

My Life with Always-On Video

Carman Neustaedter

Simon Fraser University, School of Interactive Arts + Technology

Author Note

This research was supported by Eastman Kodak Company and the Natural Sciences and Engineering Research Council. Thanks to Tejinder Judge for her invaluable efforts on the Family Window design and field evaluation as well as Tony Tang, Andrew Kurtz, Elena Fedorovskaya, Andrew Blose, and Rodney Miller for their encouragement, software help, and collaboration. Most importantly, I thank my wife, Kirstin Neustaedter, for allowing our home and life to be a “living laboratory” for my research. Correspondence concerning this paper should be addressed to Carman Neustaedter, 250-13450 102nd Avenue, Surrey, BC, Canada, V3T 0A3. Email: carman_neustaedter@sfu.ca, Phone: (778) 782-9034.

Abstract

Video chat systems have seen a recent uptake in usage amongst family members given the widespread and free availability of such software and the decreasing costs of webcams. All are designed in a manner that suggests a particular pattern of usage to end-users that models the familiar practice of “phone calling” one another. My own past experiences with video systems was in the form of media spaces from the workplace and I wondered if such “always-on” video links might play a role in the domestic realm or if they would be too privacy intrusive to render any benefit to family members. Over the course of four years, we designed and built four such systems despite strong hesitations initially to do so. This article describes the design of two domestic media spaces in particular, the Family Window and Honey, and their longitudinal usage for approximately one year each. Through an autobiographical design approach, I show how each became a core communication tool for my family and the unique ways in which the technologies supported unsuspected practices amongst family members as a result of the media space’s location.

Keywords: video conferencing, media space, family, awareness, connectedness

My Life With Always-On Video

Video conferencing systems are rapidly becoming an everyday communication tool to connect family members. Such systems are now readily available for free and webcams are relatively inexpensive. This contrasts earlier attempts to bring video calling to the home through the picturephone of the 1970s where cost was much higher (Noll, 2002, Lipartito, 2003). Yet the design of modern day video conferencing systems (e.g., Skype, Google Talk, Apple iChat) reflects this earlier design paradigm. Many (if not all) are designed to be used in a fashion very similar to phones, despite running on computers. You select a person from a contact or buddy list (akin to dialing a person's number), hit a connect button, and then can see and hear the remote person. You use the video to augment your conversation by showing (and watching) body language, facial expressions, and gestures. Then, when finished, you (click) hang up. But what if this was not the case? What if the design of video calling systems moved away from this phone-like model? How might we open up the experiences available to people through an alternative design? And, how might people appropriate and use such technologies?

These were exactly the questions that I asked myself approximately four years ago. As a Computer-Supported Cooperative Work (CSCW) researcher, I had used *media space* applications at work in the past where an always-on (or nearly always-on) video link was used to connect distributed colleagues and provide awareness and interaction between them. These included, first, the Notification Collage (Greenberg and Rounding, 2001) and, second, the Community Bar (McEwan and Greenberg, 2005) where both showed a live and continuous video feed of me working to my distributed colleagues. Similarly, I saw a live video feed of them. Through the systems, we could gain a sense of awareness of each other's availability and leave messages or chat about our work activities. Despite some (mostly minor) concerns about privacy

(Boyle et al., 2000, Neustaedter et al., 2003, Boyle et al., 2009), my experience with such systems was largely successful as were much earlier attempts by other researchers at various industrial research labs and universities (Bly et al., 1993, Harrison, 2009). Turning to the domestic realm, our past research on commercially-available video conferencing systems (e.g., Skype) showed that families often liked to leave their video link open for an extended period of time with remote families, yet the software was not typically designed in a way to easily support this (Judge and Neustaedter, 2010). This made me wonder, could the idea of a media space be adapted to home environments to more easily connect family members over distance for extended periods of time?

Roussel (2009) used a media space in his university work environment over the course of five years as he helped design and implement various aspects of it. He also designed two media space-like applications for the home, VideoProbe and Mirror Space (Roussel, 2009). When reflecting on this work, Roussel (2009) argued that he happily worked in a media space, but would never use one at home because the home is full of highly dynamic locations containing mostly private activities. In a similar fashion, I pondered whether to pursue a project investigating media space usage in the home and continually came back to the same thought: Nobody is going to want a video connection going all the time in their home. It is simply too privacy invasive. Four years later, I can certainly say, I was wrong.

I have spent the past four years investigating the use of always-on video as a part of domestic life in order to understand how distributed families can share everyday life over extended periods of time. I have collaborated on the design of four such systems (Judge et al., 2010, Neustaedter and Judge, 2010, Neustaedter et al., 2010, Judge et al., 2011) and used two within my home as a core part of my family's domestic communication routine. This article

looks at the longitudinal use of these two domestic media spaces. First, it explores the year long usage of the Family Window, a media space designed originally to connect my children with their grandparents over distance. The design of the system and its field evaluation with my family, as well as four other families, is described in Judge et al. (2010). In this article, I offer critical reflection on the factors that made my family's long term usage successful. Second, I explore the design and usage of Honey, a media space originally designed to connect myself to my wife, between my work office and our home. This system is not reported elsewhere. I contrast the use of Honey with the use of the Family Window and explore the effect of the change in context, from a home-home connection to a work-home connection. I also contrast both domestic media spaces with workplace-based media spaces of the past.

The accounts in this article are certainly autobiographical in nature (Erickson, 1996, Sengers, 2006, Gaver, 2009). That is, they are focused on my own usage with two systems where each system was originally designed to support my own needs and that of my family. Yet I argue that reporting such experiences is highly valuable, in particular, when they are derived from rich longitudinal usage. This usage provides a very nuanced understanding of technology usage "in the wild" to truly understand the social and physical context in which the technology is being used (Buxton, 2007). Such experience and understanding is necessary. As Buxton says, "The only way to engineer the future tomorrow is to have lived in it yesterday" (Buxton, 2007). Longitudinal usage is very difficult to come by in the context of video conferencing systems and more specifically, media spaces. The always-on nature of the video channel makes it difficult to keep the technology "working" long term (Hindus et al., 2001). In fact, looking at early media space research in the workplace, we see a similar strategy emerge where many of the reported uses of media spaces are based on the technologists' use of their own systems or that of their

colleagues (e.g., Fish et al., 1990a, Mantei et al., 1991, Dourish and Bly, 1992, Dourish, 1993, Dourish et al., 1996). This has also occurred more recently (Kim et al., 2007, Boehner et al., 2008, Gaver, 2009).

Related Work

Media spaces have been investigated as a means to connect distance-separated coworkers for over twenty years (Harrison, 2009). The main premise is that as coworkers become separated by distance, it can be harder for them to collaborate (Kraut et al., 1988). One reason for this is that they lose out on opportunities for casual interactions with one another and awareness cues that allow people to easily move into such interactions (Kraut et al., 1988, Bellotti and Sellen, 1993, Whittaker et al., 1994). Media spaces were designed to overcome this problem by supporting existing face-to-face practices in a distributed environment. That is, rather than change people's practices, media spaces sought to support what people already do when face-to-face, only now they could do it across distance (Roussel, 2009). Video links would broadcast awareness information—an understanding of who was around and available—and then permit people to move into interactions with others over the same channel (Harrison, 2009). Sometimes this was just through video, some systems had optional audio links (e.g., Fish et al., 1990b), sometimes audio was always on (e.g., Bly et al., 1993), sometimes text chat channels were available (e.g., Tang et al., 1994), and in one case, audio was only available (Hindus et al., 1996). Other solutions also augmented a video link with shared drawing capabilities (Tang and Minneman, 1990, Tang and Minneman, 1991). In the remainder of this section, I look at two of the main factors relevant to the adoption and usage of media spaces—location and privacy—as

they become focal points of my own media space analysis in the remainder of this article. I then describe research on video conferencing and media space designs for home environments.

Location has always been an important factor in the design and use of media spaces in the workplace. First, some media spaces connected *common areas* like meeting rooms, sitting spaces, or even shared kitchens (Fish et al., 1990a, Jancke et al., 2001, Bly et al., 1993). For example, the Virtual Kitchen provided a video link between two lunch/kitchen rooms in buildings at Microsoft Research (Jancke et al., 2001). Because these media spaces were placed in areas commonly used by many people, anybody could use the media space if they went to the common area. Yet it also meant that people could not utilize the common area unless they were fine being captured and broadcast from within it (Fish et al., 1990a, Jancke et al., 2001, Bly et al., 1993). Remote participants may also not be around in the space when one enters it, thereby rendering its use minimal (Jancke et al., 2001). Second, some media spaces connected specific co-workers' *offices* where a user could see into several offices all the time (Mantei et al., 1991, Dourish and Bly, 1992, Lee et al., 1997, Coutaz et al., 1998) or choose to "peek" or "glance" in periodically (Fish et al., 1990b, Tang et al., 1994), much like walking down an office hallway. The idea is that the location is more private and, thus, individual users can agree to be a part of the space if they wish. Yet in actual practice this is more challenging. People may share offices, cameras may accidentally capture views into hallways, or sound from adjacent spaces may also be captured (Dourish et al., 1996). Third, some media spaces connected *different contexts* and explored asymmetry of place (Volda et al., 2008). For example, the Magic Window connected a public lab space to the inside of an office by placing a video display of the office's interior on the office door (Kim et al., 2007) and the Home Media Space connected a telecommuter's home office with the work offices of colleagues (Neustaedter and Greenberg, 2003). The benefit is

certainly that people in mixed contexts can utilize the awareness features of the system (Neustaedter and Greenberg, 2003, Kim et al., 2007), yet there are additional social challenges found when merging the social norms of the different spaces (Neustaedter and Greenberg, 2003).

It is clear then that media spaces bring with them unique privacy challenges. A number of researchers have provided frameworks for exploring this. Hudson and Smith (1996) describe privacy in terms of its tradeoff with awareness: As more awareness is gained by sharing information about oneself and one's location, the more a person's privacy is at risk. Gaver et al. (1992) articulate that media space users want control over what is broadcast and when, knowledge about when someone is watching them, and knowledge about the remote user's intention in doing so. Similarly, Bellotti and Sellen (1992) and Bellotti (1993) argue that users need *feedback* of what information is available and to whom, and *control* over information about themselves. Boyle et al. (2009) articulate these ideas as three control modalities—solitude (freedom from interruption), confidentiality (control over what is seen), and autonomy (choosing when and how to participate)—and explain that media spaces should allow users to regulate all three. Given these privacy challenges, many researchers have looked at ways to mitigate privacy concerns while still providing users with the awareness and interaction that media spaces afford. These have included feedback views of what is being captured (Mantei et al., 1991, Lee et al., 1997), various forms of video obfuscation (Coutaz et al., 1998, Hudson and Smith, 1996, Boyle et al., 2000, Neustaedter and Greenberg, 2003, Neustaedter et al., 2006), and control mechanisms for easily turning the camera on and off (Lee et al., 1997, Jancke et al., 2001, Neustaedter and Greenberg, 2003).

Turning to the home, we see several studies emerge recently on the ways in which families make use of video chat systems. These highlight the technical challenges associated

with starting up video chat sessions (Ames et al., 2010, Kirk et al., 2010, Judge and Neustaedter, 2010) as well as social issues such as maintaining the attention of children across the video link (Ames et al., 2010, Yarosh et al., 2010). Judge and Neustaedter (2010) showed that families with children benefitted by leaving video links going for extended periods of time to share family life with remote grandparents. For example, one study family with two small children would routinely connect with the remote grandparents every Saturday morning using Skype. They would leave the video connection going for several hours so the grandparents could see the family's normal morning routine (Judge and Neustaedter, 2010). Studies by Greenberg and Neustaedter (2010) similarly showed that partners in long distance relationships also leave their video connections going for extended periods of time in order to create a sense of 'shared living' despite being separated by distance. Together, these study findings suggest that families might benefit from a media space because it easily allows long term sharing of activities through a video link. However, the problem is that we do not understand families' specific privacy concerns when it comes to media spaces and we do not know if families' needs for privacy in their home might supersede the value they can gain from media spaces.

Several researchers have also designed video systems for the home, albeit some are more media space-like than others. Hindus et al. (2001) proposed KitchenNet, a media space that could connect two homes together through video, but it was not pursued because of connection challenges in broadcasting video. They also designed an audio-only media space called RoomLink, however, it was never evaluated to understand its use (Hindus et al., 2001). VideoProbe captured images of activity in front of a display and transmitted these to a remote family's display (Conversy et al., 2003, Hutchinson et al., 2003, Roussel, 2009). It was even evaluated with families and shown to be relatively successful at connecting family members

(Hutchinson et al., 2003). The difference between it and the current work, however, is that with VideoProbe, a continuous video stream was not provided between households (Hutchinson et al., 2003); thus, we still do not know how families might react to always-on video in their homes. More recently, we have seen the emergence of new video systems for the home. This includes media spaces designed to connect parents and children in divorced families (Yarosh et al., 2009) and video storybooks designed to support interactions between grandparents and grandchildren (Raffle et al., 2010, Raffle et al., 2011). In neither case did the systems provide a long-term video connection though. My own collaborations with others have resulted in the design of two domestic media spaces not discussed in this article: a mobile media space called Peek-A-Boo that connects a smartphone with an in-home display (Neustaedter and Judge, 2010) and a successor system to the Family Window called Family Portals. In this system, three families are able to connect through a multi-family media space (Judge et al., 2011).

Despite a variety of media space and video chat systems existing for the home, none have been evaluated in a longitudinal setting like this article reports on. Such evaluations are important for they illustrate how families make use of media space systems in ‘real’ situations, how they adopt them into their existing routines and use them long term, and how families cope with privacy issues. In the next section, I describe my own family’s usage of the Family Window media space to connect our own home to my parents’ home. This provides one set of answers to these unknowns. Following this, I detail our usage of the Honey media space system that connected our home to my remote work office.



Figure 1. Initial Family Window design.

Connecting Two Homes

The Family Window is a media space that connects two homes through always-on video (Figure 1). I designed the original version of the Family Window with the intent of connecting my home with that of my parents; thus, I aimed to connect my wife, my two young children, and myself with my childrens' grandparents who lived approximately 4000 kilometers (2600 miles) away, across three time zones. We were living in the Eastern United States and they were living along the West Coast of Canada. We did not have many opportunities to see them in person (about once a year), which meant we had a real need and desire for a system to connect us. This is certainly not true of all families, but studies have shown that many families do wish to connect to their loved ones in such a way (Neustaedter et al., 2006, Tee et al., 2009). My son at the time was two years old and my daughter was born one week after we first started using the Family Window. My parents were in their mid to late 50s, though the primary user of the Family Window was my mother because she occupied the space surrounding it much more than my father.

In its simplest form, the Family Window provided a two-way video link for us. The remote home is shown spanning the majority of the display and a feedback view of local video is shown in the bottom left corner (Figure 1). The camera can be turned on and off by touching the feedback view with your finger; it works like a toggle switch. Video transfers at a low rate of one frame per second. This was necessary to keep the video link going continuously and minimize software crashes. While one frame per second may sound slow, our usage suggests it was high enough to make the system useful. I included a blur filter as well as “blinds” that could be opened and closed in order to help regulate privacy; these were very rarely used. The Family Window was purposely designed for a Tablet PC, such that it could embody the idea of an information appliance and be *just* a media space. There was no audio link. This was done for two main reasons. First, it was technically more challenging to get an audio link working than a video link and I wanted to quickly get the design up and running so we could start using it. Second, my wife and I were willing to “give up” some of our privacy by providing a video link to my parents’ home, but we weren’t willing to have them hear everything we said through an audio link. Certainly the system could have supported an optional audio link, but I felt the phone would suffice in these instances.

I designed the basic system that is shown in Figure 1 and as we used the media space, I tinkered with its design and implementation over the first four months of our usage. With the help of collaborators, Judge and Kurtz, several additional features were added after this point (Judge et al., 2010). Figure 2 shows the revised version which included video recording and playback with a time shift feature, an activity timeline, and ability to write on top of the video link (Judge et al., 2010). A video of the system is also available in Neustaedter et al. (2010). My family and I used this updated version for another eight months (until an unfortunate

hospitalization of my mother caused us to stop using the system). Some of the features were certainly helpful. Yet our long-term usage, and the success of it, mainly related to the always-on video and not these additional features. The Family Window is also certainly not unlike media spaces of the past (Harrison, 2009). In fact, its design combined many of the successful media space features that have been reported in the literature. The novelty of the work comes from the application of these features within the context of the home.

My family's use of the Family Window was more than just a family using a new technology. As a researcher, I actively sought to understand how the system was being used (at both ends of the connection) and took great measures to document our understanding and experiences. I created a private blog for my family and thoughts about the Family Window were recorded in it. These were predominantly observations from myself but this did occasionally include reactions and thoughts from my mother and wife. I analyzed the blog entries using affinity diagramming to understand the common, and also not so common, usage patterns (Holtzblatt et al., 2005). In affinity diagramming, analysts go through all of their observations

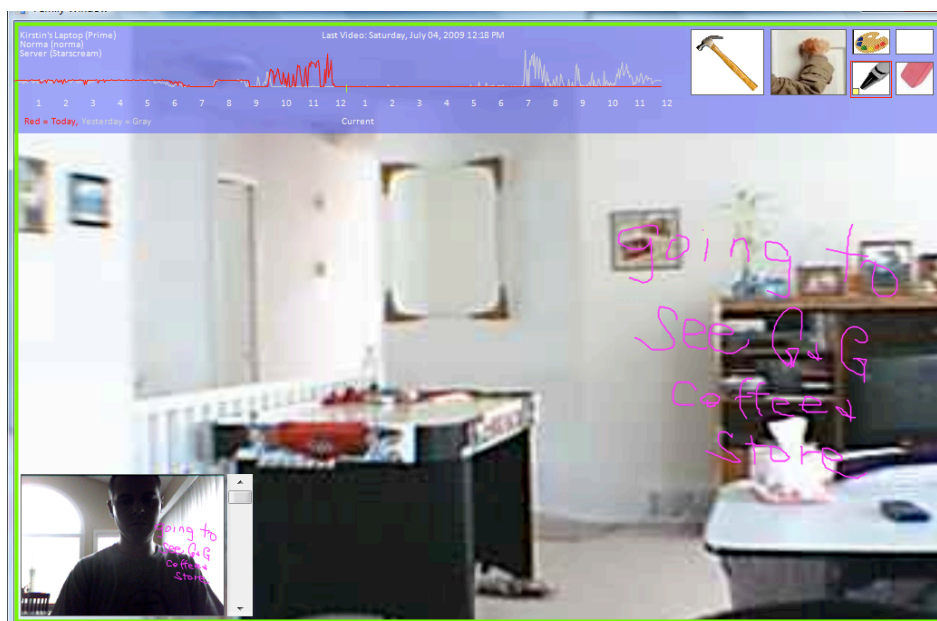


Figure 2. Revised Family Window design.

and notes and record each relevant piece of data on individual pieces of paper (e.g., sticky notes) (Holtzblatt et al., 2005). These are placed on a wall or large surface (somewhat randomly) and then moved spatially to bring similar ideas together (Holtzblatt et al., 2005). This is followed by the labeling of key findings (Holtzblatt et al., 2005). Thus, the process of affinity diagramming provides a systematic means to analysis, synthesize, categorize, and label important findings from a study. Overall, this process revealed two dominant factors that affected our use of the Family Window: the media space's *location* and the *relationship* of the people within the space.

Location, Location, Location

We quickly and repeatedly learned that the location of the Family Window was critical for its use. The main floor of our home was an open design that connected the living room, kitchen, and dining room. Adjacent to the kitchen was an exit out of our home to a garage. Figure 3 shows this area of our home's main floor. The Family Window was initially placed on a central counter in the kitchen and turned to capture the dining room. I did this for two reasons. First, I wanted to capture an area of "family activity" in our home. In this case, it was meal

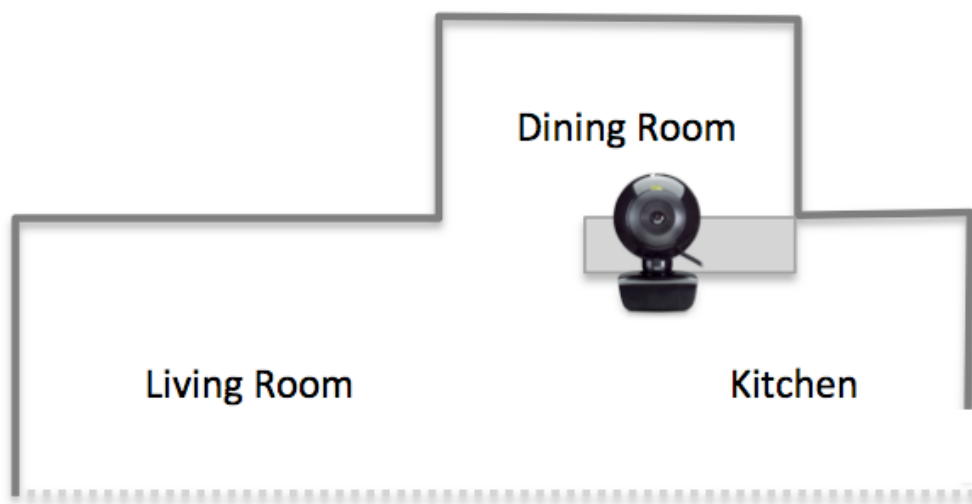


Figure 3. The Family Window's placement in my home.

times. Second, I did not yet know how we would react to having an always-on video link in our home so I wanted to restrict the space that it would capture. By pointing the camera at the dining room, it was fairly obvious when you would be captured by the Family Window and when you would not be. You simply had to enter the area around our dining room table. In this way, I purposely tried to mitigate privacy concerns that might arise.

As it turned out, this was a poor location choice for seeing us: We were rarely ever in our dining room. In fact, we were only there three times a day at best and for less than thirty minutes in each instance. Moreover, the three hour time difference meant that our breakfast occurred before my parents awoke for the day, and lunch and dinner occurred while they were both away working. Thus, the location afforded a great deal of privacy, but provided very little awareness of our life to my remote parents. However, all was not lost. This location did reveal that things other than “people” were interesting for my mother to see over the video link. In particular, she became interested in seeing the weather outside of our house, which was visible through our open blinds on the far side of the dining room. The changing nature of the blinds—either open or closed—also made it so she could know when we were awake for the day and when we had gone to bed, as we routinely opened and closed the blinds at these points in time.

Despite this, after using the Family Window for a month, we realized that my mother was having a less than ideal experience because she didn’t see us very often. We remedied this with a simple modification. Instead of having the camera face the dining room, we rotated the Family Window (and corresponding camera) towards our open kitchen. Thus, the location stayed the same, but it now faced a much more open area with a higher degree of traffic. This was not an easy decision for we recognized the effect it would have on our privacy: We would now be potentially “on camera” most of the time when we were at home and on the downstairs floor of

our house. It would also be much more difficult to know when one was *not* on camera. We decided to try it to see if we could cope.

As it turned out, the Family Window stayed this way for the remainder of our usage. We would periodically rotate it to face the living room on some occasions and then other times to face the kitchen, and in some cases, even back to the dining room. Yet predominantly, the camera faced the kitchen. Overall, this change in angle—from solely facing the dining room to facing the kitchen—had a dramatic effect on the experiences my mother had with the system.

This blog post was written by my mother the day following the change in camera angle:

“I was really happy to be able to see into your kitchen area the island, fridge etc, It was like Oh wow there they are. I saw [grandson] playing, dancing around and playing his toy guitar. It was nice to see you walking by getting things ready to head outside. Then you changed the camera area to the door way and i could see you leave the house. I could also tell when you arrived home again as I saw the diaper bag go onto the counter. Then I saw [daughter-in-law] with the baby. Later on I saw into your living room. I could see [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 entry from my mother

It is also worth noting where we did *not* place the Family Window. First, it could have easily been placed in our home office with my work desktop PC. This was in a dedicated room on our main floor. Such placement would have likely been quite similar to the dining room though, and, perhaps even worse, the Family Window would have mostly only captured me and not my wife and children. We could have also placed the Family Window on the second floor of our home, which contained all bedrooms. Yet this would certainly have compromised our privacy beyond an acceptable level.

Turning to my parents' home, we see a similar location emerge, only this time it did not see any adjustments. My mother's computer is located on a desk at the end of a living room and the Family Window was originally placed next to it because this made sense to her. In her mind, it was a computer and should be placed next to the other computer. It was also one of the few areas that contained a surface with empty space. Figure 2 shows our view of my parents' home. The layout of the home made it such that we could see my mother at her computer, which she often was when at home. We could also see the television (Figure 2, right), which was commonly turned on once my mother had returned home from work. We also saw the staircase leading in and out of their home (Figure 2, left). Thus, the location meant we saw my mother a great deal when she was at home and also could pick out various cues that signaled if my parents were at home or not. The following blog excerpt by me describes one such situation:

"Last night we were eating dinner when my parents were getting ready to head out for a Valentine's Day dinner. I showed my mom the two kids on the Family Window and she smiled and waved and seemed to really like it. Then a little while later she showed my dad and he was able to see them as well. We sat back down to dinner and a little while later I noticed them head down their staircase and leave. It was nice to know that they had gone out and done something for Valentine's Day. I also noticed a little while later that a light had come on at their place. I knew that they must be home and the time span between when they left and arrived back home was just enough to go for dinner. I guess they had decided not to go and see a hockey game after dinner. The Family Window made me feel more connected to them because I could actually see them coming and going." – Blog entry by me

The People and Their Relationships

As we used the Family Window, we also recognized that our usage was remarkably positive because of the people who were involved in the connection and the relationship we shared. Both my wife and myself had a good relationship with my parents even though they were her "in-laws." Our children also certainly had good relationships with their grandparents, as much as an infant and toddler can. My wife and I also recognized that the view into our home

was no different than what would be seen if my parents were to come and visit. Only now, they were “visiting” all the time, yet it didn’t feel this way. Instead, it was remarkably lightweight and our concern about them seeing something we didn’t want them to see was minimal. In this way, we had taken our existing routine of having my parents spend time at our home through “visiting” and extended it across distance.

In addition to these people and relationships, it was clear that the users of the system extended beyond this core group of individuals to periodically include people who did not share close relationships with either my parents or my wife and myself. First, we realized from the onset that guests would come and go from my parents’ place and this was not necessarily comforting. For example, several days prior to setting up the Family Window for the first time, I wrote this blog entry:

“[My wife] made a good point today on our drive home. I was discussing the idea of hooking up the Family Window to my mom's house and she mentioned that she wasn't concerned about my mom seeing it, but was concerned about other people (like guests, visitors, etc) seeing it. She didn't know who may happen to be at the house and privy to seeing the video link. This presents an interesting privacy challenge about knowing who is at another person's house in order to control the video feed.” – Blog entry by me

And, this situation did certainly occur (and maybe even more than we noticed). On one such instance we happened to notice a man who we didn’t recognize on the Family Window. He moved closer to it at one point and it appeared as though he was looking directly into our house. This made us feel uncomfortable so we turned our camera to face the counter. We learned later through conversations with my mother that the man was a computer repair technician who was trying to fix her computer. He happened to be close to the Family Window given its proximity to her computer; his gaze was at her computer and not us. In fact, my mother said he didn’t even

notice the Family Window was there. This brings up the additional issue that guests may not realize they are captured by the media space.

Second, we sometimes had friends visit our own home that we knew, but my parents did not. In these cases, people commonly asked about the Family Window because it was prominently visible in our kitchen. Some did not care about being captured by the camera, but others did. For example, on one occasion, my wife was hosting a “Mom’s Group” at our house. This was a collection of four moms who all had children roughly the same age as ours. The “Moms” asked about the Family Window and were somewhat apprehensive about the system once they found out its usage. To remedy this, my wife adjusted the angle that was being captured; in essence, this caused it to revert to its previous view of the dining room for the day. My blog post from the time describes this:

“[My wife] just told me that her Mom's Group was over for their weekly meeting and they asked about the [Family Window]. They wondered at first if it was a baby cam, and she explained the basic purpose of connecting with remote family. They wondered if they were being captured right now and didn't want to be. So [my wife] turned the camera to face the dining room, as opposed to the current placement of capturing part of the kitchen. They were fine with this new positioning.” – Blog entry by me

Third, we also occasionally had other family members visit our home and so did my parents. This included my sister and her family visiting my parents’ home and my wife’s family (e.g., parents, sibling) visiting our home. The difference from the previous situation is that in these cases we all knew each other and had some degree of social relationship, even if it was not strong. That is, both our sets of parents knew each other and they also knew our siblings. In these situations, I would often pre-emptively turn our camera to capture the more private area of the dining room or an inanimate object like our fruit bowl because I suspected our guests would not want to be on camera. However, to my surprise, being captured was not typically an issue

with visiting family members. I suspect this was because of the existing social ties. At times when I did turn our camera, my mother would notice this and either not worry about it, or turn her camera as well. My blog post describes one such time when my wife's sister and her boyfriend were visiting our home:

"We were in Boston for CHI two weeks ago and then we had [my sister-in-law and her boyfriend] at our house for a week. My mom didn't get to see us while we were gone and then when we had company I turned the camera back to face the dining room. I had suspected [my sister-in-law] would be pretty apprehensive about the Family Window and so I thought this would make her feel more comfortable. She wasn't as concerned as much as I thought she'd be. Her and [her boyfriend] would make comments like 'oh, your mom is back home' or 'she isn't home right now' and didn't really say anything about not wanting to be captured. Now that everyone is gone, we have turned the camera and Tablet PC back to face the kitchen. This is nice again because we can now see my mom much more easily and it is like she is a part of things again." – Blog entry by me

Overall, situations involving visitors or guests were rare, which is why they did not pose any dramatic challenges to our use of the Family Window. If they had been more frequent, the media space would not nearly have been as successful. In fact, if visitors were more regularly present at my parents' home, we likely wouldn't have felt comfortable keeping the Family Window going and our usage would have stopped. On the other hand, if we had more frequent company at our house, my parents would not have likely wanted to continue using the Family Window either. This reflects how the media space supported our existing routine of having our parents "visit" our house and, additionally, how this routine was extended to allow other people beyond our parents to visit our house *through* the Family Window and vice-versa. In the case of the former, it did not bother us because it reflected our existing routine (albeit the virtual visits were now continual and not intermittent). In the case of the latter, this was a new routine that was less than comfortable for us. The fact that situations involving other people beyond my parents were rare—and when they did occur, it was easy and lightweight to adjust what the

Family Window captured—meant that we did not concern ourselves with privacy worries very often, if at all.

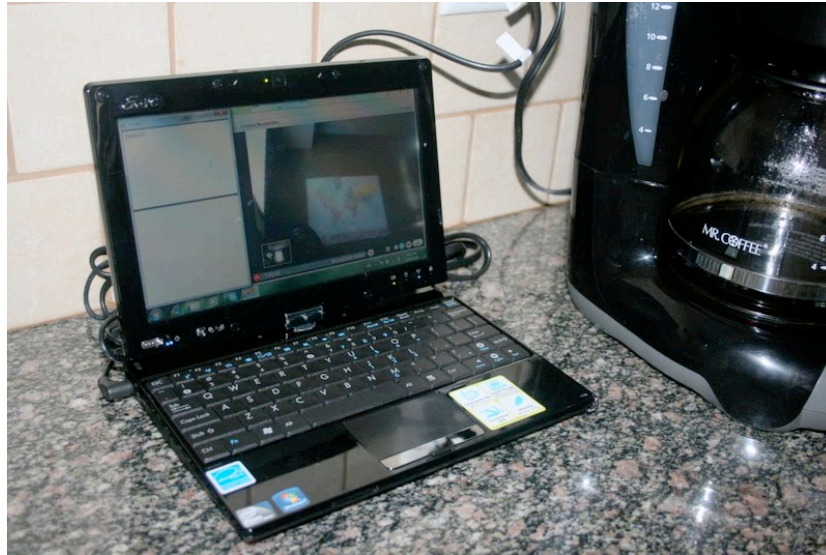


Figure 4. Honey running in our kitchen.

Connecting Home and Work

Following from our explorations of the Family Window, I was interested in understanding how I might be able to better connect with my family when I was away from home at work. To explore this, I designed a media space called Honey to connect my work office at Simon Fraser University's campus to my home. On days when I travelled in to campus to work, the media space connected me to my wife (my "honey") who stays at home with our children during the day. I designed the system so I could see my family during the day and feel more a part of their home routine when I was gone. I also hoped that they too would feel more a part of my life when I was at work. These expectations were based on our experiences with the Family Window.

Figure 4 shows Honey running on a touch-sensitive Netbook and sitting on a counter in the corner of our kitchen. An identical version sat on my office desk at work. Figure 5 shows

the user interface in more detail. It contains two main features: a chat channel (Figure 5, left) and a video link (Figure 5, right). The chat window in the top left shows the local person's text and the chat window in the bottom left shows the remote person's text. Text updates in real time as it is typed. The right side of Honey is filled with a view of the remote location and a mirror of the local view is shown in the bottom right corner. Video transmits at approximately 1-2 frames per second again. Touching or clicking the video view causes both cameras to stop broadcasting video; thus, the connection is reciprocal to make it easy to understand when your own video is broadcasting. The chat window and the Netbook (with keyboard) were purposely chosen. Following our experience with the Family Window, I wanted to understand what effect instant messaging would have on the use of a domestic media space. I also purposely built an audio link into Honey that could be turned on and off as desired; again, I wanted to try out a new feature that had not been available in the Family Window. Somewhat surprisingly, we have never found the need to use the audio link and it has remained off throughout our entire usage. Instead, the phone has again sufficed for talking with one another on an "as needed" basis.

Honey's design is certainly simple; in fact, it really does not differ in any way from what

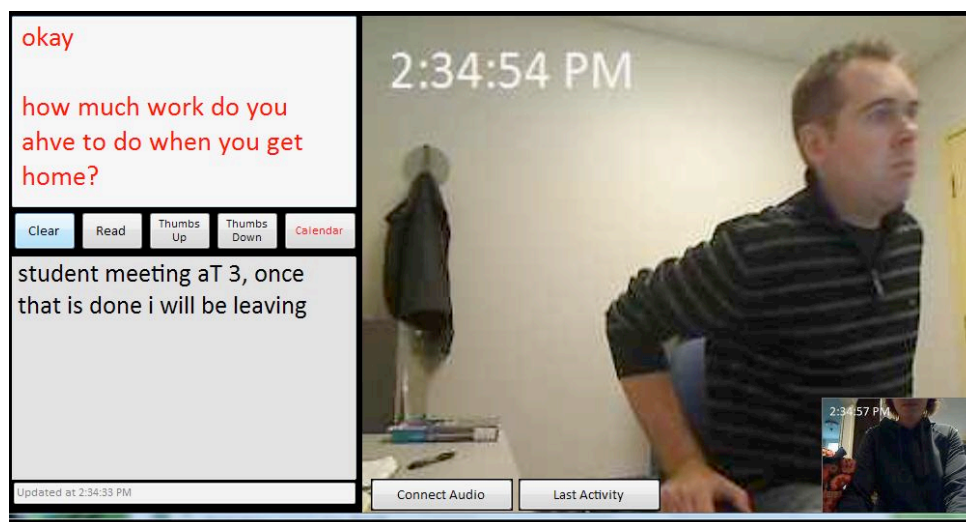


Figure 5. Honey's view into my work office.

is provided in other readily available video chat systems (e.g., Skype). However, in testing such systems, I was not able to keep the video connection open for more than several hours, which would have undermined the desire to explore an always-on video connection. Designing my own system also meant that I could log usage data and also easily add features as needed.

My family and I used Honey for approximately one year until the equipment was needed for another project. I generally worked from home 2-3 days per week and was in my office on campus the remaining days. Some days Honey was not working because of technical problems (e.g., it crashed at either end), but this can be expected with prototype technology. Again, we qualitatively recorded our experiences with the system by making entries to a private blog. These were analyzed using affinity diagramming to understand our patterns of use with the system (Holtzblatt et al., 2005). This analysis revealed the critical role that location again played and a surprising pattern of usage, micro-coordination.

Micro-Coordination

The original intention of Honey was to allow me to see my family while I was at work and vice-versa. I also expected the chat channel to be used to exchange greetings and terms of endearment, much like what was found for the messaging capabilities in the Family Window (see further studies in Judge et al., 2010). The hope was that the combination of video and chat would make us feel emotionally closer to one another and support affective communication. Yet our routines surrounding Honey quickly diverged from this. We would certainly glance at the media space to see each other and my wife and children would wave at me, but the system did not provide an emotional connection between us like the Family Window had between my family and my parents. Instead, Honey primarily became a micro-coordination tool for my wife

and I and we began to use it in place of frequent phone calls throughout the day. That is, the system directly supported our existing communication routine rather than create a new one focused on affective communication. For example, Figure 5 shows a text chat between my wife and I. My text in the bottom window is a response to a previous question asking me when I was going to be home from work. Her text in the top window is her next question that asks me how much work I have to do in the evening. The goal of the conversation for her was to find out if we could make plans that evening. Figure 6 shows a similar situation—now from my viewpoint at work—where we are discussing what to have for dinner that night.

When micro-coordinating through Honey, the primary communication channel being used was the text chat windows, as evidenced by Figures 5 and 6. Here the value was twofold. First, the text chat allowed us to have synchronous conversations if we were both in front of our Honey devices. This matched our existing routine of using conversation to coordinate, however, now we were coordinating through the text channel as opposed to voice over the phone. Second, in cases when one of us was not around (e.g., I was at a meeting, my wife was in another room), the text chat window allowed us to have asynchronous conversations and, at times, share information that did not require immediate attention. This further extended our communication

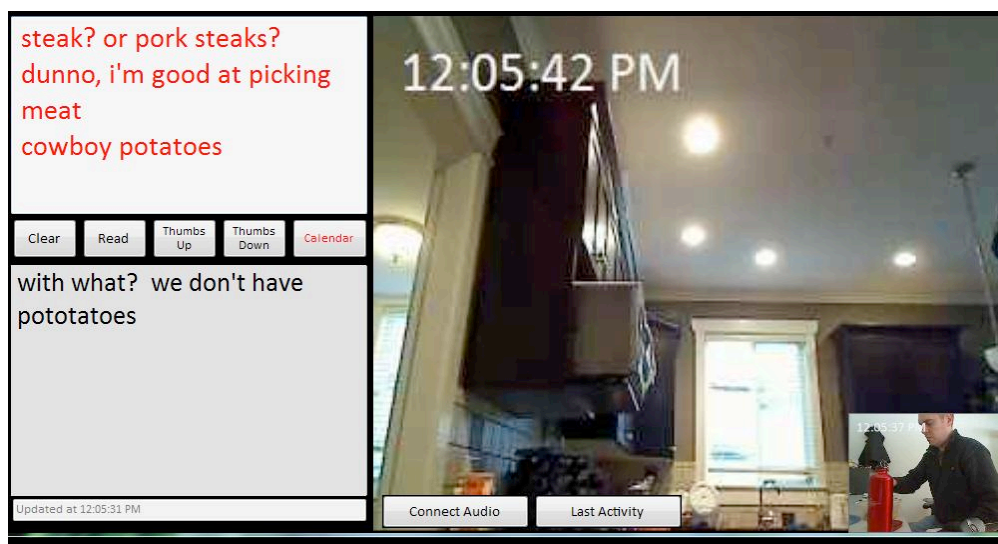


Figure 6. Honey's view into our kitchen.

routine to a new medium and interaction modality (asynchronous vs. synchronous communication). This is evidenced by the following two blog posts:

“A little later, I wrote a message to tell her that I was going to call someone to get our van in to have the brakes checked. It was nice just being able to write it down and know she'd see it at some point, it wasn't immediate so there was no rush. If I had of wanted her to know right away, I probably would have just called her on the phone. I also could have sent it to her email but I know she isn't able to easily check that with the kids during the day. I expected it would be easier for her to see Honey because she could just walk by it (as opposed to opening up her laptop).” – My blog entry

“This afternoon I left a message for [my wife] to tell her I was stopping for a doctor appointment on my way home from work. I didn't want to bug her with the phone again and it didn't seem formal enough to send via email (not sure why it seemed so "informal" though).” – My blog entry

Clearly the text chat window was important. Yet, perhaps more surprisingly, the video link was also important for coordination. When seated in my office, I could always see Honey's display out of the corner of my eye. This meant any motion in the video link would catch my attention. Thus, when my wife would walk over to Honey to chat with me, I would often see her approach and know that I should pay attention to the chat window. While seemingly simple, the importance of this was not truly realized until the video link crashed for several days, and only the text chat feature was available. On these days, I often would miss seeing my wife's messages appear as she typed them. At times, this caused breakdowns in our communication.

“The core features of the system - the video and the text box - are really what supports our activities. The other features are just icing on the cake, that we may not even use. I've noticed from the system crashing sometimes and not showing video, that really the video is really important. So is the textbox. Without either of them, the system is pointless. There is something really nice about actually seeing home. It helps me feel like there is actually someone there. It also helps me see when someone wrote something because I see movement in front of the screen.” – My Blog entry

Once I realized that our routine was heavily focused on micro-coordination with Honey, I added several features to it that I thought might further aid our routine. This involved adding a

series of buttons in the middle of the chat windows (Figure 6, left) that would provide additional functionality. The button labeled “Read” turned the text black so the remote person knew the message was read. The “Thumbs Up” button turned the text green to acknowledge positive acceptance of a message and the “Thumbs Down” button turned the text red to illustrate disapproval of the message. The hope was that these buttons would remove the need to type certain text phrases like, “Okay,” “I agree,” “No, that won’t work,” etc. The “Calendar” button made a window appear that displayed my work calendar; the goal was to provide more coordination information automatically. We used these new features for a couple of days after their addition; however, beyond this they were rarely ever used. In fact, the calendar hasn’t been loaded since the week of its addition. Instead, the chat channel and video window in their initial form sufficed and we preferred to micro-coordinate through our own messages.

Location, Yet Again

I knew from our experiences with the Family Window that Honey should be placed within our kitchen if I was going to be able to see my family periodically throughout the day. Within the kitchen, the specific location was chosen more for pragmatic reasons than anything: I needed to find an empty counter space that was also near a power outlet. This caused Honey to be placed near the back corner of the kitchen with a view of about half of the room (we had moved since our Family Window usage so the home layout was different). This turned out to be sufficient for me while at work and Honey has never moved in our home. The greater challenge was locating Honey at work, and, through this, we learned a great deal about who could or could not see into our home, and vice-versa.

At work, I initially placed Honey next to my computer display on my desk. In this location, I could easily see home while I worked at my computer and my family could see me

working. Yet two main issues emerged in relation to this location. First, other people at work were susceptible to being (accidentally) caught on camera beyond just me. Naturally, because I am a professor, students often meet with me in my office and occasionally so do other faculty or administrative staff. There is also a glass door on my office, so I can see out into the hallway. As it turned out, so could my wife from home, but only when I was not sitting in my office chair. When I was sitting down, I blocked the camera's view into the hallway. My wife commented on one such situation when I was away at a meeting and left the camera running:

“privacy issues - perhaps a sign on your door? I saw some people in hall talking and i doubt they knew they were being recorded - students too should know.” – Message left on Honey by my wife

My first reaction to circumventing such situations was to turn off the camera when 1) people visited my office and 2) when I left my office. This worked some of the time, but for the most part, it was hard to remember to do this because the technology was so engrained in my routine that I forgot about it even being there. Instead, to make it so it didn't matter if I remembered or not, I virtually split my office in two: One side would be captured by the camera and one side would not be. This involved angling the camera to only capture half my office and also reconfiguring my furniture. My desk was placed in the “capture” side of the office and the guest chair and table were placed in the “non-capture” side. The door to my office and view into the hall also strategically fell in the “non-capture” side. These changes made it so it was unlikely that visitors and hallway passersby would be captured by Honey. Throughout the remainder of our usage, this sufficed. I still routinely told people (when I remembered) that I had a camera capturing part of my office and most were interested and not bothered (that they said). I also informed them that they were nearly always out of view of the camera.

Second, and even more difficult to contend with, was having people inadvertently see into my home (through Honey). As it turns out, it was harder to locate Honey's display so that it wasn't visible from the guest area of my office or from the hallway than it was to adjust the camera's capturing angle so visitors weren't being captured. Here the risk was that visitors or passersby might notice Honey and then be able to see into my home (even while not being captured by the camera). In the mornings, this may include seeing my family members dressed in pajamas, with messy hair, etc. In the afternoons, this might include seeing my wife cooking lunch or tending to my children. Here the nature of the activities and my family members' appearances are not that sensitive, yet the situation is still undesirable.

In order to try and circumvent this, I used objects in my office to block the view of Honey's display from certain areas. For example, I adjusted the distance of my computer monitor from the wall such that the monitor blocked the view of Honey's display from my glass office door. I also used angles again as a tool for privacy regulation. Honey's display was angled such that people sitting in or standing near my visitor's chair could only see it at a poor angle (e.g., looking at its side and not straight on). This made it mostly unintelligible and overly dark. The display was also relatively small; it was only 10 inches across the diagonal, which meant that you needed to be relatively close to understand what was shown on the display.

The above configurations and adjustments were easy and lightweight to do and they changed every now and then because of this. Yet, more interesting perhaps, is the fact that *I* had to do this from my office. It was not possible for my wife to make the adjustments from home. Instead, I had to infer her privacy expectations and make adjustments. And, even more challenging than this, was recognizing the situations that needed adjustments. As mentioned, my usage of Honey became so routine that I didn't often notice it was there.

Despite the challenges of locating Honey within my work office, our usage of Honey was largely successful, especially given the large reward we saw from its ability to help us micro-coordinate. This benefit certainly outweighed any privacy threats we faced.

Discussion and Conclusions

In this article, I have described the design of two domestic media spaces, the Family Window and Honey, along with my family's yearlong usage of both systems. Each has changed the way I think about communication between family members and the benefits of opening up our homes, even when privacy challenges might seem insurmountable. I have focused on describing the factors that have made our usage largely successful, despite challenges with privacy. This brings several important issues to the surface.

First, our understanding of how we wanted to use the systems was not immediately apparent. We also evolved our usage until we reached a routine that "fit" with what we needed the systems for. In both cases, this was different than what we had anticipated. We began our usage of the Family Window with the intent that we would share a part of our life with my parents; basically, we would share whatever happened in our dining room. From their end, they had little anticipation as to what the system might afford them, having never used anything like it before. Our practices evolved to the point where we shared much more than just a single room. The Family Window became a tool for sharing many aspects of our everyday family routine. This eventual usage was akin to what my parents would see and participate in if they were visiting us in person; thus, our usage of the Family Window essentially created continual *virtual* visits by my parents, and vice-versa. It was through this "shared living" that the relationships that my family and I shared with my remote parents strengthened. The emotional connection we

had with my parents increased as a result of them being able to see us and our activities on a daily basis, as well as us being able to see this of them.

With Honey, we anticipated a usage similar to that of the Family Window. But we were wrong again. The needs of my wife and I to micro-coordinate our daily activities superseded the need to emotionally connect through a media space while I was at work. There is no reason why the media space could not have connected us more emotionally, and indeed it did some of the time, yet our lifestyle did not necessarily need this first and foremost. It needed micro-coordination. One might suggest this need is particular to our family or those with young children. However, prior research on family calendaring has shown that most families with children, be it pre-school-aged, school-aged, or teenagers, have detailed (and important) routines for coordinating individual and family activities (Neustaedter, 2007, Neustaedter et al., 2009). This suggests that our media space usage is likely similar to what other families might experience.

For the most part, both systems were designed in a simple fashion. And, their core features—always-on video for the Family Window, and always-on video plus text chat for Honey—were not constraining in their presentation or design. A person could conceivably use these features for a multitude of purposes and with only a small act of resituating the location of the system, it could afford a new set of practices. Thus, it is through this design flexibility that I believe our use of the systems was successful for such a long period of time. The systems allowed us to start from an assumption about our usage, evolve our routine to what made sense, and then continue our pattern of use over an extended period of time. In the case of both systems, some aspects of our usage reflected our existing routines, but some aspects also extended these routines in new ways. When the routine was extended too far—to allow non-

family members to be virtual visitors in our home (by seeing in over the video link)—privacy challenges emerged.

Second, we see an important understanding about privacy control emerge. Many researchers have said that users of media spaces require mechanisms to allow them to be in control of what is captured and what others can see (Gaver et al., 1992, Bellotti and Sellen, 1992, Bellotti, 1993, Boyle et al., 2009). We also have been told that these controls should be lightweight and fine grained (Boyle et al., 2009). Our findings resonate with this. Yet we didn't find that software controls like video obfuscation (e.g., video blurring) mattered. This is despite a wide variety of such filters being explored in the workplace media space literature (e.g., Coutaz et al., 1998, Hudson and Smith, 1996, Boyle et al., 2000, Neustaedter and Greenberg, 2003, Neustaedter et al., 2006). We also didn't find that physical controls (e.g., touching buttons to turn on/off) were that important (as proposed by Neustaedter and Greenberg, 2003 and seen in Lee et al., 1997, and Jancke et al., 2001). Instead, the most important aspect was the camera's angle (for both the Family Window and Honey) and the display's positioning (for Honey). Adjusting these were relatively simple, and certainly lightweight; however, knowing when and how to do so was much more difficult. It was most definitely through these lightweight mechanisms that my family and I felt confident in our ability to control our privacy while benefitting from the media spaces. Yet there was a learning curve and it took time to realize how to regulate our privacy.

The findings reported in this article certainly relate specifically to my own experiences and that of my family. Not all families will be as comfortable with always-on video as we were. However, it is reasonable to expect that some will, given the "right" locations and "right" relationships. For these situations, we now have a better understanding that the use of a media

space in the home will vary and that the specific practices it affords should be left for family members to decide upon for themselves. What is most important is that the design affords a variety of behaviors and uses. We also have a better understanding of privacy and the importance of the camera and display in regulating it. Lightweight controls for regulating privacy are essential, and I would argue there is nothing simpler or more obvious than moving the device doing the capture, along with the device doing the display.

I hope that others will continue to explore media spaces in the home to understand the many additional ways in which they might be utilized.

References

- Ames, M., Go, J., Kaye, J., Spasojevic, M., Making Love in the Network Closet: The Benefits and Work of Family Videochat, Proc. CSCW, ACM Press (2010), 145-154.
- Bellotti, V. Design for Privacy in Multimedia Computing and Communications Environments, Technology and Privacy, Agre and Rotenberg eds., MIT Press (1998), 63-98.
- Bellotti, V., and Sellen, A. Design for Privacy in Ubiquitous Computing Environments, Proc. ECSCW, Kluwer Academic Publishers (2003), 77-92.
- Bly, S., Harrison, S. and Irvin, S. Media spaces: Bringing people together in a video, audio, and computing environment, Communications of the ACM 36(1), ACM Press (1993), 28-46.
- Boehner, K., Sengers, P., and Warner, S., Interfaces with the ineffable: Meeting aesthetic experience on its own terms, Transactions on Computer-Human Interaction, 15(3), ACM Press (2008).
- Boyle, M., Edwards, C. and Greenberg, S. The Effects of Filtered Video on Awareness and Privacy, Proc. CSCW, ACM Press (2000).
- Boyle, M., Neustaedter, C. and Greenberg, S. Privacy Factors in Video-based Media Spaces, Media Space: 20+ Years of Mediated Life, Springer (2009).
- Buxton, W. Sketching User Experiences : Getting the Design Right and the Right Design, Morgan Kaufmann (2007).
- Conversy, S., Mackay, W., Beaudouin-Lafon, M., and Roussel, N. VideoProbe: Sharing Pictures of Everyday Life, Proc. IHM, ACM Press (2003).
- Coutaz, J., Bérard, F., Carraux, E., Crowley, J. Early experience with the mediaspace CoMedi, IFIP Working Conference on Engineering for Human-Computer Interaction (EHCI), (1998).

Dourish, P. Culture and Control in a Media Space, Proc. ECSCW '93, Springer (1993), 125-137.

Dourish, P., Adler, A., Bellotti, V., and Henderson, A. Your Place or Mine ? Learning from Long-Term Use of Audio-Video Communication, Journal of CSCW, 5(1), Kluwer Academic Publishers (1996).

Dourish, P., and Bly, S. Portholes : Supporting Awareness in a Distributed Work Group, Proc. CHI, ACM Press (1992), 541-547.

Erickson, T., The design and long-term use of a personal electronic notebook, Proc. CHI, ACM Press (1996).

Fish, R., Kraut, R., and Chalfonte, B. The VideoWindow System in Informal Communications, Proc. CSCW, ACM Press (1990).

Fish, R., Kraut, R., Root, R., and Rice, R. Video as a Technology for Informal Communication, Communications of the ACM, 36(1), ACM Press (1990), 48-61.

Gaver, W. The Video Window: My Life with a Ludic System, Media Space: 20+ Years of Mediated Life, Springer (2009).

Gaver, W., Moran, T., MacLean, A., Lovstrand, L, Dourish, P., Carter, K., and Buxton W. Realizing a Video Environment : EuroPARC's RAVE System, Proc. CHI, ACM Press (1992), 27-35.

Greenberg, S. and Neustaedter, C. Shared Living, Experiences, and Intimacy over Video Chat in Long Distance Relationships, Research Report 2011-005-17, Department of Computer Science, University of Calgary, Calgary, Canada, July (2010).

Greenberg, S. and Rounding, M. The Notification Collage: Posting Information to Public and Personal Displays, Proc. CHI, ACM Press (2001).

Harrison, S. Media Space: 20+ Years of Mediated Life, Springer (2009).

- Hindus, D, Mainwaring, S.D., Leduc, N., Hagström, A.E., and Bayley, O. Casablanca: Designing Social Communication Devices for the Home, Proc. CHI 2001, ACM Press (2001), 325-332.
- Holtzblatt, K., Wendell, J., and Wood, S. Contextual Design, Elsevier/Morgan Kaufmann (2005).
- Hudson, S. E. and Smith, I. Techniques for addressing fundamental privacy and disruption tradeoffs in awareness support systems, Proc CSCW 96, ACM Press (1996), 248-257.
- Hutchinson, H., Mackay, W., Westerlund, B., Bederson, B., Druin, A., Plaisant, C., Beaudouin-Lafon, M., Conversy, S., Evans, H., Hansen, H., Rouseel, N., Eiderback, B., Lindquist, S., and Sundblad, Y. Technology Probes: Inspiring Design for and with Families, Proc. CHI, ACM Press (2003), 17-25.
- Jancke, G., Venolia, G.D., Grudin, J., Cadiz, JJ., and Gupta, A. Linking Public Spaces: Technical and Social Issues, Proc. CHI, ACM Press (2001), 530-537.
- Judge, T.K. and Neustaedter, C., Sharing Conversation and Sharing Life: Video Conferencing in the Home. Proc. CHI, ACM Press (2010), 655-658
- Judge, T.K., Neustaedter, C. and Kurtz, A., The Family Window: The Design and Evaluation of a Domestic Media Space. Proc. CHI, ACM Press (2010).
- Judge, T.K., Neustaedter, C., Harrison, S., and Blose, A., The Family Portals: Connecting Families Through a Multifamily Media Space. Proc. CHI, ACM Press (2011).
- Kirk, D., Sellen, A., and Cao, X., Home Video Communication, Proc. CSCW, ACM Press (2010).
- Kraut, R., Egido, C., and Galegher, J. Patterns of contact and communication in scientific observation, Proc. CSCW, ACM Press (1988), 1-12.

- Kim, H., Gutwin, C., and Subramanian, S. The Magic Window: Lessons From a Year in the Life of a Co-Present Media Space, *Proc. Group*, ACM Press (2007), 107-116.
- Lee, A., Girgensohn, A., Schlueter, K. NYNEX Portholes: Initial User Reactions and Redesign Implications, *Proc. Group*, ACM Press (1997), 385-394.
- Lipartito, K. Picturephone and the Information Age, (2003), 50-81.
- Mantei, M., Baecker, R., Sellen, A., Buxton, W., Milligan, T., and Wellman, B. Experiences in the use of a media space, *Proc. CHI*, ACM Press (1991), 203-208.
- McEwan, G. and Greenberg, S. Supporting Social Worlds with the Community Bar, *Proc. Group*, ACM Press (2005).
- Noll, A. Anatomy of a failure: picturephone revisited, *Telecommunications Policy* (2002).
- Neustaedter, C. Domestic Awareness and the Role of Family Calendars, PhD Dissertation, University of Calgary, Calgary, Canada, January (2007).
- Neustaedter, C., Brush, A.J., and Greenberg, S. The Calendar is Crucial: Coordination and Awareness Through the Family Calendar, *Transactions on Computer-Human Interaction*, ACM Press (2009).
- Neustaedter, C., Elliot, K., and Greenberg, S. Interpersonal Awareness in the Domestic Realm, *Proc. OzCHI*, ACM Press (2006).
- Neustaedter, C. and Greenberg, S. The Design of a Context-Aware Home Media Space for Balancing Privacy and Awareness, *Proc. UbiComp*, Springer-Verlag (2003).
- Neustaedter, C., Greenberg, S., and Boyle, M. Blur Filtration Fails to Preserve Privacy for Home-Based Video Conferencing, *Transactions on Computer-Human Interaction*, ACM Press (2006).

- Neustaedter, C. and Judge, T. Peek-A-Boo: The Design of a Mobile Family Media Space, Video Proc. of Ubicomp, Springer (2010).
- Neustaedter, C., Judge, T., Kurtz, A., and Fedorovskaya, E. The Family Window : Connecting Families over Distance with a Domestic Media Space, Video Proc. CSCW, ACM Press (2010).
- Raffle, H., Ballagas, R., Revelle, G., Horii, H., Follmer, S., Go, J., Reardon, E., Mori, K., Kaye, J., and Spasojevic, M. Family story play: reading with children, Proc. CHI, ACM Press (2010).
- Raffle, H., Revelle, G., Mori, K., Ballagas, R., Buza, K., Horii, H., Kaye, J., Cook, K., Freed, N., Go, J., Spasojevic, M. Hello, Is Grandma There? StoryVisit: Family Video Chat and Connected E-Books, Proc. CHI, ACM Press (2011).
- Roussel, N. From Analog to Digital, from the Office to the Living Room: Why I Happily Worked in a Media Space but Don't Live in One, Media Space: 20+ Years of Mediated Life, Springer (2009).
- Sengers, P. Autobiographical Design, CHI 2006 Workshop on Theory and Method for Experience-Centered Design, April 2006.
- Tang, J., Isaacs, E., and Rua, M. Supporting Distributed Groups with a Montage of Lightweight Interactions, Proc. CSCW, ACM Press (1994), 23-34.
- Tang, J., and Minneman, S. VideoDraw: A Video Interface for Collaborative Drawing, Proc. CHI 1990, ACM Press (1990).
- Tang, J., and Minneman, S. VideoWhiteboard: Video Shadows to Support Remote Collaboration, Proc. CHI 1991, ACM Press (1991).

- Tee, K., Brush, A.J., and Inkpen, K. Exploring Communication and Sharing Between Extended Families, *International Journal of Human-Computer Studies*, 67(2), (2009).
- Voida, A., Voida, S., Greenberg, S., and He, H. Assymetry in Media Spaces, *Proc. CSCW*, ACM Press (2008).
- Whittaker, S., Frohlich, D., and Daly-Jones, O. Informal workplace communication: What is it like and how might we support it? *Proc. CHI*, ACM Press (1994), 131-137.
- Yarosh, S., Cuzzort, S., Mueller, H., and Abowd, G.D. (2009) Developing a Media Space for Remote Synchronous Parent-Child Interaction. *Proc. of IDC*, ACM Press (2009), 97-105.
- Yarosh, S., Inkpen, K.M., and Brush, A.J. Video Playdate: Toward Free Play across Distance. *Proc. CHI*, ACM Press (2010), 1251-1260