The Family Window: The Design and Evaluation of a Domestic Media Space

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ABSTRACT

Families have a strong need to connect with their loved ones over distance. However, most technologies do not provide the same feelings of connectedness that one feels from seeing remote family members. Hence our goal was to understand if a video connection, in the form of a media space, could help families feel more connected and what design factors would be critical for its success. To answer this, we designed a video media space called the Family Window and deployed it within the homes of two families for eight months and four families for five weeks. Our results show that always-on video can lead to an increase in feelings of connectedness by providing availability awareness and opportunities for sharing everyday life. However usage and value of such media spaces hinges on close-knit relationships and control over one's autonomy.

Author Keywords

Media spaces, domestic, families, awareness, video

ACM Classification Keywords

H5.3. Information interfaces and presentation: Group and Organization Interfaces – *Computer-supported cooperative work*

General Terms: Design, Human Factors

INTRODUCTION

Most families have a strong need and desire to stay connected and aware of one another when they become separated by distance [28,33,39]. Typically distance-separated families gather this awareness using technology such as phones or email [28,39], for example, to learn about one another's activities and health. In addition to this, we now see that many people turn to video conferencing systems as a communication and awareness tool. This is evidenced by the increasing number of instant messaging systems that support video calls (e.g., Skype, Google Talk).

Despite this usage, there are few investigations of video conferencing in the home. Notable exceptions include

O'Hara et al.'s [32] study of video calling on mobile phones and our own study of domestic video conferencing [18], done in parallel to this work. Instead, most research has focused on supporting domestic awareness (e.g., activities, health) using abstracted representations [40] or messaging services [15]. The challenge is that abstracted awareness information does not typically provide the same feeling of connectedness that one gets from actually seeing a remote family member [33].

Given this, we were interested to know how we could expand the ways in which family members are able to maintain an awareness of one another, feel connected and communicate over distance by actually seeing each other. Media spaces attempted to do this and showed relative success in the workplace [12]. For this reason, we chose to investigate media space usage within the domestic realm. First, we wanted to understand in what ways families would use a media space. Would it be used for real time communication and awareness (akin to workplace media spaces), or for altogether different purposes? Or, would it be fraught with too many privacy concerns thus prohibiting its usefulness? Second, we wanted to understand how a domestic media space should be designed to meet family needs, for example, what privacy concerns would need to be addressed? How should the system be designed so it can be situated in desired home locations? To date these questions remain unanswered. Researchers have not pursued such options because of assumed privacy concerns [21,26,29] or network bandwidth issues [14].

We took a largely design-oriented approach to answer these questions. First, we constructed a media space for the home called the Family Window and one of the authors used it for eight months to connect him and his family with their parents/grandparents. Throughout the first four months of this usage, we iterated on the Family Window's design as needed. We then deployed the revised prototype in the homes of four additional families from the general public for a period of five weeks. Together, these investigations provide a rich understanding of the ways in which media spaces can be used in the home and the design factors that are critical for their success.

RELATED WORK

Workplace Media Spaces. Media spaces have been investigated as a means to connect distance-separated co-

workers for over twenty years [12]. The first media space connected two Xerox PARC labs and, since then, media spaces have taken on many incarnations within a variety of research and academic institutions (see [12] for an extensive review). In most cases, video (and sometimes audio) was left always-on to simulate the idea of a shared physical space. In general, researchers found that these media spaces allowed co-workers to gain an understanding of each other's comings and goings along with knowledge of availability for conversation [10]. In turn, this informal awareness increased one's ability to easily move into casual interactions and informal encounters with others [5,10]. Thus, the crucial design factor for workplace media spaces was the support of both awareness and interaction, plus the ease at which one could move between the two.

We also know that media spaces were not used without their issues. Unsurprisingly, many users expressed privacy concerns from broadcasting live video [3,5,8,15]. Here privacy relates to three control modalities: solitude, confidentiality, and autonomy [3]. First, *solitude* involves the control over one's interactions [3] and can be violated if someone interrupts another over a media space at an inappropriate time. In many ways, media spaces helped preserve solitude by allowing others to judge one's availability for interaction [10]. Second, *confidentiality* relates to control over what people know about oneself [3]. Media spaces can affect confidentiality by showing more than one may wish to reveal. And lastly, *autonomy* is control over how one interacts [3]. Choosing when and how to participate in a media space is control over autonomy.

Given these concerns, a body of research focused on developing privacy-protecting strategies that could balance the awareness information provided by video with the privacy concerns it brought with it. This included various methods for obscuring or filtering video [2,7,15,27] along with more direct controls such as mechanisms to easily disable the camera [3,27] or provide feedback of what was being captured [27]. Boyle et al. [3] argue that privacy preservation techniques must be both lightweight and fine-grained to permit users to adequately regulate privacy.

Domestic Communication. Turning to the domestic realm, research has shown that people have a strong need to gather an awareness of remote families' or close friends' activities, locations, and status (e.g., health) [25,28,33,39]. Knowledge of this can help people coordinate or simply feel more connected to their loved ones [25,28]. Here people prefer in-the-moment sharing of information where sharing is targeted at specific people [33]. In contrast, they dislike feeling obligated to send information [14,33]. This type of awareness is most often shared through conversation, e.g., in email, on the phone, in person [28,39].

Numerous research prototypes have been designed to provide remote families with awareness. These systems range from providing *abstracted awareness* information to concepts that provide *direct awareness* information. For example, abstracted awareness information is provided by awareness appliances such as the Remote Presence Lamp [40] or Digital Family Portraits [25]. In the latter, lights and icons change around the border of a digital picture frame to show the activity levels of an elderly family member in her remote home. While beneficial for monitoring activities, such abstract awareness information does not typically provide sufficient feelings of connectedness [33].

On the other hand, some systems provide direct awareness information through messages [16], photo sharing, or the combination [4,14,33]. This means that the awareness information is not abstract. People can see what has happened (e.g., in a photo or video), or be told about it directly. This can enhance feelings of connectedness. However, these systems are still limited in terms of timeliness and interaction: The information being shared is typically from the past and sharing may require explicit interaction with the system (e.g., pushing a button or writing a message). In contrast, media spaces do not require users to perform any additional acts for awareness information to be sent, except that the system is on and that people appear reasonably frequently in front of it.

Domestic Media Spaces. Media spaces have made their way into the home in several cases, although none address the research questions that interest us. Hindus et al. [14] designed RoomLink, an audio-only media space, yet it did not incorporate video nor was it evaluated for its ability to support awareness or connectedness. KitchenNet [14] provided a video link but it was not formally evaluated because of network bandwidth issues. VideoProbe captured images of activity in front of a display and transmitted these to a remote family's display [6,16,34]. Families enjoyed the ability to share images and would routinely try to capture themselves in front of it. Yet at times, privacy was still an issue and families sometimes turned the camera to face a wall. While valuable, VideoProbe did not investigate the use of always-on video, which is the focus of this paper. Neustaedter et al.'s [27] home media space connected telecommuters to office-based colleagues; however, this system was not designed to support family communication. Lastly, Gaver's Video Window [11] transmitted outdoor images to a display inside the home. This is certainly a domestic media space, but it does not attempt to connect distance-separated families.

As can be seen, there is a large body of media space research for the workplace along with many efforts to understand and design for awareness in the home. We have only shown a small sampling of these. Despite the amount of research in this space, no one has specifically looked at the role that always-on video can play for connecting distance-separated families. Next we describe our investigations of this topic: the design of our own domestic media space and its usage by six families.

Activity Timeline

Local View

Blinds Adjustment

Time Shift Preview

Figure 1. Revised Family Window for field deployment.

Tool Buttons
Left to right:
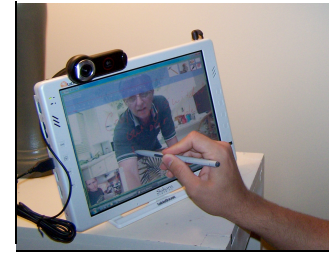Settings, knock,
ink color, clear,
write, erase

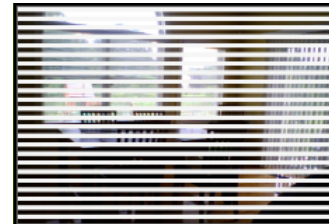Figure 2. Family Window on a dedicated device.

Figure 3. Slate-style privacy blinds.

THE FAMILY WINDOW

Our first step to understand how a media space could be used in the home was to design our own system that we could test and iterate on as needed. We called this prototype the Family Window (FW), shown in Figure 1. Next we describe the initial design followed by its iteration.

Initial Design

The FW was designed to be an always-on video media space that connected two households. We did not include an always-on audio link as this was felt to be overly privacy-intrusive. Hindus et al. [13] had a similar finding during the field deployment of their audio-only media space, Thunderwire. The FW used a basic web camera connected to a Tablet PC (Figure 2) to simulate the idea that it was an information appliance such as a digital picture frame (as opposed to a PC where users multitask and switch between applications). This design also permitted the FW to be highly mobile, if desired, which sets our design apart from picturephone concepts of the 1970s [21,26] and media spaces of the past (e.g., [5,23,27]).

Video from the remote home filled the majority of the display and, in the bottom left corner, a mirrored view of the local camera's view was shown. Clicking this view turned the local camera on/off. Our Tablet PCs supported both passive and active input, so users could interact with either a stylus or their finger. Reciprocity was purposely not enforced, so each household could choose when their camera was on, and this was not linked to the remote household's status. Users were able to blur their video to varying degrees using a secondary dialog box.

Video was transmitted using a client-server architecture (for ease of connecting) over the Internet at a rate of one frame per second, 320 × 240 resolution. We experimented with higher frame rates but latency issues were difficult to

circumvent for typical home Internet connections.[1] Despite low frame rates, the always-on nature of the video link differentiates the FW from work such as Video Probe [6], which bases broadcasting on motion detection in front of the camera. To foreshadow, the always-on nature becomes important for it creates opportunities for serendipitous awareness information to be transmitted, which may or may not be triggered by motion.

Design Iterations

The initial FW design was used for a period of four months in the homes of a researcher (an author on this paper) and his parents. We iterated on the design throughout this period to address a variety of needs that appeared, as well as expectations of what a broader user audience may want. Thus, they started with a basic system and features were added as the need for them became apparent. A video found in [30] shows the final design and its usage.

Notification. Very early on in our self-usage, we realized that local family members needed a way to notify remote family members that they wanted their attention at the FW. We implemented a "knock" feature to support this need. Family members touch the knock icon (Figure 1, top right) and a knocking sound plays at both ends.

Handwritten Messages. We also recognized a need for family members to share short bits of communication, e.g., saying a quick hello. We implemented several types of audio features (e.g., push-to-talk, phone call), but encountered technical challenges with audio latency. As a result, we opted to provide a messaging feature instead. Families can leave handwritten messages for each other by writing on the background of the video (Figure 1). Using the icons in the top right corner, users can choose ink color and change between write and erase modes. The local view

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[1] Participants in our field deployment did not comment that the low frame rate had any negative effects on their use of the system, although they were not able to compare this usage to a higher frame rate.

in the bottom left corner shows ink as it is written so users can realize how their writing appears to the remote family. A notification appears at the bottom of the display when new writing appears. Drawing or writing on a video link is similar to several systems [17,37,38]; however, all were meant to support shared drawing spaces for work activities and not domestic communication. Writing is also available in CommuteBoard [14] but this is not coupled with video.

Time Shift Recording. We also realized that families were not always in front of the FW at the same time (e.g., different time zones or work schedules) and could easily miss seeing each other. To help alleviate this, we added a basic time shift mode. If a user enables time shift mode, their FW will record video that is captured and transmitted by the remote FW. Only video containing activity is recorded. This is sensed by comparing the difference between successive video frames. The remote family sees a notification when the local family turns time shift recording on, although the remote family need not accept/decline. Thus, control to start/stop recording is in the hands of the viewer. We chose this approach because we felt that users would want to turn on recording when they knew they would be away from the FW. This is akin to someone who records a television show when not at home.

Users can toggle back and forth between watching live video or time shifted video by clicking on the Time Shift Preview image (Figure 1, bottom right). With the hope to mitigate assumed privacy concerns over recording video, the FW deleted recorded video immediately after it was watched. If not watched within 24 hours, it was also deleted automatically. We felt this would make people more comfortable with the idea of recording by ensuring that only recent video could be watched, and that it could only be watched once (in case embarrassing acts were recorded). The FW's time shift mode is similar to the Where Were We system [24], which records meeting activities with video and audio, yet, again, their focus is on the workplace.

Activity Timeline. Since distance-separated families do not necessarily know each other's schedules, it seemed important to generate this awareness. We added a timeline (Figure 1, top left) that showed how much activity occurred in front of the FW. This was measured by comparing the differences between successive video frames. The timeline showed today's activity levels in red and yesterday's in grey and a marker indicated when in the day video had been recorded. The timeline could also be used to understand when families are typically in front of their FW (to attempt to time interactions) or provide awareness of family members' presence without actually seeing them. Several other systems offer activity timelines [1,15,31] although they do not offer video replay [1,15] nor are they linked to a media space [15,31].

Privacy. We were concerned that other families would have larger issues with privacy than our own self-usage had found. For this reason, and building on the metaphor of a real-world window, we added blinds to the FW. Users can adjust a slider (Figure 1, bottom left) to open and close blinds that cover the window (Figure 3). This is similar to a technique by Coutaz et al. [7]. We provided slate blinds (Figure 3) as well as top-down or bottom-up blinds. In the latter cases, either the top or bottom of the video is blocked. The slider adjusts the amount blocked.

Comparison to Video Conferencing Systems. Aspects of the FW could also have been recreated by using an existing video conferencing system such as Skype or Google Talk, run on a dedicated laptop or Tablet PC and with two clients connected at all times. Our design builds on this with additional features (e.g., time shift recording, writing, activity timeline) that allow us to investigate broader usage patterns. Yet, the most fundamental deviation is a paradigm shift in the way people use and think about video conferencing in the home. This moves the activity from one resembling video phone conversations to always-on awareness connections and sheds light onto a unique set of routines that we highlight next.

SELF-USAGE AND FIELD DEPLOYMENT METHOD
Following design iterations, we used the FW for an additional four months within the homes of the researcher and his parents; thus, their usage spanned a total of eight months. We also recruited an additional four families—two household pairs—through snowball sampling. Potential participants who answered our study advertisement were asked initial questions to allow us to learn about them and their communication pattern with extended family. We selected participants who we thought would provide interesting and different relationship dynamics. Participants chose the remote family they wanted to connect to because we wanted to study families with a close relationship. These four families used the FW within their homes over a period of 5 weeks. All 6 families were told to set up and use the FW as they naturally saw fit. This included selecting its location and turning the system on/off as desired.

Self-Usage. *The Researcher family* was composed of a researcher and his wife, along with their two children, aged 3 years and 8 months. They connected with the researcher's parents. The two households were separated by a three-hour time difference with one in Canada and one in the United States. The Researcher family used the FW on a Tablet PC and placed it on a counter in the kitchen. From this location, the FW could be turned to capture the dining area, the kitchen, or the living room. The *Researcher-Parents* used the FW on a desktop PC for 5 of 8 months, and a Tablet PC for the remaining three months. This was done to compare the different styles of usage. Both computers were situated at one end of a living room. We collected data from these families through a private blog where they recorded their experiences and thoughts.

Sister-Sister. *The Sister1 family* was composed of two parents and a son who was 18 months old. They used the FW to connect with the wife's sister and her long-term male

companion. We refer to them as the *Sister2 family*. The sisters have a very close relationship, describing it as being like a mother-daughter relationship as Sister2 is 20 years older than Sister1. Both families live in midsized cities in New York, USA, with a two-hour drive apart. Despite this seemingly short distance, they typically saw each other in person only once every few months, yet talked on the phone or email regularly throughout each week. Neither had ever video conferenced. The sister families both used the FW on a Tablet PC and chose to place them in their home office near existing computers. They were accustomed to keeping computer devices in this space and this was also pragmatic: They wanted to keep the device out of reach of children (Sister1) and large pets (Sister2).

Daughter-Parents-Grandchildren. *The Daughter family* was composed of two parents and a son who was 2 years old. They used the FW to connect with the wife's mother and stepfather who we call the *Daughter-Parents family.* The daughter and mother were very close to one another and talked and emailed frequently. As a routine, they also used Skype every weekend to allow her parents to talk to and see their son at play. Both families lived in midsized cities, one in New York and one in Florida, USA. They lived in the same time zone but were a 21-hour drive apart. The Daughter family used the FW on a Tablet PC and placed it on a short stand in the corner of the living room so that it could capture most of their living room and adjacent kitchen. The stand also enabled their son to easily see and interact with the FW. The Daughter-Parents family used the FW on a home laptop, which was moved throughout the home but was generally found in the kitchen or living room. This let us compare laptop-to-Tablet PC use.

Data Collection and Analysis. We conducted four semi-structured contextual interviews with the field deployment families, one each during the first and second week of usage, one at the end of five weeks, and a follow-up interview a week later. We also sent emails and phoned between interviews to ensure families were not having technical difficulties. Software usage was also logged throughout the study (e.g., on/off state, blinds level). Each family received gift cards for participating. Usage data was collected by interviews as well as self-reports in a diary given to each family. All interviews were audio-recorded and handwritten notes were taken to aid analysis. We used open coding to analyze this data and generated codes that reflected a variety of usage patterns. These codes were combined to create themes that are reported in our results.

RESULTS

All families left the FW running continuously throughout the study (at their choice) and it was typically only off as the result of technical difficulties, which required it to be restarted. Across all families, we saw remarkably similar usage patterns where, in many ways, the FW became the central focus of communication between the subject families. In fact, all families wanted to continue to use it after the study. Next we highlight the interesting patterns of

usage that occurred and discuss the critical design features that led to and supported these routines. We also discuss the features that did not meet users' needs, thereby causing workarounds to be used.

Availability Awareness Leads to Interaction

First, and most similar to the use of media spaces in the workplace, we saw family members use the FW as a tool for discerning availability, which they could then use to easily move into interaction if desired. Here participants would check the FW before making phone calls to see if remote family members were around and then sometimes gesture at one another (e.g., making a phone shape with one's hand) or write on the FW to ask if it was all right to call. At times, this awareness acquisition and subsequent interaction was serendipitous where family members would notice something unexpected and then call to talk about it. For example, they may see someone with a new haircut, nice shirt, or home at an unexpected time, which could prompt a phone call. In addition, awareness acquisition was also part of planned interactions. For example, a family member may routinely call at a certain day and time, but they would first check the FW to ensure that, even though the interaction was planned, the other person was indeed around and available.

These types of experiences are exemplified by a situation arising between the Sister families, which began as awareness leading to impromptu interaction and evolved into awareness for planned interactions. Prior to the FW, the two sisters would normally talk several times a week on the phone but it could be a challenge to catch the other person before 9 pm. After 9 pm, Sister1 assumed her older sister was already asleep, while Sister2 assumed her younger sister would be trying to put her nephew to bed. One evening during her first week of using the FW, Sister1 noticed that her sister was awake at 10 pm and on a desktop PC in the home office, which she could see on the FW. She knocked and wrote on the FW to ask if they could talk. Sister2 said yes and then called her on the phone. Since this incident, they have been talking regularly in the late evening after checking the other's availability. Thus, the FW let them to discover new opportunities for interaction.

"Seeing each other every day allows us to be more connected and to talk about our days. Example [my sister] would ask 'how did that meeting go today?' as opposed to weekly calls where we only used to talk about our week in general and highlight important points" – Sister2

Determining availability for communication was not without its challenges. As one might expect, family members were not always in front of their FW (regardless of its location) given the large size of most homes and the varied location of family members. This is in contrast to most media spaces designed for workplaces where the media space showed an office view and, most of the time, the office worker was in front of the camera. To overcome this, family members would sometimes knock on the FW to see if people were around or they might rely on other visual cues. For example, the lighting of the room may indicate

people were awake, or changes to the "background" (e.g., movement of a book on the counter) may show recent activity and, thus, presence.

"i [sic] could see you leave the house.I [sic] could also tell when you arrived home again as I saw the diaper bag go onto the counter". – Researcher-Parents Grandmother

The activity timeline could have seemingly helped families determine recent presence and likely availability, although none reported using it for this. In fact, most families found this feature offered little immediate value. Instead, family members would often augment the video channel with handwritten messages to provide additional availability information. For example, both the Daughter and Daughter-Parents family left messages saying when they would return if they were going out during the day. In essence, this firsthand information provided a more trustworthy account of one's availability.

Of particular interest is the fact that family members actually *chose* to discern an awareness of presence and availability *before* phoning each other. They did not have to, and this would have reflected their previous communication patterns of calling based on an assumption of availability or simply not concerned if they interrupted the remote family. The fact that families had additional information to help determine availability *and* acted on it points to the value of having this availability awareness.

Interacting through the Family Window

Families also used the FW as a communication tool for interacting with their remote family members. We did not supply an audio link although it turned out that family members desired this, albeit in a limited fashion. Always-on audio was seen as a large invasion of privacy and instead families wanted simple mechanisms that permitted sending short messages to one another.

"I do wish that there was a talking feature on the program. Sometimes I have said Hi, I love you. Then I realize they cannot hear me. I have been trying to think and act out the words. If you could just press a button and say Hi, How are you? Hope you have a good day. How is the baby? How is [grandson] doing? What is the weather like? I love you. Have a good sleep. Just some simple little chat." – Blog excerpt from Researcher-Parents Grandmother

In addition to this, families also saw the need for longer conversations, akin to the manner in which they were accustomed to using the phone. Given the lack of both of these types of audio, we saw families develop workarounds.

First, as described previously, families often coupled their use of the FW with the phone or an audio conferencing tool. The FW would provide the video link to see family members, gesture, or show items of interest while the phone supported the voice conversation. Several of the families even used the phone in speakerphone mode so that multiple family members could converse simultaneously. Yet the phone calls only sufficed for situations where family members wanted to have longer conversations. In situations where they wanted to simply say a quick "hi" they relied on the writing capabilities of the FW. Here we saw families

leave many messages throughout the study as a form of asynchronous communication. Messages often began with a simple "good morning" at the beginning of the day and then evolved into more detailed discussions with messages left at various points in reply to one another. Participants told us that seeing these messages in the context of the FW made them special and required less effort than email.

"It is nice to come home or wake up to see a message from [my sister]. A simple message like 'have a nice day' is all I need to know that she is thinking of me." – Sister1

We also saw instances of synchronous communication occur where families would leave "bursts" of messages one after another in a turn-taking fashion. In essence, they had turned the FW's drawing canvas into a handwritten "chat window." This method can cause conversations to progress slowly (handwriting is often slow), although we found that there was an enhanced feeling of connectedness that came with seeing a loved one's handwriting.

The placement of the FW in the Daughter family's house also led to rich interactions between the two-year-old grandson and his grandmother. The grandson would have exchanges with his grandmother where she would write alphabet letters on the FW for him, draw shapes, or hold up different colors to try to teach him new things. In turn, he would draw pictures for her. This routine became so important to the grandson that he would run to the FW each day after returning home from daycare, scribble a message on it, and kiss the video of his grandmother's face. If his grandmother was not around, his father would call her house and tell her that her grandson was looking for her. This illustrates that, if placed in an accessible location, even young children can establish new ways of interacting with remote family.

Interacting through drawing on the FW is simple with a Tablet PC, yet this task quickly became onerous on the desktop PC and laptop where stylus or touch interaction was not supported. For example, the Daughter-Parents grandmother stopped trying to write on the FW at one point and developed a workaround of writing messages on a notepad and then holding it up in front of the FW. We could have simply enabled typed text on the FW, but this would have taken away from the richness associated with seeing the remote family member's handwriting. Clearly a balance between ease of use and this richness is needed.

Sharing Everyday Life

We also found that all families routinely used the FW to share episodes of everyday life such as eating, preparing meals, child bathing, playing, etc. This went beyond simply conversing to actually showing or making the remote family members a part of the activities at one's home. Family members did not have to do this nor did we suggest it. It evolved out of the needs people had to make the remote family members a part of their seemingly mundane everyday activities. At first these instances were opportune, but many of them evolved into routine practices that often occurred on a daily basis.

"[My grandson] has tea parties with his stuffed animals and I get to watch that. One day [my daughter and son-in-law] moved [the FW] to the kitchen so I could watch them cook breakfast. [My husband] took ours to the pool one day so they could see us in the pool." – Daughter-Parents Grandmother

"[My son-in-law] takes the Family Window up to the bathtub and we watch [my grandson] take his bath, get ready for bed, read books together and [my grandson] just loves to see us, just loves! So every night between 7:00-8:15 we set the time to see him... THAT WAS SO COOL! It was the next best thing to being there!" – Diary entry by Daughter-Parents Grandmother

"I could see [my grandson] playing and I could see the tv going with the [hockey] game. This really made me happy to see the daily activity happening. After awhile you walked by waved good night things went dark the camera was off and I knew you went upstairs to bed. This all made me feel more connected to my distant family." – Blog excerpt from Researcher Grandmother

The feelings of connectedness that developed between the families as a result of sharing activities surpassed that which they felt with other technologies, like email or phones. Seeing the remote family members and their activities was the crucial aspect. This point is exemplified by the Daughter family whose son required minor dental surgery. The daughter contacted her mother several times throughout this ordeal to let her know the situation and that everything was fine after surgery. Only when she saw her grandson on the FW and he showed her the tooth and his stitches did she feel relieved and reached peace of mind.

"He hurt his tooth the other day and the dentist had to take it out. So it was very traumatic. We were watching him when he came home and he showed me his tooth. It was nice for me to be able to see him after what happened" – Daughter-Parents Grandmother

Sharing everyday life also involved seeing more than just the remote family members. Other visible items in the home were sometimes just as important. For the Daughter family and the Sister families, seeing pets became a surprise interest of the families. Researcher-Parents Grandmother felt more connected by seeing the weather outside of the Researcher's home (through an outdoor window) because it provided a better understanding of the circumstances surrounding the family's day. These findings illustrate that unexpected information can become important and it is not always easy to know in advance what information may be relevant at what point in time. Patterns may develop, yet these are likely to be different for different people who may value certain information over other pieces of information.

The sharing of everyday life was supported by both the always-on nature of the FW along with its mobility. Thus, they were critical factors for supporting these behaviors. Families could easily move the FW to locations that contained activities that they wanted to share, such as a child's play area or the kitchen. A fixed location would not have sufficed for capturing all of the moments families wished to share. Yet when the FW was left stationary, always-on video meant that a portion of the families' activities were shared with no additional effort placed on the family. They simply carried on life as they normally did, except now it was being captured and shared via the FW. The fact that the video was live meant that families

were more a part of the remote family's life *right now*, somewhat akin to visiting the home in person.

Workplace media spaces were used to share meetings and other similar social gatherings, but a work colleague would hardly show you their routine for checking email or writing a document via a video link. Thus, we see a large contrast between the workplace and home. In the home, everyday mundane activities *are* shared. Sharing these activities led to families feeling more connected and being a part of each other's lives. We also see that our findings in this regard are similar to O'Hara et al.'s [32] study of mobile video conferencing. They too found that people enjoyed sharing everyday episodes of life where the mobility of the mobile phone played an important role.

Privacy

All families initially expressed concerns over privacy, specifically confidentiality, that remote family members may learn or see more details about their lives than they were willing to share. This concern was minor, however, because they were connecting with close family members. They also all chose FW locations that were comfortable to them, that revealed the same amount of information as one might gather if visiting the home in person. The difference here was that the remote family would see this space *all* of the time. Through the first week of usage, four of the families (the exceptions being the Researcher families) used the blinds periodically to indicate they were busy or did not want to be seen. This activity soon dissolved as families grew comfortable with the FW, developed patterns of use around it, and realized that what was visible to the remote household was not of particular concern. Following the first week, none of the families used the blinds again.

This acclimation is best illustrated through two stories from the Daughter family. First, the wife in the Daughter family routinely did exercises in her living room after putting her son to bed. During these times, she would close the blinds on the FW because she did not want to be watched. One night she noticed her mother's legs in the air on the FW and called her to ask what she was doing. As it turned out, her mother was also exercising. The daughter's reply was that if her mother was fine with showing this, she was fine too. Following this, she never closed the blinds again.

Second, we saw instances where using the FW on a laptop or desktop PC caused privacy concerns. The husband in the Daughter family usually stayed up late watching TV at night but quickly grew uncomfortable because he saw his father-in-law in the FW staring intently at him every night. After several nights of this occurring, he asked his father-in-law what he found so interesting. As it turned out, the father-in-law had minimized the FW application on his laptop and was checking his email. After understanding this behavior, the son-in-law did not feel concerned about his privacy. This does reveal, though, that non-dedicated displays can easily send mixed messages about one's

actions because it is not clear what application they are directed towards.

We also learned that some family members felt awkward as viewers of a remote household. Thus, there existed different concerns when watching vs. being watched. For example, one family member was initially concerned because she did not know if the remote family would be fine with her watching them and did not want to "intrude". This feeling dissolved after a few days of use. Some family members were also surprised about the manner in which they saw remote children behaving and being disciplined. They chose to accept the differences in child-rearing styles or to ignore it. The Researcher family often had guests visit their home who would notice and ask about the FW. In some instances, they would sense the visitors' discomfort in watching or being watched. To alleviate this, the Researcher family turned the FW to capture the wall or an obscure object (e.g., flowers). In other instances, visitors would be fine with the FW continuing to capture the home's activities.

A common privacy concern with domestic technologies relates to violations of solitude. People can easily interrupt home inhabitants at inopportune times (e.g., by phoning them) or not allow them to have time and space to themselves [3]. One might expect that a media space could infringe on solitude because it would mean that a family could be watched all the time. However, none of our families expressed concerns over solitude. In fact, the FW often acted as a passive awareness device where family members did not have to do any additional work to share information about their lives. They simply had to have it on and continue their normal routine. Families did not feel obligated to talk or interrupt their normal activities to share information (like one may have to do if phoning a family member and conversing).

Time Shift Recording
Although families valued "in the moment" sharing over viewing past events, they liked the ability to record video while they were away. The Daughter-Parents family and Sister2 family watched time shifted video when they got home from work to catch up on their respective grandson and nephew's daily activities. This increased feelings of connectedness as families could easily share parts of their lives even when they weren't at home at the same time. Despite this, there were still instances where families wanted to record activities with the FW and have them saved *permanently*. However, our design did not support this. Here participants wanted to record video in a manner similar to capturing photos/videos of events and then save or share these clips.

This is exemplified by a situation with the Daughter family. The Daughter family's son was having a birthday party and Grandmother wanted to be able to see it, however she was not going to be at home. On the day of the party, the Grandmother forgot to turn on time shift recording. Because control over recording was in the hands of the

viewer, the son-in-law had no way of recording the activity for her with the FW. For this reason, we see a need to adjust the control mechanisms for time shift recording to permit recording at either location. We also recognize that a more sophisticated version of time shift may be needed in the case that users forget to turn on recording or realize that they would like something recorded after the fact. For example, the system could automatically record activities that may be characterized as interesting based on activity or person detection. This could even be coupled with automated camera control [20].

Studies of workplace awareness have shown that recording activities can be important [1,15,31], however in the workplace, the importance is not in capturing memories for sentimental value like it is in the home. It is typically about capturing information to discern availability, predict future patterns of activity, or review meetings. Thus, we see a contrast between the workplace and home in this regard.

Post-Deployment Communication
Two weeks after the end of the deployment we interviewed the Daughter family, the Daughter-Parents family and the Sister families. All families reported that their communication acts (e.g., serendipitous conversations, sharing of everyday life) increased during the FW usage as compared to before it was introduced. After the FW was removed, communication patterns returned to what they had been prior to the FW usage. Families felt less connected as they could not see each other anymore and they no longer had impromptu conversations during the day.

DISCUSSION AND CONCLUSIONS
Our explorations have revealed key behaviors and routines surrounding the use of a domestic media space to connect families over distance. These were similar to workplace media space usage (e.g., availability awareness, impromptu conversations) and also different (e.g., sharing everyday mundane activities) where the mobility of the FW and its always-on video played a critical role.

First, because family members could see their distant loved ones on a regular basis, they were more aware of each other's presence. This led to families thinking about each other more often and interacting more frequently. Family members didn't necessarily feel more obligated to call, they simply *wanted* to call. The always-on video also gave new purpose to those calls where family members could ask or talk about the everyday mundane things that they saw on the FW for which they may not normally be aware. Other technologies do not provide this same level of awareness and sense of presence. One may see an email from a remote family member or see their name on an IM buddy list, but this does not engender the same feelings that one gets when they actually see someone in person.

Second, family members felt more connected because they could actually see their distant family members, their home, and their life. They explored and built this connection by showing and watching everyday episodes of life. This also

came from seeing unexpected things such as a television turned on, a pet moving in the room, the weather outside, or even just an empty room. Families can share everyday life through photos or video recordings, or even tell others about things via email or phone conversation, but this is not the same. Seeing things live brings an additional sense of believing and increases connectedness by making the remote family a part of the activity. Currently most communication technologies do not support this well. This calls for continued design efforts to support the sharing of everyday domestic activities.

Third, we saw that privacy concerns over the use of always-on video in the home are most commonly related to autonomy where users choose when and how to participate in such a system. Thus, the ability to easily turn on/off a domestic media space is critical. Researchers have posited about the sanctity of the home and the need for solitude within it so that people can "escape" from others [3]. Yet our findings revealed this was not a concern for our field study families. Confidentiality has also been a large concern for workplace media spaces [3,7,15], but again this was not a large concern for media space usage in the home. What is clear is that relationships matter [34]. All of our field study families had close relationships where they had a need to connect over distance. In other situations, people will naturally not be as comfortable with always-on video.

We can also learn from our experiences with domestic media spaces to inform the design of other non-media space technologies. Here we see a clear need for technologies that enable both availability awareness and seamless interaction amongst family members over distance. Systems such as the Whereabouts Clock [35] could provide information that family members could use to deduce availability, yet there is no means to seamlessly move into interaction with the same system. On the other hand, systems such as Home Note [36] or BubbleBoard [22] could provide availability awareness via messages saved/written by family members, thereby inherently supporting both awareness and interaction in a single device. Yet here users must explicitly provide the availability information as opposed to a media space, which transmits this information passively.

Our results also illustrate that it is not always clear what awareness information is important to families. Thus, awareness appliances that preselect which content is important or are designed around specific contextual information can easily fail to provide families with the awareness information they want or need to see in order to feel connected. These findings suggest that awareness appliances should be adaptable or allow users to change what information is presented to them. For example, Elliot et al.'s [9] location-dependent appliances allow users to change what awareness information is presented depending on a device's location. However, even though family members can select content, it can be difficult for users to know what information is relevant until they actually see it. In the case of media spaces, this suggests the continual

transmission of video. In contrast, systems like VideoProbe [6], which transmit intermittently and only if there is motion in front of the camera, may easily miss interesting pieces of awareness information. For example, gradual changes in weather patterns or lighting may go undetected yet be valued by some family members.

Certainly this paper has only scratched the surface of domestic media space usage. We still do not know the complete range of information that people are interested in seeing within a media space. We also do not know what the long-term effects are of such a system. Four of our families used the system for five weeks, which is a short time period (although typical of most domestic field deployments). Given that the patterns of usage were similar (if not identical) to our own self-usage of eight months, it is likely that the families' routines would extend longer term. We also do not have a good understanding of how teenagers living with parents and young adults may interact with a media space. An additional series of design probe interviews we conducted with broader demographics [19] reveals potential reluctance though more work is needed to validate this finding. In addition, it is unclear how usage of domestic media spaces would change when extended across multiple family and friend households. We pose these questions in hopes that our efforts can act as a stepping-stone to this very interesting set of explorations.

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