obvious, and adding the meaningful.*

This, last, law is related to all previous laws of simplicity; in particular the first: *reduce*. In order to be truly usable, the Globetoddler system needs a clear focus, a core feature and goal, and that focus has to consist of the factors that are most meaningful to the users - the child and the parent.

4.3 Discussion and critique of methodology

This section presents and discusses some of the factors that may have influenced the outcome of the user study. The section should not be viewed as a saving clause, but as a way to highlight potential pitfalls that were discussed and tackled during the study. As a matter of fact the personal preferences and ideas of researchers almost always influence the design and outcome of the study to some extent. Thus, it is important to be aware of these influencing factors in order to minimize their effects. In this study, there were several risk factors when it comes to bias. The most significant issue is the fact that the system was designed and evaluated by the same person, which brings about an apparent risk that the tests, interviews, and surveys unconsciously were designed to provide answers that are in favor of the goals and ambitions of the project [49].

Reliability and validity

Reliability and validity are two ways of evaluating research. A user study or experiment that yields consistent, stable, and uniform results over repeated observations or measurements is considered reliable. Validity concerns the accuracy of the study or experiment. A study that measures what it is supposed to, in accordance with its fundamental purpose, is valid [49]. In qualitative studies, the concepts of validity and reliability may have to be adjusted to the fact that these studies normally are not concerned with exact measurements and statistics. For example, it is almost impossible to assure consistent and uniform results in an observational field study; partly because people tend to change and behave differently over time, partly because external factors are not fully under control. This section covers some of the aspects of reliability and validity that concern the evaluation study of this thesis, as well as in what way and to what extent these concerns were attended to:

Internal validity (credibility)

- Communicative validity. By clearly describing my intensions and expectations, comprehension, as well as the processes that constitute this project (data collection, selection, and analysis) the ways in which the research process may have influenced the validity of the study become more clear.

- External control. This aspect involves giving the participants a change to review and clarify data that they have provided, for example interview transcripts. In this project, the participants were unfortunately not asked to go through any transcripts and surveys. Neither did the participants request such reviews.

- Triangulation. Several methodologies were used in the evaluation process, observations, surveys, interviews, and automatic event data collection, in order to be able to compare different viewpoints. In this way, the weaknesses in any one

method are compensated for by the strengths of another. In addition, corresponding results in most cases increase the validity of these results.

External validity (generalization)

- When it comes to external validity there are three factors that are particularly interesting and influential: time, place and people. The challenge is to convince people that the results of your study, which was done in a specific place, with certain types of people, and at a specific time, can be generalized to another context where some or all of these factors may be different. In this thesis the degree to which the conclusions in this study would hold generally has not been assessed, mainly due to the small number of participants. In addition, a majority of the participanting families were found via the MIT Media Laboratory message mailing list for current and former Media Laboratory employees and students; a group that most likely is above average when it comes to adopting emerging technologies. It is therefore highly plausible that involving families from other parts of the society and with a different attitude to technology would have generated different results.

Reliability

- In qualitative studies reliability concerns both the technology and humans that are involved in the study. For example, it is important to describe both the technologies and applications that were used for collecting data, as well as the role, viewpoint, and experience of the researchers involved in the study [49]. Such a description can be found in this section.

4.4 Summary and future design proposals

The conclusions and insights in this chapter show that, although parts of the Globetoddler system were appreciated by the participants, the system prototype as a whole is not extensive and robust enough to satisfy the design goals: making remote interaction between children and their traveling parents easier and more fun. Unfortunately, Globetoddler was not even intuitive and robust enough to be used for full-scale realistic testing. As a result, Globetoddler was mostly evaluated in settings where the parent and child were, partly or fully, co-located. Although these short-term co-located evaluation sessions generated a number of interesting insights, most of the insights are related to the user interface, rather than to more high-level and long-term concerns, such as the overall user experience. Thus, it is currently not possible to say whether the Globetoddler system actually makes remote parent-child interaction "easier and more fun". Further, the results do not indicate whether the system succeeds in making the parent and child feel more connected or close while apart.

When it comes to future design implementations, the conclusions of the evaluation suggest drastically changing the design of the Globetoddler system. Rather than aiming for a system that satisfies all needs, the system should be designed to support what matters: allowing the parent and child to form and engage in rich interactions and "be together", without compromising the rules and routines that define their relationship. As stated in section 2.3.1, one way in which parents tend to respond to their desire for greater contact with the child is by trying to maximize the quality of the time that is spent together with the child [65].

When it comes to the current version of the Globetoddler system, results presented in section 4.1.4 indicate that the following aspects are the most appreciated:

- The system is continous and easily accessible;
- The system allows the child to manage and initiate his or her own interactions;
- The system enables new ways of "being together" in real-time that are richer, more meaningful, and more personal than talking on the phone;
- The system partly encourages the users to share their experiences with the person at the other end.

Furthermore, the results show that the following aspects are desirable but missing or insufficient:

- The system should support the expression of emotions to a larger extent;
- The system should enable simpler, less restricted, but richer interactions;
- The system should provide a stronger sense of (the other person's) presence, mood, and emotions;
- The system should enable the users to create their own contextualized interactions. When it comes to child-parent interaction, almost everything requires a story, a context and a purpose;
- The system should address the fact that preschool children like to move and are impatient.

The rest of this section will describe a number of ways in which the different aspects of the Globetoddler system could be developed or improved based on the conclusions above.

4.4.1 Suggested improvements and changes

Photo and video sharing

Capturing and sharing photos and videos were appreciated by both parents and children, but for different reasons. Whereas the parents enjoyed sharing their experiences and surroundings with their child in order to try to involve them in the trip, the children mostly enjoyed taking photos of themselves while making funny faces. It would be interesting to explore whether this difference is merely a result of the fact that the children's camera, contrary to the parents' mobile camera, was stationary (attached to the screen), or if it reflects the fact that preschoolers tend to be more self-centered. This could be explored by making the child's photo feature more mobile. It could be embedded in the doll, or in another device that allows the child to take photos of themselves in new ways, for example by moving the device in different ways, or by throwing it up in the air. Another possible approach is to make the child more involved in the parent's activities by letting him or her remote control the mobile phone camera.

Furthermore, as pointed out before, photos and videos require a context and a story to be meaningful. The simple audio annotation feature of Globetoddler (see table 3.3) was appreciated, but is not advanced enough. When it comes to real-time interaction, a mechanism that allows the users to easily show each other specific photos or videos while talking about them could be used to enhance the experience.

Affect

Parent-child interaction is, like other types of human-human interactions, an emotional and social act. Globetoddler does however not support affective expression. The virtual avatars are likable but, despite the fact that the avatars have been de-

signed to represent the child and the parent, they do not provide information about the users' expressions and reactions. A future implementation of Globetoddler should incorporate affect and expressions via multiple modalities. This may require that the avatars are replaced by real faces (video), or more sophisticated avatars.

Another method for enabling emotional expressions is to design a system that encourages the users to respond and react to received messages, photos, and videos. For example, by implementing facial expression recognition, one could enable so that a photo of the child's face is captured when he or she is watching a new video or photo and smiles. The photo could then be sent to the parent [5].

Playing games

Both the parents and the children enjoyed playing games together, in real-time, the most. Asynchronous activities and games could work, but require a strong storyline and rich interactions that make them feel more like real-time interactions; young children are not patient enough to wait for feedback. Rich gameplay experiences are all about the social interaction and emotions. When parents play games with their children, the interaction is normally centered on helping and encouraging the child. Remote games, such as the ones implemented in Globetoddler, have to incorporate these factors in order to enable rich gameplay experiences. The users should possibly also be allowed to create their own games and interactions.

[5]However, it should be pointed out that a feature where a photo is taken without the knowledge or explicit approval of the child violates the core philosophy of Globetoddler: equality and balance. The system has not been designed for "child monitoring". Thus, pictures should only be captured and sent if the child is aware of it and approves.

Tangible interface

Many assumptions were made during the design process regarding the tangible part of the Globetoddler system. The initial idea was to design a self-contained doll that travels with the parent. The current solution is drastically different; there is one doll and two avatars. The traveling aspect has been pushed to the background. It would be interesting to take a step back in order to explore the initial concept of a traveling shared object. It does not have to be a doll, but any object that the child is interested in or emotionally attached to. Currently, the children have no choice but to use the provided Ugly Doll, which they may not like or relate to.

Presence

Globetoddler needs to provide a stronger sense of presence and connectedness. The participants testified that, currently, interacting with the system sometimes feels like interacting with a computer. Future work should therefore include exploring ways in which the identity, presence, and emotions of the person at the other end can be made more visible. Again, this may require that the avatars are replaced with something less abstract. Enhancing the system's sound and voice features may be another approach.

Story and context

One way of creating a context for the interactions that Globetoddler supports is to focus on mutual care giving and responsibility. Care giving is a central concept in many toys and applications for children, for example *Tamagotchi* [11], *Webkinz* [15], *AdoptMe* [1], and regular dolls [6]. However, most of the toys and games in this category

[6]In addition, shared responsibility is one of many factors that make children feel needed and competent [http://www.preteenagerstoday.com/articles/family/the-role-of-responsibility-1128/].

have been designed for single use - one child using one or several toys or virtual avatars. However, in real life, families usually take turns on taking, for example, the dog for a walk. Thus, Globetoddler could be designed around a mutual virtual pet that has to be taken care of by both the parent and the child. Fun tasks, such as feeding, exercising, and training, could be implemented, as well as a platform for discussing and planning responsibilities. The users' daily lives would then be incorporated into the interaction rather naturally: *"Tomorrow I'll be in a meeting the whole day. Will you make sure that Abima is taken care of? I think she will need a bath tomorrow, because she hasn't had a bath in two days."* This approach would exclude the concept of traveling, as well as photo and video sharing, almost completely. Still, as the results of this thesis show, the main task when it comes to designing technologies for remote parent-child interaction is not to enable cool features, such as content sharing, but rather to help children and their remote parents to maintain their routines of rich and fun interactions.

Chapter 5

Conclusion

This thesis offered a vision for a new kind of communication platform for remote interaction between preschool children and their traveling parents. This vision was initially motivated by the fact that many traveling parents seem to think that it is particularly hard to stay in touch with the youngest children, mainly due to complicated technologies and the children's lack of interest in using these technologies. The final outcome of the thesis project, Globetoddler, was designed around the notion that physical and virtual objects can be used for motivating children to communicate and carry out tasks. The system consists of two main parts: (1) a simple mobile application on the parent's side, and (2) a sensor-equipped doll, which is wirelessly connected to an interactive virtual world and avatar, on the child's side. The virtual world has primarily been designed for the child, but is also a mutual meeting place to which the parent easily can connect from the cell phone, for example by calling, sending photos and videos, or adding his or her own avatar in order to interact with the child's avatar. In addition, there are several gameplay features that allow the child to play games either individually or with his or her parent. The system supports both asynchronous and synchronous activities.

The child's avatar guides the child through different interactions and encourages the child to, among other things, take photos and record videos that are sent to the parent. The Globetoddler system has been designed to be a fully balanced system; both the parent and the child have access to the same set of features. Still, the system respects the different needs and requirements of the two users by incorporating two very different user interfaces.

Although the current Globetoddler prototype unfortunately proved to be too flaky to be deployed in a realistic, full-scale manner, a series of unstructured short-term studies and evaluation sessions were conducted. In these evaluation sessions, the gameplay features of the system generated a particularly enthusiastic response among the evaluation participants, which suggests that the focus of the Globetoddler system should be shifted to enabling truly rich real-time interactions. Not surprisingly, the things that matter virtually are the things that matter in real-life.

Appendix A

The Globetoddler Technology

The Globetoddler system consists of three main parts: (1) the *MainAgent* (server), (2) the *FlashClient*, and (3) the *MobileClient*. The *MainAgent* functions as the main connection hub of the system. It listens for incoming connection requests from the *MobileClient* and *FlashClient*, forwards messages between the connected clients, and stores media files to the local hard drive for future use. All parts of the Globetoddler system communicate via TCP/IP (socket connections). This appendix section will first describe the design and core components of each part of the system. It will then cover the communication protocol of the system as a whole.

A.1 System structure and core components

A.1.1 The MainAgent

The MainAgent consists of a total of 19 classes, divided into nine subgroups: *Constants*, *Flash*, *GUI*, *Interfaces*, *Logging*, *MainAgent*, *Network*, *Sensors*, and *Utilities*. Table A.1 describes the general role of each subgroup.

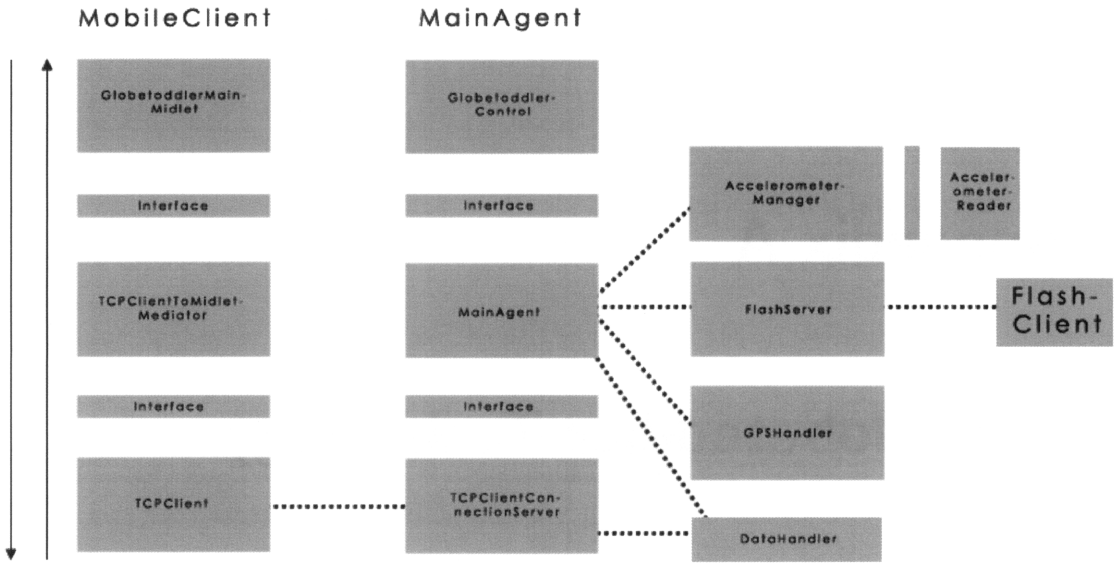


Figure A-1: A schematic plan of the Globetoddler system components. Only core classes are shown.

AccelerometerReader The *AccelerometerReader* class is built on top of the open-source Wii remote controller Java API *WiiUseJ* [1]. Once a remote controller has been connected to the computer via the computer's Bluetooth stack, establishing a connection between the *WiiUseJ* Java interface and the controller is straightforward:

```
Wiimote[] wiimotes = WiiUseApiManager.getWiimotes(1, true);
```

The API is event-driven in the sense that when a certain event occurs, for example motion, a corresponding method is called automatically:

```
public void onMotionSensingEvent(MotionSensingEvent arg0);
```

In the case of *onMotionSensingEvent()*, the motion-related data can then easily be accessed via the *arg0* variable:

[1] For more information, see http://code.google.com/p/wiiusej/.

Table A.1: MainAgent classes

MainAgent classes	
Subgroup:	**Classes and functionality:**
Constants	Contains all the String commands that constitute the Globetoddler communication protocol.
Flash	Contains the class *FlashServer* - an extension of the *MainAgent* that communicates with the *FlashClient*.
GUI	Contains the *GlobetoddlerControl* class, which functions as both the *MainAgent* GUI (see figure A-1) and the main Java class.
Interfaces	Contains interface classes that are used "between" the different classes of the system (see figure A-1). The interface classes are mainly used as "listeners", that is for forwarding information to the *MainAgent* class from classes further down in the system hierarchy.
Logging	Contains the class *DataLogger*, which is used for logging events both locally and remotely, via a socket connection.
MainAgent	Contains the main class *MainAgent*.
Network	Contains *TCPClientConnectionServer*, which handles connections to the *MobileClient*, as well as "local" events that do not have to be forwarded to the *FlashClient*, or other parts, via the *MainAgent*.
Sensors	Contains the two classes that handle connections to the Wii remote controller: *AccelerometerReader* and *AccelerometerManager*. The former is built using the *WiiUseJ* library, an event-driven interface with methods that are automatically triggered when a certain event occurs, for example when the Wii remote is moved. *AccelerometerManager* parses the incoming data and classifies the events.
Utilities	Contains random classes that, among other things, parse data and save general status information about the data flow.

```
RawAcceleration raw = arg0.getRawAcceleration();
float x = raw.getX();
float y = raw.getY();
float z = raw.getZ();

Orientation orientation = arg0.getOrientation();
float pitch = orientation.getPitch();
float roll = orientation.getRoll();
```

AccelerometerManager The motion event classification algorithm used in the Globetoddler system is very simple. Four different categories are used:

```
public static final String SHAKING = "SHAKING"; (not tilted left or right)
public static final String NOT_SHAKING = "NOT_SHAKING";
public static final String LEFT = "LEFT"; (implies shaking)
public static final String RIGHT = "RIGHT"; (implies shaking)
```

The roll value of the Wii remote controller's current orientation is currently the only accelerometer value that is being used, since it has proven to work sufficiently. The variable *deltaValueForRoll* contains the difference between the maximum and minimum values of the last five roll values and is used for determining if the accelerometer is shaking [2]:

```
if(roll > 50 && deltaValueForRoll > 5){
        newToyEvent = RIGHT;
}else if(roll < -50 && roll > -110 && deltaValueForRoll > 5) {
        newToyEvent = LEFT;
}else if(deltaValueForRoll > 5){
        newToyEvent = SHAKING;
}else {
        newToyEvent = NOT_SHAKING;
}
```

DataHandler The class *DataHandler* is used by the *MainAgent* for managing information related to the asynchronous features of the Globetoddler system, such as sending media files and playing *Hide-And-Seek* (see sections 3.3.1 and 3.3.2). This enables the *MobileClient* and *FlashClient* to be offline without "missing out" on im-

[2]Shaking causes the roll value to change quickly.

portant information. Among other things, the *DataHandler* class keeps track of the number of new photos or videos that have been stored by the *MainAgent*. When the *MobileClient* connects to the server, the information is automatically sent to the *MobileClient* and displayed as a report on the screen, for example "2 new photos and 1 new video exist." In addition, if either party has hidden their avatar in *Hide-And-Seek*, the user is encouraged to play *Hide-And-Seek* in order to find the hidden avatar. Information regarding where the avatar is hidden is automatically sent to the client concerned when the client connects.

A.1.2 The FlashClient

The GUI and features of the *FlashClient* is thoroughly described in section 3.3.1. This section will cover recording and sending of media image and video files only.

Image files Storing images that have been capture in *Flash* (Action Script 2.0) turned out to be one of the most complex tasks in the process of designing the *FlashClient*. One of the least complicated approaches, in which the image files are sent over a *Flash XMLSocket* connection, was chosen after careful consideration. Since the *XMLSocket* is already used for sending regular String status messages and commands to the *MainAgent*, it was fairly easy to use the same socket connection for transmitting the image data. After extracting the discrete RGB pixel values of the image by using the Flash method *BitmapData.getPixel32(x,y)*, the bitmap pixel values are converted into a String message, with comma as the delimiter (between each pixel value) and "IMAGE" as the string header. The image data String is then sent to the *MainAgent* that reconstructs and stores the image file. The image file is sent to the *MobileClient* when the parent chooses to download it through the mobile application.

Video files Video files recorded in *Flash AS2* are even more complicated to store locally. Hence, a *Red5 Media Server* (see section 3.3.3) was implemented to store the video files on the server. The FlashClient opens a *Real Time Messaging Protocol* (RTMP) connection to the media server, which is running as a Windows service on the computer, and streams the video data to the server as it is being recorded:

```
var nc:NetConnection = new NetConnection();
// connect to the local Red5 server
nc.connect("rtmp://localhost/videoStreamer");
// create the netStream object
var ns:NetStream = new NetStream(nc);
```

The same connection protocol is used for playing back stored video files in the Flash interface.

A.1.3 The MobileClient

The *MobileClient* consists of a total of 30 classes, divided into 10 subroups. The subgroups are presented in table A.2.

A.2 The Globetoddler communication protocol

The communication protocol of the Globetoddler system is relatively simple. Three different command classes are used; one for communication between the *MainAgent* and the *MobileClient* (*MobileClientServerCommunicationCommands*), one for communication between the *MainAgent* and the *FlashClient* (*FlashClientServerCommunicationCommands*), and finally one specifically for handling transfer of media files,

Table A.2: MobileClient classes

MobileClient classes	
Subgroup:	**Classes and functionality:**
Constants	Contains all the String commands that constitute the Globetoddler communication protocol.
HideAndSeek	Contains three classes, which are used for the Hide-And-Seek game (see section 3.3.1).
GUI	Contains a majority of the applications Forms and Canvases (screens).
Interfaces	Contains interface classes that are used "between" the main classes of the system (see figure A-1). The interface classes are mainly used as "listeners", that is for forwarding information to the MainAgent class from classes further down in the system hierarchy.
Location	Contains *GPSHandler*, which is used for retrieving the client's current location (GPS coordinates).
Media	Contains classes for recording audio and capturing photos and videos.
MIDlet	Contains the midlet of the *MobileClient*: *GlobetoddlerMainMIDlet*.
Network	Contains classes that request and establish connections to the MainAgent server.
RMS	Contains the RecordStoreManager that stores file data and information to the handset's permanent record store.
Utilities	Contains random classes that, among other things, parse data.

that is audio, images and video (*MediaContentFormatConstants*). Since the system has been designed for one-to-one use (one *MobileClient* connected to one *FlashClient*) no advanced ID protocol is used. When a mobile client connects to the *MainAgent*, the IP address of that client is stored and used for data transmission until the client disconnects [3].

Most of the commands are used as pure information or command messages, rather than as data headers and are therefore sent independently, without attached data or additional information. Below are some examples of such commands:

```
public final static String addAvatarMessage = "ADD_AVATAR";
```

[3]The MainAgent's IP address is managed by a DynDNS service, which allows individual machines to keep human-readable URL's even as their IP address changes. Using DynDNS means that the MainAgent's URL stored in the MobileClient does not have to be updated or changed, even if the server is moved. A demon provided by DynDNS has to be installed on the server in order to automatically update the associated IP address if it changes. See http://www.dyndns.com/services/dns/dyndns/ for more information.)

```
public final static String kissAvatarMessage = "KISS_AVATAR";
public final static String newClientVideoMessage = "NEW_CLIENT_VIDEO";
public final static String gamesSectionMessage = "GAMES_SECTION";
public final static String imageRequestMessage = "SHOW_IMAGE_LIST";
public final static String buttonAPressedMessage = "BUTTON_A";
```

The *MediaContentFormatConstants* are used for sending media files between the different parts of the system and specify which kind of media a data message contains. This information is required since the files are sent as pure byte streams and have to be "reconstructed" once they have reached their destination. The file header messages are:

```
public static final int NO_OBJECT = 0; (text)
public static final int PHOTO_ONLY = 1;
public static final int AUDIO_ONLY = 2;
public static final int PHOTO_AUDIO = 3;
public static final int VIDEO_ONLY = 4;
public static final int FILE_LIST = 5;
```

When a video file is sent from the *MainAgent* to the *MobileClient* the following content is being sent:

```
outputStream.writeInt(MediaContentFormatConstants.VIDEO_ONLY);
outputStream.writeUTF(filePath);
outputStream.writeInt(width);
outputStream.writeInt(height);
outputStream.writeInt(data.length);
outputStream.write(videoData);
```

When the *MobileClient* receives the first "video only" constant value, it goes into a

"receive video file mode", that is a method that reads the incoming data in the right order (local file path, width, height, length of file byte stream, and data) and saves the data accordingly. The six content types all trigger separate parsing methods on the *MobileClient* side, since the media data has to be parsed and reconstructed in different ways, based on their content and format.

Appendix B

Questionnaire and interview questions

This appendix contains questions and data from (1) the initial interview study, (2) the post-evaluation study interviews, (3) the logbook, and (4) the online survey.

B.1 Initial interview study

B.1.1 Interview questions: child

- Initial discussion to make the subject more comfortable with the situation. Talk about things that the subject likes: interests, friends etc.
- Tell me about your family. What do your parents do? And your sisters and brothers?
- What do you like to do when you are at home?

- Are you ever at home alone?
- Do your parents travel a lot?
- Do you miss them when they travel? Do you think about them a lot?
- Do you talk to them when they are traveling?
- What do you so to stay in touch when they are gone? Do you call? Talk on the computer? Do you use webcam?
- Do you ever/usually wonder what your dad/mum is doing when he/she is away? Are you curious? Interested?
- Is there anything that makes you feel angry or sad when your parents are away?
- Is there anything that makes you happy when your parents are away?
- Does your parent normally tell you where they are going and what they are doing when they travel?
- Is there anything that your really like or dislike about talking to your parents when they are not here?
- Do you want to change the way you stay in touch somehow? Do you want to stay in touch with them more often? Or in a different way?
- Do you ever/usually initiate the conversation with your parents when they are away or do they?
- Is there anything special that you like telling your parents about when they are away? Your school day? Football?
- Is there anything that you would like to know about them?

- How often would you like to talk to them when they are gone?
- Do you have your own computer and/or mobile phone?
- If yes, how much/often do you use them?
- Do you use them to talk to your parents or your friends?
- If you could make your own machine to stay in touch with your family or friends, what would it look like? How would it work? (Feel free to draw if you want).

B.1.2 Interview questions: traveling parent

- Initial discussion to make the subject more comfortable with the situation. Talk about the family situation in general: Tell me about your family. How many children do you have? What do your children do? Do both you and your partner work? Do both you and your partner travel?
- How do the members of your family stay in touch when you are at home? Which channels and what technology? Do you have any routines? Do you communicate in the same way with all kids?
- Do you feel that you manage to stay in touch? Is it enough, or do you wish it would be more/less/different?
- What is the main reason to why you travel?
- Do you normally make special family life arrangement before you travel? If yes, what kind of arrangements? Do you tell your children where you are going and what you are doing there? Are they usually interested?
- Do your communication routines change when you are away? If yes, how do

they change? Does it change altogether, or just with certain family members? What communication channels do you use to communicate when you are away? How often do you talk?

- Are you happy with the way you communicate when you are gone? If yes, what aspects do you like? If not, what aspects do you dislike? Is there anything in particular that frustrates you?
- What aspects of your interactions do you cherish the most? Which aspects do you think are most valuable to stay in touch and feel a connection?
- What are you mostly interested in knowing about your children when you are away?
- What would you like to share with your children?
- Ideally, how often would you like to interact with them?
- Are there any particular situations in which you feel a need to interact with your children? Any particular information or stories that you tend to share with them?
- Do you want to change the way you stay in touch somehow? Do you want to stay in touch with them more often? Or in a different way?
- Do you ever/usually initiate the conversation with your children when you are away or do they? Would you like to change the way it is?
- Do you have your own computer and/or mobile phone?
- If yes, how much/often do you use them?
- Do you use them to interact with your family?

- If you could make your own machine/software to stay in touch with your family or friends, what would it look like? How would it work? (Feel free to draw if you want).

B.1.3 Interview questions: non-traveling parent

- Initial discussion to make the subject more comfortable with the situation. Talk about the family situation in general: Tell me about your family. How many children do you have? What do your children do? Do both you and your partner work? Do both you and your partner travel?

- How do the members of your family stay in touch when you are at home? Which channels and what technology do you use? Do you have any specific routines? Do you help your traveling partner stay in touch with your children?

- Do you feel that your family manages to stay in touch in general? Is it enough, or do you wish it would be more/less/different?

- Do you normally make special family life arrangement before your partner travels? If yes, what kind of arrangements? Do you tell your children where your partner is going and what you are doing there? Are they usually interested? Do you continuously talk about your partners trip? Do your children ask?

- Do your communication routines change when your partner is away? If yes, how do they change? Does it change altogether, or just with certain family members? What communication channels do you use to communicate when you are away? How often do you and your children interact with your traveling partner? Do you normally interact together, or do your children ever talk to your partner individually?

- Are you happy with the way you communicate when your partner is away? If yes, what aspects do you like? If not, what aspects do you dislike? Is there anything in particular that frustrates you?
- What aspects of your interactions do you cherish the most? Which aspects do you think are most valuable to stay in touch and feel a connection?
- What are you mostly interested in knowing about your partner when you are away? What do you think your children like hearing about from their traveling mum/dad?
- What would you like to share with your partner?
- Ideally, how often would you like your family to interact when your partner is away?
- Are there any particular situations in which you feel a need for your whole to interact although somebody is away? Any particular information or stories that you tend to share with them?
- Do you want to change the way you stay in touch somehow? Do you want your family to interact more often? Or in a different way?
- Who initiates your interaction? Would you like to change the way it is?
- Do you have your own computer and/or mobile phone?
- If yes, how much/often do you use them?
- Do you use them to interact with your family?
- If you could make your own machine/software to stay in touch with your remote partner, family, and friends, what would it look like? How would it work? (Feel free to draw if you want).

B.2 Post-evaluation study interviews

B.2.1 Interview questions: child

- Did you like using the toy?
- What did you like the most?
- Is there something you dont like about the toy?
- Was something hard to use?
- Did you talk to your mum/dad on the computer?
- Did you look at the pictures he/she sent you?
- Did you listen to the messages?
- Did you play with the toy?
- Would you use it again?
- If not, why not? If yes, which part do you think you would use the most?
- Is there something you want to add/change?
- Did you feel closer to your mum/dad when you used the system?
- Do you like using it more than the regular phone or the computer?

B.2.2 Interview questions: traveling parent

- Did you use the system?

- If yes, how often would you say you used it?
- If not, why not? Did it not work? Was it not fun? Was it too complicated to use?
- Which feature/s did you use the most?
- Which feature/s did you like the most?
- Which feature/s did you not like?
- Are there any features or aspects of the system that you had trouble understanding or using?
- Any features you would like to remove or add?
- Overall, did it make you feel more connected to your child/ren?
- Did you enjoy using the system more than traditional technology (phone/computer)?
- Was it more useful than traditional technology?
- Did your child/ren seem to enjoy using the system? More than regular phone calls/video calls?
- Do you think the system makes more sense to them than traditional communication technology/devices?
- Could they understand how the system works/can be used or did you/somebody else help them?
- What would you say is the most important benefit of the system?
- What would you say is the most important drawback of the system?

B.2.3 Interview questions: non-traveling parent

- Did you use it while your partner was away?
- If yes, how often would you say you used it?
- If not, why not? Did it not work? Was it not fun? Was it too complicated to use?
- Did you personally test/use the system at all?
- If yes, which feature/s did you like the most?
- Which feature/s did you not like?
- Are there any features or aspects of the system that you had trouble understanding or using?
- Any features you would like to remove or add?
- Overall, do you think the system helped your partner feel more connected to your child/ren?
- Do you think the system functions better than traditional technology (phone/-computer) when it comes to connecting distributed family members?
- Do you think it is more enjoyable and fun to use than traditional technology? If yes, for both parents and children?
- Did your child/ren seem to enjoy using the system? More than regular phone calls/video calls?
- Do you think the system makes more sense to them than traditional communication technology/devices?

- Could they understand how the system works/can be used or did you/somebody else help them?
- What would you say is the most important benefit of the system?
- What would you say is the most important drawback of the system?

B.3 Logbook

B.3.1 Initial questions

- Define intimacy in your own words.
- How do you normally feel about going on a business trip? Why?
- How strong is your guilty conscience on a scale from 1 (not at all)-10 (very strong)?
- How would you describe your relationship to your child?
- What do you miss most about your child when you are away?
- What do you like best about traveling for business?
- What do you hate the most about traveling for business?
- Which factor, if any, makes remote interaction with your child most difficult?
- Which factor, if any, helps you the most with interacting remotely with your child?
- Draw a picture of your ideal device for remote interaction with your child.

- What is the worst remote interaction device you can image?

B.3.2 Daily questions

The subjects were asked to answer the same set of questions every day of the trip.

- How connected did you feel to your child today on a scale from 1 (not at all connected) 10 (very connected)?
- How hard was it to use the Globetoddler system today on a scale from 1 (very easy) 10 (very difficult)?
- How fun was it to use the Globetoddler system today on a scale from 1 (not at all) 10 (very fun)?
- Describe your experience of using the system with maximum three words:
- Which feature did you use the most today?
- Which feature did you enjoy using the most?
- Generally, when did you tend to use the system today?
- Additional comments?

B.4 Online survey

See the following pages [1].

[1] A complete summary can be found at http://web.media.mit.edu/ paulina/gt/survey/Survey-Summary.html

The Business Traveling Parent

1. In which country do you live?

	Response Percent	Response Count
Country:	100.0%	13
answered question		13
skipped question		0

2. How many children between the age of 3 and 6 do you have?

	Response Percent	Response Count
1	61.5%	8
2	38.5%	5
>2	0.0%	0
answered question		13
skipped question		0

3. How many parents are there?

	Response Percent	Response Count
Just me. I am a single parent and the only/main caregiver.	0.0%	0
Two but we live apart and I am the only/main caregiver.	7.7%	1
Two but we live apart and have shared custody of the children.	0.0%	0
Two.	92.3%	12
Other.	0.0%	0
Other (please specify)		0
answered question		13
skipped question		0

4. Who in your family travels for business?

	Response Percent	Response Count
You	61.5%	8
Your spouse	7.7%	1
Both you and your spouse	30.8%	4
answered question		13
skipped question		0

5. How often do you go on a business trip of the following length?

	Never	1-2 times per year	3-10 times per year	11-20 times per year	Monthly	Weekly	Response Count
1 night	**36.4% (4)**	**36.4% (4)**	27.3% (3)	0.0% (0)	0.0% (0)	0.0% (0)	11
2-4 nights	12.5% (1)	37.5% (3)	**50.0% (4)**	0.0% (0)	0.0% (0)	0.0% (0)	8
One week	20.0% (2)	**50.0% (5)**	10.0% (1)	0.0% (0)	20.0% (2)	0.0% (0)	10
Several weeks	**62.5% (5)**	25.0% (2)	12.5% (1)	0.0% (0)	0.0% (0)	0.0% (0)	8
Several months	**85.7% (6)**	14.3% (1)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	7
At least a year	**85.7% (6)**	14.3% (1)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	7
answered question							13
skipped question							0

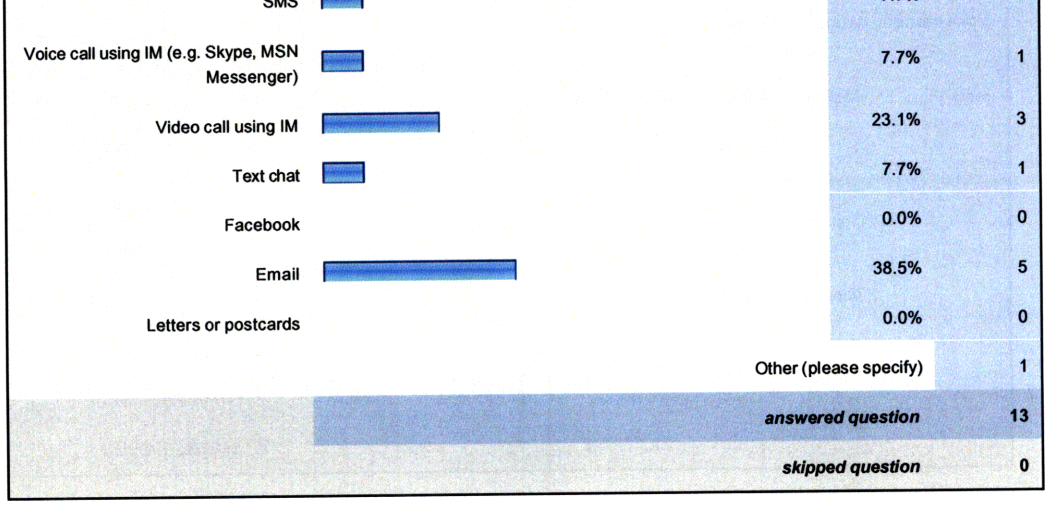
6. Who takes care of your children when you or your spouse travels (multiple answers allowed)?

	Response Percent	Response Count
I or my spouse (the non-traveling parent)	**100.0%**	13
Grandparent/grandparents	30.8%	4
Other relative/s	7.7%	1
Day care	30.8%	4
Baby sitter	15.4%	2
Other	0.0%	0
answered question		13
skipped question		0

7. How often does the traveling parent normally communicate/interact with the preschool children in the family?

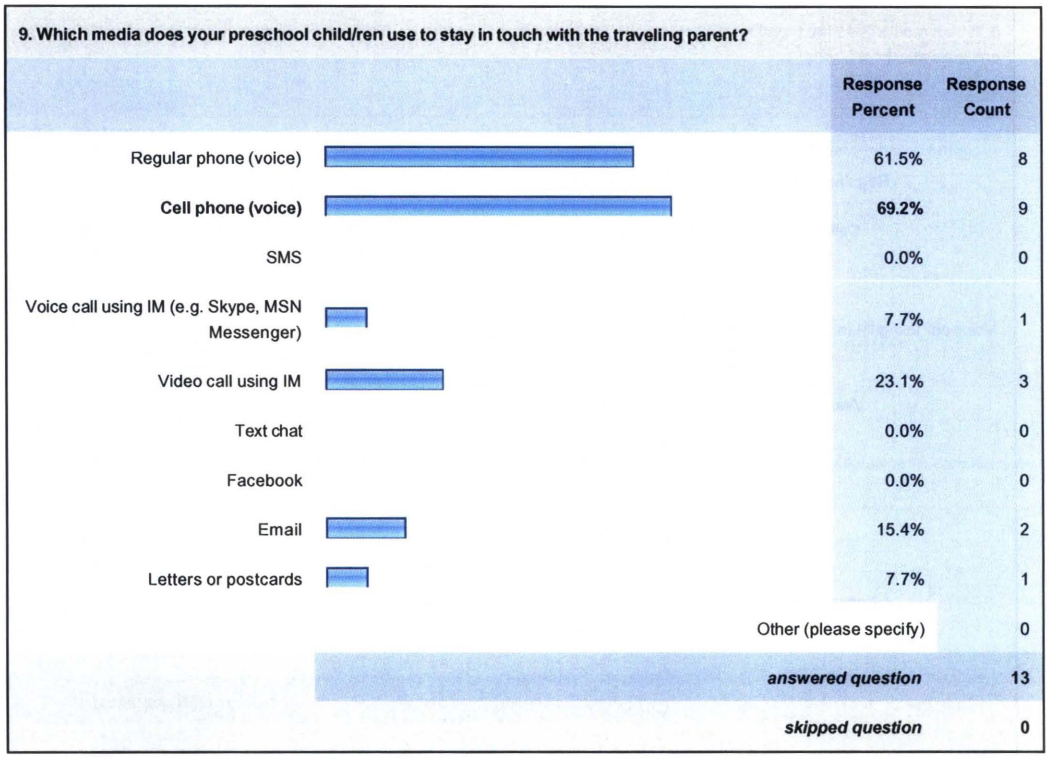
	Response Percent	Response Count
Never	0.0%	0
Once per day in the evening	38.5%	5
Once per day in the morning	0.0%	0
Every other day	15.4%	2
Once per week	0.0%	0
Depends on the length of the trip	0.0%	0
Depends on the possibility to connect (e.g. due to technology, schedules, time difference)	**46.2%**	6
answered question		13
skipped question		0

8. Which media does the traveling parent in your family use to stay in touch with the preschool children in the family (multiple answers allowed)?



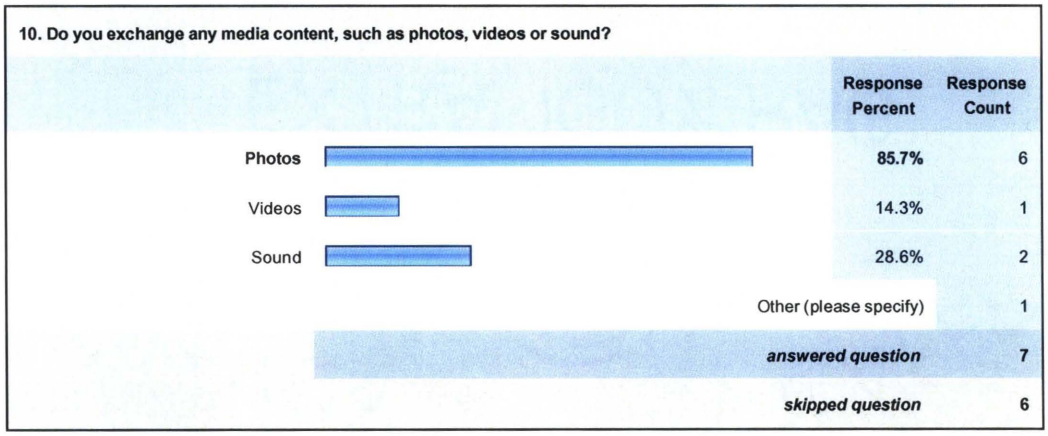
	Response Percent	Response Count
Regular phone (voice)	53.8%	7
Cell phone (voice)	100.0%	13
SMS	7.7%	1
Voice call using IM (e.g. Skype, MSN Messenger)	7.7%	1
Video call using IM	23.1%	3
Text chat	7.7%	1
Facebook	0.0%	0
Email	38.5%	5
Letters or postcards	0.0%	0
Other (please specify)		1
answered question		13
skipped question		0

9. Which media does your preschool child/ren use to stay in touch with the traveling parent?



	Response Percent	Response Count
Regular phone (voice)	61.5%	8
Cell phone (voice)	**69.2%**	9
SMS	0.0%	0
Voice call using IM (e.g. Skype, MSN Messenger)	7.7%	1
Video call using IM	23.1%	3
Text chat	0.0%	0
Facebook	0.0%	0
Email	15.4%	2
Letters or postcards	7.7%	1
Other (please specify)		0
answered question		**13**
skipped question		**0**

10. Do you exchange any media content, such as photos, videos or sound?



	Response Percent	Response Count
Photos	**85.7%**	6
Videos	14.3%	1
Sound	28.6%	2
Other (please specify)		1
answered question		**7**
skipped question		**6**

11. Do you (or your spouse) ever have a guilty conscience when you travel without your child/ren?

	Every time	Often	Rarely	Never	Rating Average	Response Count
Guilty conscience	15.4% (2)	**46.2% (6)**	38.5% (5)	0.0% (0)	2.23	13
					Additional comment	0
					answered question	13
					skipped question	0

12. What is your preschool children's attitude to your or your spouse's traveling (multiple answers allowed)?

	Response Percent	Response Count
They don't seem to mind	25.0%	3
It varies (e.g. length of trip, destination)	**58.3%**	7
My children all react differently	8.3%	1
The days before I/my spouse leave are the worst	16.7%	2
The first days of traveling are the worst	16.7%	2
They seem to miss me most of the time	50.0%	6
They absolutely hate it	8.3%	1
They don't talk about it that much	8.3%	1
Other (please specify)		3
answered question		12
skipped question		1

13. Which methods, if any, have you tried/are you using in order to reconcile travel-related problems (both regarding technological and social aspects), e.g. story telling before trip, video calls, maps, remote story telling over the phone, gifts?

	Response Count
	12
answered question	12
skipped question	1

14. Do you find business traveling problematic from a family communication/management point of view?

	Response Percent	Response Count
Yes	61.5%	8
No	15.4%	2
Not sure	23.1%	3
Please elaborate if you feel like it		7
answered question		13
skipped question		0

15. Please rate how well the following travel-related communication problems apply to your family

	I agree completely	I agree to a certain extent	I mostly disagree	I disagree completely	N/A	Rating Average	Response Count
I/my spouse rarely has the time to interact with those at home	0.0% (0)	**36.4% (4)**	27.3% (3)	**36.4% (4)**	0.0% (0)	3.00	11
I/my spouse usually forgets to get in touch with those at home	0.0% (0)	23.1% (3)	30.8% (4)	**46.2% (6)**	0.0% (0)	3.23	13
My child/ren never have time to interact with me/my spouse	0.0% (0)	27.3% (3)	9.1% (1)	**63.6% (7)**	0.0% (0)	3.36	11
My child/ren are not interested in talking to me/my spouse	9.1% (1)	27.3% (3)	18.2% (2)	**45.5% (5)**	0.0% (0)	3.00	11
The technology we use doesn't work properly	0.0% (0)	30.8% (4)	**38.5% (5)**	30.8% (4)	0.0% (0)	3.00	13
The technology we use/want to use is too complicated for me/my spouse	0.0% (0)	16.7% (2)	25.0% (3)	**50.0% (6)**	8.3% (1)	3.36	12
The technology we use/want to use is too complicated for my children	9.1% (1)	**45.5% (5)**	9.1% (1)	36.4% (4)	0.0% (0)	2.73	11
The technology we use/want to use currently doesn't support the things we would like to be able to do	**33.3% (4)**	16.7% (2)	**33.3% (4)**	16.7% (2)	0.0% (0)	2.33	12
					Additional comments		4
					answered question		**13**
					skipped question		**0**

16. If you find remote communication with your children problematic and you believe that your child/ren are the main reason to why the communication fails , please elaborate on what you believe the main issue is (e.g. technology is too complicated for them to use, technology isn't fun enough to use)?

	Response Count
	8
answered question	**8**
skipped question	**5**

17. If you find remote communication with your children problematic and you believe that you or your spouse is the main reason to why the communication fails, please elaborate on what you believe the main issue is (e.g. technology is too complicated for you/your spouse to use, technology isn't fun enough to use)?

	Response Count
	5
answered question	5
skipped question	8

18. If you find remote communication with your children problematic and you believe that technology is the main reason to why the communication fails , please elaborate on what you believe the main issues are (e.g. technology is too complicated, technology doesn't allow me to do what I would like to do)? If you find current technology insufficient, what would you like to change or add?

	Response Count
	10
answered question	10
skipped question	3

19. How (if at all) would you say remote communication with your child/ren has changed over time as they have gotten older?

	Response Count
	11
answered question	11
skipped question	2

20. Additional comments?

	Response Count
	4
answered question	4
skipped question	9

Bibliography

[1] Adopt me. http://www.adoptme.com/.

[2] Amelie. http://en.wikipedia.org/wiki/Am\%C3\%A9lie.

[3] Build-a-bearville. http://www.buildabearville.com/.

[4] Flat stanley goes hi-tech. http://www.chesterfield.k12.sc.us/Jefferson\%20Elementary/FlatStanley/stanleypage_3.htm.

[5] The flat stanley project. http://flatstanley.enoreo.on.ca.

[6] Glogger. http://glogger.mobi/.

[7] Monkey-to-go. http://www.media.mit.edu/speech/speechMobility/projects/MonkeyToGo.html.

[8] Phone interview with charlie hudson.

[9] Phone interview with dale hubert.

[10] Second life. http://secondlife.com/.

[11] Tamagotchi. http://www.tamagotchi.com/.

[12] Travel industry association (tia). http://www.tia.org/index.html.

[13] The traveling gnome prank. http://en.wikipedia.org/wiki/Travelling_gnome_prank.

[14] Ugly dolls. http://www.uglydolls.com/.

[15] Webkinz. http://www.webkinz.com/.

[16] World of warcraft. http://www.worldofwarcraft.com/index.xml.

[17] N. Barley, B. Council, and B. C. Staff. *Lost and found: Critical Voices in New British Design.* British Council, The, 1999.

[18] K. Blocher and R. W. Picard. Affective social quest: emotion recognition therapy for autistic children. *Socially Intelligent Agents: Creating Relationships with Computers and Robots. Kluwer Academic Publishers, Dordrecht, The Netherlands*, 2002.

[19] S. A. Bly, S. R. Harrison, and S. Irwin. Media spaces: bringing people together in a video, audio, and computing environment. *Communications of the ACM*, 36(1):28–46, 1993.

[20] L. Bonanni, C. Vaucelle, J. Lieberman, and O. Zuckerman. PlayPals: tangible interfaces for remote communication and play. *Conference on Human Factors in Computing Systems*, pages 574–579, 2006.

[21] A. Chang, B. Resner, B. Koerner, and H. Ishii. LumiTouch: an emotional communication device. *Conference on Human Factors in Computing Systems*, pages 313–314, 2001.

[22] H. Chung, C. H. J. Lee, and T. Selker. Lover's cups: drinking interfaces as new communication channels. *Conference on Human Factors in Computing Systems*, pages 375–380, 2006.

[23] L. Cohen-Kreisberger. The Creation of a Shared Space through Fantasy between a Seven Year Old Child and his Therapist: A Case Study. *Clinical Social Work Journal*, 33(3):259–270, 2005.

[24] T. Dalsgaard, M. B. Skov, M. Stougaard, and B. Thomassen. Mediated intimacy in families: understanding the relation between children and parents. *Interaction Design And Children*, pages 145–152, 2006.

[25] T. Daly. *Sometimes I Work in Ft. Lauderdale.* Relevant Ventures, LLC, Atlanta, GA, 2004.

[26] H. Davis, M. B. Skov, M. Stougaard, and F. Vetere. Virtual box: supporting mediated family intimacy through virtual and physical play. *Proceedings of the 2007 conference of the computer-human interaction special interest group (CHISIG) of Australia on Computer-human interaction: design: activities, artifacts and environments*, pages 151–159, 2007.

[27] P. De Greef and W. A. Ijsselsteijn. Social Presence in a Home Tele-Application. *CyberPsychology & Behavior*, 4(2):307–315, 2001.

[28] P. Dourish, A. Adler, V. Bellotti, and A. Henderson. Your place or mine? Learning from long-term use of Audio-Video communication. *Computer Supported Cooperative Work (CSCW)*, 5(1):33–62, 1996.

[29] B. Gaver, T. Dunne, and E. Pacenti. Cultural Probes. *Interactions*, 6(1):21–29, 1999.

[30] W. Gaver, A. Boucher, A. Law, S. Pennington, J. Bowers, J. Beaver, J. Humble, T. Kerridge, N. Villar, and A. Wilkie. Threshold devices: looking out from the home. 2008.

[31] C. Geertz. *The Interpretation of Cultures: Selected Essays.* Basic Books, 1973.

[32] R. Harper, T. Regan, and M. Rouncefield. Taking hold of TV: learning from the literature. *Proceedings of the 20th conference of the computer-human interaction special interest group (CHISIG) of Australia on Computer-human interaction: design: activities, artefacts and environments*, pages 79–86, 2006.

[33] D. Hindus, S. D. Mainwaring, N. Leduc, A. E. Hagström, and O. Bayley. Casablanca: designing social communication devices for the home. *Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 325–332, 2001.

[34] E. M. Hoekstra. *Your Family Close When Frequent Travel Pulls You Apart.* Crossway Books, Wheaton, IL, 1998.

[35] C. Hudson. *The parent's guide to business travel.* Capital Books, Inc., Sterling, VA, 2003.

[36] H. Hutchinson, W. Mackay, B. Westerlund, B. B. Bederson, A. Druin, C. Plaisant, M. Beaudouin-Lafon, S. Conversy, H. Evans, H. Hansen, et al. Domesticated Design: Technology Probes: Inspiring technology design with and for families. In proceedings of CHI 2003. pages 17–24, 2003.

[37] G. Jacucci, A. Oulasvirta, and A. Salovaara. Active construction of experience through mobile media: a field study with implications for recording and sharing. *Personal and Ubiquitous Computing*, 11(4):215–234, 2007.

[38] J. J. Kaye. I just clicked to say I love you. *CHI'06 Extended Abstracts*, pages 363–368, 2006.

[39] J. J. Kaye, M. K. Levitt, J. Nevins, J. Golden, and V. Schmidt. Communicating intimacy one bit at a time. *Conference on Human Factors in Computing Systems: CHI'05 extended abstracts on Human factors in computing systems*, 2(07):1529–1532, 2005.

[40] J. J. Kaye and A. Taylor. What Does Science Know about Experience? Alternatives Approaches to Evaluating User Experience. NordiCHI 2006 Workshop: User Experience Towards a unified view, October 2006.

[41] I. Keller, W. van der Hoog, and P. J. Stappers. Gust of Me: Reconnecting Mother and Son. 2004.

[42] M. Klein. The Psychoanalysis of Children. The Writings of Melanie Klein, Vol. 2, 1975.

[43] S. Lookabaugh Triebenbacher. Children's use of transitional objects: Parental attitudes and perceptions. *Child Psychiatry and Human Development*, 27(4):221–230, 1997.

[44] J. Maeda. *The Laws of Simplicity (Simplicity: Design, Technology, Business, Life)*. The MIT Press, 2006.

[45] P. Markopoulos, N. Romero, J. van Baren, W. IJsselsteijn, B. de Ruyter, and B. Farshchian. Keeping in touch with the family: home and away with the ASTRA awareness system. *Conference on Human Factors in Computing Systems*, pages 1351–1354, 2004.

[46] P. Modlitba. Monkey Business: Creating social awareness among distributed group members, using a network of animatronic agents. Master's thesis, Kungliga Tekniska Hogskolan, Stockholm, Sweden, July 2006.

[47] E. D. Mynatt, J. Rowan, S. Craighill, and A. Jacobs. Digital family portraits: supporting peace of mind for extended family members. *Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 333–340, 2001.

[48] K. S. Nagel, J. M. Hudson, and G. D. Abowd. Predictors of availability in home life context-mediated communication. In *CSCW '04: Proceedings of the 2004 ACM conference on Computer supported cooperative work*, pages 497–506, New York, NY, USA, 2004. ACM.

[49] J. Preece, Y. Rogers, and H. Sharp. *Interaction design: beyond human-computer interaction*. J. Wiley & Sons, NYC, NY, 2002.

[50] N. Romero, P. Markopoulos, J. van Baren, B. de Ruyter, W. IJsselsteijn, and B. Farshchian. Connecting the family with awareness systems. *Personal and Ubiquitous Computing*, 11(4):299–312, 2007.

[51] G. Saslis-Lagoudakis, K. Cheverst, A. Dix, D. Fitton, and M. Rouncefield. Hermes@ Home: supporting awareness and intimacy between distant family mem-

bers. *Proceedings of the 20th conference of the computer-human interaction special interest group (CHISIG) of Australia on Computer-human interaction: design: activities, artefacts and environments*, pages 23–30, 2006.

[52] M. W. Silin and H. M. Stewart. Mother Bear: A Relational Approach to Child Therapy. *Clinical Social Work Journal*, 31(3):235–247, 2003.

[53] D. G. Singer and J. L. Singer. *The House of Make-Believe: Children's Play and the Developing Imagination.* Harvard University Press, 1990.

[54] J. L. Singer and D. G. Singer. Preschoolers'Imaginative Play as Precursor of Narrative Consciousness. *Imagination, Cognition and Personality*, 25(2):97–117, 2006.

[55] W. D. Stiehl, J. Lieberman, C. Breazeal, L. Basel, R. Cooper, H. Knight, L. Lalla, A. Maymin, and S. Purchase. The huggable: a therapeutic robotic companion for relational, affective touch. *Consumer Communications and Networking Conference, 2006. CCNC 2006. 2006 3rd IEEE*, 2, 2006.

[56] W. D. Stiehl, J. Lieberman, C. Breazeal, L. Basel, L. Lalla, and M. Wolf. Design of a therapeutic robotic companion for relational, affective touch. *Robot and Human Interactive Communication, 2005. ROMAN 2005. IEEE International Workshop on*, pages 408–415, 2005.

[57] R. Strong and B. Gaver. Feather, Scent and Shaker: Supporting Simple Intimacy. *Proceedings of CSCW*, 96:29–30, 1996.

[58] D. Verdick. *The Business Traveling Parent - How to Stay Close to Your Kids When You're Far Away.* Robins Lane Press, Beltsville, MD, 2000.

[59] F. Vetere, M. R. Gibbs, J. Kjeldskov, S. Howard, F. Mueller, S. Pedell, K. Mecoles, and M. Bunyan. Mediating intimacy: designing technologies to support strong-tie relationships. CHI'05: Proceedings of the SIGCHI conference on Human factors in computing systems, 2005.

[60] B. J. Wadsworth. *Piaget's theory of cognitive and affective development.* Longman New York, 1989.

[61] B. E. Whitley. *Principles of research in behavioral science.* McGraw-Hill, NYC, NY, 2002.

[62] D. W. Winnicott. Transitional Objects and Transitional PhenomenaA Study of the First Not-Me Possession. *International Journal of Psycho-Analysis*, 34:89–97, 1953.

[63] D. W. Winnicott. *Playing and Reality.* Routledge, 1982.

[64] C. I. Wu, C. James Teng, Y. C. Chen, T. Y. Lin, H. H. Chu, and J. Y. Hsu. Point-of-capture archiving and editing of personal experiences from a mobile device. *Personal and Ubiquitous Computing*, 11(4):235–249, 2007.

[65] S. Yarosh. Supporting long-distance parent-child interaction in divorced families. 2008.

[66] S. Yarosh. Supporting Parent-Child Interaction In Divorced Families. *Proceedings of the 7th international conference on Interaction design and children*, 2008.

[67] O. Zuckerman and P. Maes. Awareness system for children in distributed families. *Proceedings of the 4th International Conference on Interaction Design and Children (IDC'05)*, 2005.