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SAUL GREENBERG, CARMAN NEUSTAEDTER, KATHRYN ELLIOT

AWARENESS IN THE HOME

The nuances of relationships, domestic coordination and communication

1. INTRODUCTION

Computing has changed dramatically over the last decade. While some changes arose from technological advances, the most profound effects are in *how* technologies are used by everyday people for activities other than task-oriented work. Computers are now central to new ways of engaging in play, interpersonal and small group communication, community interaction, entertainment, personal creativity dissemination, personal publication and so on. We are particularly interested in *domestic computing*, where technology mediates how families and other inhabitants interact within the context of the home. While domestic computing can incorporate many things, we focus in this chapter on the role awareness plays in domestic coordination and communication.

As we will see, the home has its own special attributes. The behaviours, actions and interactions of people within the home are quite different than its workplace counterparts (e.g., see [27] for awareness in the workspace). The opportunities to 'improve' home life via technology intervention are also murkier. The home is a well-oiled machine, where people have developed many social practices that enable fluid and flexible interactions and coordination. Because it works so well, it is not always obvious if and how technology can be designed to improve how people go about their daily home life.

In this context, we need to understand the key role that awareness plays in the home. Similar to the work settings described in other chapters in this book, we believe that awareness is the 'glue' that makes home life work. Yet awareness in the home is very different from awareness at work. This chapter explains some of these differences by summarizing and reflecting on our current understanding of awareness in the home. Our explanation is formed from the combination of existing theories, other people's studies of domestic culture, lessons learned from technology design, and our own semi-structured contextual interviews of 10 households (see [8,19,6,16] for methodological details).

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We begin by defining *interpersonal awareness* (Section 2), which considers the spectrum of relationships that people have with others both within and outside the home. Specifically, interpersonal awareness is defined as the awareness information and mechanisms necessary to satisfy people's real need and desire to know about each other [19,16]. As we will see, differing relationships implies different needs for interpersonal awareness. We then focus on communication information in the home (Section 3), where we explicate how *contextual locations* mediates this communication (Section 4) through the interplay of *time, ownership* and *awareness* (Section 5) [8,6].

2. INTERPERSONAL AWARENESS

Home inhabitants naturally maintain some semblance of awareness of their family members and friends [15,25,1]. For example, parents often need to be aware of their children's extra-curricular schedules to coordinate rides, or a spouse may plan dinner depending on when their partner may be home [19]. We also know that this awareness extends beyond immediate home members to include others such as friends and the extended family [10,15]. Friends may want to know about another's schedule to plan a night out. Families need to know the well-being of an elderly parent who lives elsewhere [15].

We use the term *awareness* here as this is how prior work studying domestic culture has characterized the types of knowledge we have just described. However, awareness is a widely used (and sometimes considered overused) term that encompasses many different situations [22]. We have further classified awareness in the domestic realm as *interpersonal awareness* because the existing research shows that awareness in the domestic realm is focused on existing interpersonal relationships between people. The means by which these relationships are formed and maintained is described in detail in the disciplines of sociology and social psychology (e.g., [23]).

Our interest lies in understanding how interpersonal awareness is acquired and used between individuals with established relationships, where all have a real need and desire to know about each other. As we will see, awareness cannot be described as a single generic entity. It must consider the people involved, their relationships, and whether they live together. We previously described such a model of interpersonal awareness [19,16], and this forms our basis for how we think about the interpersonal awareness space in domestic environments. In the next sub-section, we outline the spectrum of people within one's social network for whom interpersonal awareness is desired. Subsequently, we describe the information that is maintained and its uses across this spectrum, and the techniques people use to maintain the awareness. Illustrative examples are drawn from our own contextual studies.

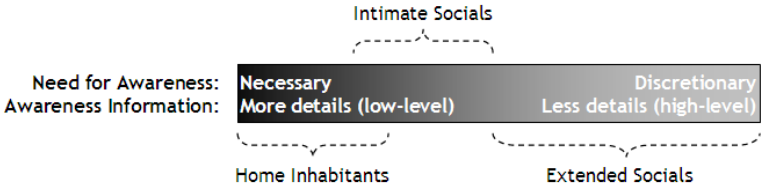

Figure 1. *The range of awareness needs for three social clusters.*

2.1 Social groupings for awareness

Our model explicates three groups of social contacts in the domestic setting: *home inhabitants*, *intimate socials*, and *extended socials*. These three groups are best viewed as broad clusters defining a spectrum of relationships *vs.* strictly bounded groups. Figure 1 provides a preview of results to come. We now describe each group in detail. Here we tend to use the words need and desire interchangeably. This is because we have found that, as it relates to interpersonal awareness, desires often strongly relate to what one perceives to be needs.

2.1.1 Home inhabitants

Home inhabitants contain those people with whom one lives: significant others, family members, and roommates (Figure 1, left end of spectrum). The number of home inhabitants will naturally vary based on the household, though commonly this ranges from one to six people. Almost all participants in our contextual study – which primarily contained families and roommates who were close friends – said they had a strong need to maintain a daily awareness of their home inhabitants.

2.1.2 Intimate socials

Intimate socials contain those people with whom one has a close personal relationship, but does not live with. This group generally consists of from one to six people. People still have a strong desire for awareness of those in this group (Figure 1, middle of spectrum). For example, one of our participants maintained a close relationship with her mother, desiring awareness on a weekly basis. Other example intimate socials reported by our participants included significant others that they were not living with, immediate family members (e.g., parents, siblings), and close friends; only a few reported work colleagues as fitting this category. Other studies also found that people typically have a strong need for awareness of elderly parents [15] along with children who have recently moved away from "home" [25].

While proximity is important for determining who is an intimate social, it is not the only dominant factor. About two-thirds of our participants had intimate socials

in the same city as they lived. About half had people from a different city but within the country, and about one quarter had people from a different and far-away country.

Most participants said their main reason for desiring an awareness of intimate socials was because s/he was close to them as s/he was considered family. A strong need to maintain awareness of an intimate social does not necessarily imply a frequent need. While nearly all participants had intimate socials for whom they desire a near-daily awareness, over one-third of the participants had intimate socials for whom they desired only weekly awareness. Thus, we emphasize that it is not the frequency of awareness that defines an intimate social, but the strength of a person's need for that awareness.

2.1.3 Extended socials

Extended socials also contain the family and friends of interest to a particular person. However, the relationship is much more casual and the desire for awareness is more discretionary (Figure 1, right end of spectrum). All our participants had friends who were extended socials. About two-thirds had co-workers/teachers, two-fifths had siblings, and about two-thirds had other relatives. Most participants had fewer than twenty extended socials, though some had much larger groups. We found that the frequency of desired awareness is highly dependent on the individual. We also found that people share their more significant life changes instead of smaller details with extended socials (specific instances of this are described in the next section). While nearly all participants wanted more frequent awareness of their extended socials, they found it difficult to maintain because of scheduling difficulties, distance separation, or the time limitations. This suggests that a natural tradeoff exists between acquiring an awareness of more individuals *vs.* distractions, interruptions, and feelings of information overload; people may not actually want an awareness of more people in practice.

2.2 Interpersonal Awareness Information

We found the interpersonal awareness information that people like to maintain for their family and friends generalizes to knowledge of one's context at varying levels of detail depending on the individual and her interpersonal relations. People want to know this information in order to coordinate, promote feelings of connectedness or comfort, or simply to have shared personal knowledge. This information typically falls into three interrelated categories: location, activity, and status. These categories largely parallel existing definitions of context [5], yet they contain subtleties specific to interpersonal awareness and, most important, they differ between our three social groups.

2.2.1 Awareness of Location

Imagine asking a family member or friend the question, "where are you going?" You would likely expect different answers depending on who you asked just like you would share different information based on who asked you. This is precisely

what we found. For home inhabitants, people want to know detailed location information: day-to-day or sometimes even moment-to-moment knowledge of the specific whereabouts of a cohabitant along with an understanding of where one plans to be. For example, one working mother from our study liked to know if her teenage son was at a friend's house after school or if he had gone straight home providing her with a feeling of comfort. Sometimes only a general understanding of locations is needed: for another mother in our study, knowing that someone has gone out to run errands, but not necessarily knowing which errands, is enough information. This kind of knowledge helps them coordinate household plans like dinner times. For many people, location information translates into knowing one's presence at a particular location [25]. For example, a married couple with no children in our study both liked to know that the other is somewhere in their home simply because the knowledge is comforting.

For intimate socials, people want similar location details but at a lesser level of detail, typically daily or every few days, and often this awareness is of past locations or upcoming ones. For a teenaged person in our study, this meant knowing what her close friends had planned for the weekend so she could coordinate activities with them. Adult children may desire to know whether their elderly parents are at home, have left home, or, in serious cases, are at the hospital [15], again creating comfort.

For extended socials, people want to know even less details about location or may not even care about one's location except in special circumstances. Normally this involves knowing what city or area an extended social resides in or their location of work. For example, one participant told us she was often curious to know where her extended socials currently work.

2.2.2 Awareness of Activity

Now imagine asking a social contact, "what are you doing?" Again, you'd expect a variety of answers depending on the person and their relationship to you. For home inhabitants, people want to know about their daily activities along with their upcoming plans. This includes knowing specifics about one's schedule of work/school and social activities. Work details generally include knowing the days and times that one is working, rather than knowledge of work appointments and meetings. For example, one wife liked to know what specific projects her husband was working on (though not the fine details of the projects) and what days he had to work. Social activities typically include knowing the activity's day/time, the type of activity (e.g., watching a movie at the theatre, visiting a friend) and the other people involved in it (e.g., which friends *vs.* just strangers). As one would expect, we found parents were typically much more aware of the activities of younger children, and less so for older teenagers. Households must coordinate their day-to-day plans [14] and it is often necessary for cohabitants to schedule their activities and events based on the activities of each other. For example, two parents of children aged 14 and 16, commented that they need to know their children's schedules in order to coordinate rides to various activities. Other researchers report similar findings [1,18].

For intimate socials, people want details about past or upcoming social or work activities, rather than knowledge of current activities. For example, a mother from

our study wanted to know what her girlfriends had been up to last week and if anything "major" happened at her job simply to maintain a level of shared personal knowledge. Intimate socials also use activity awareness to coordinate but to a lesser extent than home inhabitants. For example, two teenagers in our study wanted to know the availability of their friends, so they can "hang-out" with them. Detailed current knowledge of the availability of one's intimate socials was generally only desired by teenagers or significant others who did not live together, e.g., fiancés, girl/boyfriends. In the case of one graduate student living at his parents' home, awareness of his fiancée was much more like awareness of his cohabitants because of the close relationship with her.

For extended socials, people want to know activity information at an even higher level still. This typically equates to knowing major events or life changes, e.g., changing jobs, moving to a different city, getting married, having children. Awareness of activities of extended socials most often provides feelings of connectedness or comfort. For example, in the case of an aging elderly parent, knowing she is active can provide a sense of comfort that she has not fallen or is sick in bed [15]. Activity awareness was generally only used by extended socials for coordination at a macro level, e.g., planning visits or holidays to see these people.

2.2.3 Awareness of Status

Now imagine asking a social contact, "How are you doing?" The answers would again vary where we have found they will often relate to one's location or activity as people almost always have feelings or attitudes associated with events or situations in their lives. For home inhabitants, status involves knowing how one feels about most aspects of their lives in addition to knowing how healthy one is and knowing about personal relationships (e.g., who is dating whom). Parents have a strong desire to make sure that things are going well for their children and, as providers, to ensure they have what they need. One mother in our study was concerned daily about how her children are feeling because she wanted to provide emotional support when needed. Often this will involve knowing how they are feeling about school, such as whether a test result went well or if they are feeling overwhelmed with homework. Significant others share similar information about their lives, which can also make them feel more connected to one another [9].

For intimate socials, the same status information is desired but typically about only a selection of activities or health information. This often equates to knowledge about a shared interest or outing, a particular relationship, or a health problem. For example, a daughter recently moved out of town to go to college. The daughter and mother talk on the phone at least once a week and often their discussions will surround the daughter's latest boyfriend. A married couple was often quite concerned about the health and well-being of one of their parents who recently suffered a stroke. They try to talk to her every few days to ensure she is still feeling fine where this knowledge is used to monitor and assist.

For extended socials, most people primarily want to know status information about health changes. Extended socials are much less intimate and feelings are not typically shared, at least not in great detail. In some cases, knowledge of status can

even translate into a lack of comfort or worry if "bad news" is found out about a social contact, e.g., a relative is ill.

2.3 Techniques for Maintaining Awareness

The third aspect of interpersonal awareness that we describe is *techniques for maintaining awareness:* the methods people use to acquire and maintain interpersonal awareness. We found that interpersonal awareness is typically maintained using one or more of the following techniques: *visual cues from domestic artifacts,* and *direct* or *mediated interaction.* These techniques are not hierarchical in nature; rather, each technique offers contexts for which it is particularly well suited and each comes with its own limitations.

2.3.1 Visual Cues from Domestic Artifacts

Households are displays where people leave imprints of their lives and activities throughout the home [12,24]. Here home inhabitants receive awareness information from the presence or absence of particular domestic artifacts from routine locations [8]. Often these cues are noticed as background activities requiring little thought or active attention. For example, a college student living at home explained to us how when arriving home he would automatically check, without much thought, whose cars were at home as he entered the garage. This information led him to quickly understand which family members were around. His father similarly commented that he could tell if his sons had gone out mountain biking (a common activity) by peering into the garage to see if the bicycles were gone. Other participants we interviewed used similar strategies with items like keys or wallets left in routine locations. Related research has pointed out that the *status* of domestic artifacts also provides *location* awareness. For example, the status of a light (on/off) can often indicate the presence and location of household members: if the light is on, likely someone is in that room [25]. Naturally, inference errors can occur when gathering awareness through these types of visual cues, yet despite this, people still rely heavily on cues presented by domestic artifacts for maintaining awareness of home inhabitants. Further depth analysis of the use of domestic artifacts for awareness is described later in this chapter.

2.3.2 Direct and Mediated Interaction

When people are co-located with their social contacts in and around the home, they naturally converse and share awareness information through face-to-face interaction [12,25]. Simple conversations as people go about their home activities can provide awareness. For example, many of the mothers we interviewed talked about checking the family calendar in the evening or morning and then discussing its contents with family members to bring people 'up to date' on family activities. Significant others have even been found to streamline their conversations to develop short-hand interactions involving brief instructions, which are generally only understood by family members [14].

The use of face-to-face interaction declines for intimate socials as they are not collocated as often as home inhabitants. Face-to-face interactions with intimate socials typically occur during social outings or shared activities. While people are together, like home inhabitants, they will discuss their activities which in turn provides an awareness and shared understanding.

Extended socials often have few opportunities for awareness gathering through face-to-face interaction because they are seen on a much less frequent basis, (e.g. visits to far away family). We did find though that face-to-face communication allowed people to learn indirectly about extended socials. For example, children may learn about the health of a grandparent by talking with their mother after she has visited the grandparent. There are, of course, exceptions to these general cases: sometimes contacts are seen frequently, yet few details are shared because of the nature of the relationship (e.g., carpools).

Mediated interaction is vital for providing social contacts with awareness information when they are not collocated. Even in the case of home inhabitants, they are not always home at the same time (e.g., someone is at work) making it impossible to gather awareness through face-to-face interaction. In this case of *time separation*, mediated interaction is crucial. Nearly all participants from our study used some form of handwritten notes to provide awareness information for their home inhabitants, most often because it was very simple to do. Here individuals write a note to a cohabitant or the entire household using media like sticky notes, message pads, scraps of paper, the family calendar, or whiteboards [8]. The most crucial aspect of leaving notes that we found was the *location* of the note itself. Households typically have well established routines for locations [4] where they can help determine who a note is for [8]. For example, one mother described a situation where she wanted her teenage son to see an important note when he arrived home from school. She stuck it on the television because she knew that watching TV was one of the first things he did when arriving home. We will return the role of locations and routines later in this chapter.

Technologies like telephones, email, and instant messaging (IM) are used by individuals to maintain an awareness of their social contacts, this time for all social groupings. Here mediated interaction is used to overcome challenges of *distance separation*. We found people almost always choose the technology that is both easy for them to use and likely to reach their social contacts. Telephones and mobile phones were convenient for reaching contacts at work or while mobile. Information would be exchanged much like in face-to-face situations. We found that middle-aged adults favor the telephone because new technologies seem “foreign” or daunting to them. Yet many found other technologies like email very useful especially for contacts overseas when phone rates become expensive. Other non-technologies like letters (for postal mail) fulfill similar purposes yet only one person reported using these.

Heavy computer users would routinely use email or IM to exchange information. People enjoyed using email as it allowed them to share awareness information asynchronously (also found by [25]). For one mother, sending an email to her son from work to home was easier than trying to catch him on the phone because he may not have arrived home yet, or he could be at a friend’s house. Our participants told

us that IM provides near synchronous conversations when both parties were around, but when not, provided an easy way to leave an asynchronous message for another. One young common-law couple said they both have an IM client running on their computers when at work. This provides them with a very quick and easy communication channel to make plans or update the other on their day's activities. Many teenagers we interviewed like using IM because of its near synchronous nature, with some reporting that IM allowed them to have multiple simultaneous conversations with different people. Others have reported similar findings [10].

In summary, awareness must be considered within the quite broad context of the home setting. We have shown that there is a whole spectrum of relationships. Each has different needs for interpersonal awareness, and each has different methods for maintaining it. Table 1 summarizes this range of needs and methods. This suggests that a spectrum of design solutions is needed to address interpersonal awareness needs: we can't simply migrate awareness technologies from the workplace into the home.

3. COMMUNICATION INFORMATION IN THE HOME

For the remainder of this paper, we focus on home inhabitants. Our goal here is to understand how households and individuals currently handle communication information in the home: what communication information is present and manipulated by inhabitants, and the role meta-data about each message plays in how it is handled [8,6]. As with the previous section, this explication is formed from the combination of existing theories, studies of domestic culture, lessons learned from technology design, and our own semi-structured contextual interviews of households [8,6].

	Social Grouping Characteristics	Frequency of Awareness	Awareness Information	Techniques for Gathering Awareness
Home Inhabitants	Household members/ families; Small groups of one to six people	Frequent updates, moment-to-moment or daily	Detailed information about activity, location, and status About the past, present, and upcoming events	Visual cues from domestic artefacts Face-to-face and mediated interaction
Intimate Socials	Close personal contacts; Small groups of one to six people	Somewhat frequent updates, daily to weekly	Detailed information about activity, location, and status About the past and upcoming events	Face-to-face and mediated interaction
Extended Socials	Extended family and friends; Large groups of usually fewer than 20 people, but sometimes larger	Infrequent updates, weekly to monthly or even less frequent	Non-detailed information about activity, location, and status About the past and upcoming events	Fewer opportunities for face-to-face interaction; mostly mediated interaction

Table 1. *The characteristics, needs, and awareness patterns of each social group.*

We asked all members of each household to show us what communication information they used, and where this information was located in the home. We found that people would naturally provide a four part answer when generally asked about a specific piece of communication information:

1. ***What is it?*** What is this information about, what is it related to?
2. ***Whose is it?*** Who needs to pay attention to it? Should I pay attention to it? Is it mine? Who else needs to see it?
3. ***What needs to be done with it?*** What actions need to be taken?
4. ***When do I/others need to interact with it?*** Is it urgent? At what point in time will I/others need to interact with this information?

In analyzing our data, we saw many similarities in the kinds of communication information present in the home, in spite of the diversity of the homes, their layouts, and the people within them. We found five categories of communication information in the home distinguished in terms of how the information was used or its intended purpose, as described below.

3.1.1 Reminders and Alerts

Reminders and Alerts are intended or used as a memory trigger, e.g., to-do lists, reminder notes or emails, instant messages, or warning tags. We saw three sub-types of this information: *reminders* that remind people about things they know but may forget, *to-do* lists that contain a list of things that must be done and *alerts* that remind or inform people of critical information. This category is highly time-

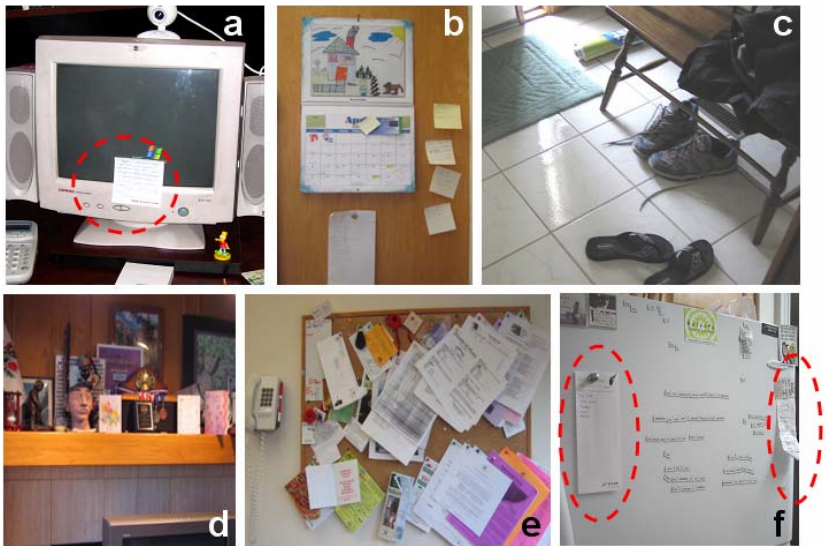

Figure 2: *Examples of Information Types*

sensitive. The goal of messages in this category is to convey information at the right time, whether this time is related to the urgency of the message (e.g., a reminder to call the shop right away, since it closes early), or to its relevancy (e.g., remembering to return a DVD on your way to work, or remembering what errands you need to run on the way home). Another example is a mother who wanted to remind her son that he is to put dinner in the oven when he arrives home from school. She placed this note on the son's computer monitor because there is some urgency to it illustrated in (Figure 2a).

3.1.2 Awareness and Scheduling

Awareness and Scheduling was the second most common type of communication information and entails much of the information we described in Section 2 of this chapter. To briefly recap, *awareness information* is used to maintain an understanding of the presence and activities of household members, e.g., this information is used to know who is currently home. *Scheduling information* includes items such as one's calendar activities or time schedule, e.g., what time someone will be returning to the house. Both awareness and schedule information involve knowing details about the day-to-day routines of household members. While Awareness and Scheduling information is not as time sensitive as Reminders and Alerts, it is critical to the smooth functioning and micro-coordination of the household and the comfort of its inhabitants. Its goal is to provide people with knowledge of the whereabouts and activities of others. For example, we saw that this information is particularly important for families with children, where parents need to coordinate who drives the children to their various activities. A more mundane example is knowing or deciding when dinner will be served. While some

of this information is left explicitly (e.g., as a note in a central common location such as the kitchen table), other times it is left implicitly through routine actions and gathered peripherally (e.g., the presence or absence of cars or shoes, as illustrated in Figure 2c). Other examples include a family calendar (Figure 2b), where events for members of the household (such as a ride schedule) are explicitly written down so that they are not missed or forgotten.

3.1.3 Visual Displays

Visual Displays are to be shared or admired. Examples include the display of birthday cards on the hall table, postcards on the fridge door, awards on the wall, children's artwork on the fridge, or funny comics in the computer room. These are all pieces of infrequently updated information that the family wishes to display in a public location, where it attracts the attention and comments of both household members and guests. Figure 2d illustrates a mantle in a family room containing pictures, birthday cards, awards and medals, as well as children's artwork and souvenirs. These are all pieces of infrequently updated information that the family wishes to display in a public location, where it attracts the attention and comments of both household members and guests.

3.1.4 Notices

Notices provide household members with information about activities or contacts outside the home. Thus, the defining characteristic of a notice is that it comes from something or someone outside the home. The most common example of this category is phone messages. Notices also include newsletters, forms or notices from school, letters, etc. For example, a family may have a bulletin board littered with these types of notices (Figure 2e). This information may be very time sensitive (e.g., a school notice that needs to be signed right away, or an urgent phone message) or not at all (e.g., the latest church bulletin). This information keeps the family aware of what is happening with their outside activities and contacts. As with Visual Displays, this category of information is often shared between home members and publicly displayed; however, its content is more practical and more frequently updated.

3.1.5 Resource Coordination

Resource Coordination includes any information used to manage the sharing of a common resource. For example, Resource Coordination items may include contact information, financial data, charts for sharing chores, bills to be split among roommates, or notes on food that is not to be eaten by others. Items from this category are less common, but still present in every home from our contextual studies. One example we saw describes how two roommates coordinate the sharing of groceries: on the left of their fridge door was a shopping list; on the right side were receipts for the recent grocery purchases (Figure 2f).

In summary, understanding the types of communication information that people

display and use in their homes is the first step to knowing how to handle a particular piece of information, i.e., '*what is it?*' We will see that this is not enough: other factors come into play to help people understand information and how it should be handled, as described below.

4. CONTEXTUAL LOCATIONS

Every household we looked at had a set of key locations (places) that inhabitants used for displaying, interacting, organizing and coping with communication information. We found that these places within the home are more than they initially seem to be. No matter what the answers were to what is it, who is it for, when do they need it or what needs to be done for a given piece of information, when we asked people "How do you know?" they would almost always reply with some variation of "Well, because it is on the fridge" or "…in the doorway" or "…on her placemat". People use placement to filter and manage communication information in their homes.

These places provide household members with important meta-data about the communication information located there. This meta-data includes *time* information, *ownership* information and *awareness* information. Places are what enable people to answer our guiding questions for each message: whose is it, what needs to be done with it, and when do I/others need to interact with it. In this way, space is interwoven not only with action [21], but also with this rich context and meta-data about the messages placed there. We call these places *Contextual Locations*, since they provide the information in them with context, and therefore richer meaning.

We first describe how places for information are initially selected. We then describe the ways these chosen contextual locations afford time, ownership and awareness to the information placed there.

4.1 Location Placement in the Home.

We consider contextual locations to include any place where communication information is placed. These could be static (e.g., the kitchen table) or dynamic (e.g., a day planner carried in a purse). In our study, the number of distinct communication information locations per household appears to be determined by two separate factors. The first is the house size: we found that the larger the home, the more locations present. The second factor is the number of independent adults in the household. The presence of children does increase the number of locations, but not as significantly as the presence of another adult. However, couples tended to have fewer locations than two unmarried friends or roommates, because they typically had very entwined lives. The number and placement of these locations is part of the home ecology, where it is a shared household understanding that develops over time. To illustrate, one participant household contained a group of roommates who had been living together for only a few weeks. While each had a good understanding of places for their individual information, the shared locations were not yet well formed or understood. Insufficient time had passed for meaning and use of these

locations to evolve.

Through their everyday routines, households implicitly select locations in order to provide answers to the four information questions. These locations develop social meaning over time, and become a strong shared language in the home. People rely on their knowledge of home routines (their own and those of others) as well as the placement of main traffic paths and common areas to find suitable places for information.

4.2 Pathways and Routines

Information locations tend to group themselves along path-ways through the house [3], for instance the path from the front door to the kitchen. Since these are routes most of the household will pass through over the course of the day, they are chosen as places to leave the information people need to or want to see. Part of this is derived from familiarity, where people know the routines of other household members—what they do when they come home, where they go, where they leave things like keys or purses—and use this knowledge in deciding where to leave messages. As Tolmie et al. [26] found "Routines are resources for action, and knowledge of others' routines can be resources for interaction."

In one of our households, the teenage son enters through the front door, passes through the kitchen, and then goes down to the basement. Parents leave notes for him on the kitchen counter since he has to pass by it on his way to the basement stairs. Knowledge of his routine, as well as the pathway he takes from the entrance way to the basement, meant that this was the logical place for this information. Households use their knowledge of routines and pathways to select information placement.

Once these locations are established however, they themselves become an element in daily routines. For example, many of our participants would describe locations they would explicitly check for information as part of their routine upon arriving home. These would include locations such as the answering machine or the kitchen table. Information locations may create or establish new routines.

4.3 Constellations

Areas also tend to be grouped. One communication area will normally cause other ones to form nearby, since it is often convenient to have different kinds of communication information in close proximity. We call these location groupings *constellations*, since they consist of many unique locations linked by common activities or subjects. For example, if the kitchen counter is used to organize coupons and flyers, other locations such as the family grocery list will usually be nearby. Constellations are most often present in common, frequently visited areas of the house, such as the kitchen, family room, entrance way, etc.

In addition, communication media and technology such as phones and computers also attract communication information. Since this technology is less portable, information typically comes to them. Since locations group together as we

described above, constellations will often form around these areas. For example, for obvious reasons phone messages usually go next to the phone (when the phone is tethered). Calendars are also often near the phone, so that people can check their schedules when making plans with others [18]. Other types of information, such as school newsletters, are needed near the calendar as they augment its information [18]. This creates an information constellation around the phone. Information locations tend to group themselves so that other relevant information and useful technology is nearby.

4.4 Location Attributes and Proximity

The attributes of a location affect both how suitable it is for information display and the kinds of information left or placed there. For instance, it would make very little sense to organize school handouts by pinning them up on the wall in the bedroom. Information would not be at hand when it is needed, and important events or letters might get missed. It is much more likely that these handouts will be stacked in piles on the kitchen counter, because it is flat, and they can be moved around easily. As a common, frequently visited place, the kitchen counter is a location where everyone who needs this information can get at it.

There is also the issue of relevance—information related to something needs to be near it, so the media will be chosen to adapt to the location, as discussed earlier. Phone messages will often be left on sticky notes near the wall phone; shopping lists on the fridge will be magnetic, etc. Places in the home will be repurposed as information locations to meet people's need for organization.

4.5 Visibility versus Practicality

The fitness of a location for communication often dominates other seemingly more practical factors. For example, it may be more practical to put new information in a location that has the space for it instead of an already heavily used information-crowded location. But this is not done. For example, there may be ample space in the basement for school handouts or church newsletters, but because the basement is not a commonly frequented place, information might be missed. Instead, it is added to the already busy central bulletin board. While it takes up much needed space, competes for attention, and gets in the way, it is more easily accessed. A second example would be placing a DVD that needs to be returned to a DVD-rental store on the first stair leading down to the entryway as all household members will see it (and perhaps trip over it) as they go by, even though it might be less hazardous to leave it by the TV. Location has such great value in terms of providing organization and relevance that it overrides more practical considerations.

5. TIME, OWNERSHIP AND AWARENESS

The above attributes and groupings described how people choose locations to communicate with members of their household; these locations become part of the household's shared language. Next, we will see how choice of location adds valuable information to messages placed there as meta-data regarding time, ownership and awareness.

5.1 Time

One primary way locations add information is in timing, where time attributes—urgency, relevance, when it needs to be seen or used, the dynamics of the information—are all conveyed by the location in which the information is placed. This helps people answer the question when do I/others need to interact with this information.

5.1.1 Urgency and Relevance

There is a definite correlation between location choice, and when information will be needed or when it should be seen. One of the most frequently stated reasons for location choice by our participants was the need for the information to be seen at a certain time. This time could be when one eats breakfast, or leaves the house in the morning, or sits down to watch TV. People use their knowledge of the routines of themselves and others to know where to put information so that it is seen in a timely way.

Household members use this knowledge to convey urgency in a message, to make sure information is at hand when needed and to provide a type of priority system for themselves and others. For example, messages from a mother to her teenage son were usually left near the computer upstairs (Figure 2a), where the mother knew it would be seen at some point. However, she would place urgent notes on the TV screen instead, as she knew her son would surely see it as soon as he returned home, since the first thing he does after school is watch TV.

This information also works for recipients of information. Household members know when there may be messages for them at certain locations. For instance, upon arriving home from school or work, people typically have a set of places they will check either implicitly or explicitly for information. If there is nothing in these locations, they assume there is nothing they need to address.

Figure 3 reveals another example where the placement of information is very frequently used to create timely reminders. Here, household members may leave things that need to be mailed with one person's wallet and keys (e.g., a letter tucked by a wife into her husband's wallet), which in turn is a part of a key rack constellation, so that it is seen when he picks up his keys to leave in the morning. This type of reminder, done by leaving things where they will be noticed at the right time, was common to all households. Thus, locations provide a vital means for people to convey time-related relevance and urgency.

5.1.2 Information Dynamics

We also found that information will change location over time as its dynamics change. This includes relevance to other messages, whether or not actions associated with that information have been taken, whether the message is still useful, and its temporality (e.g., is it a new message or an old one).

We saw that as information becomes less relevant or is dealt with, it is often moved to a new location. For example, when bills first arrive in the home, they are usually sorted and left for the person who pays them. This person will then open them, and move them to a second location, for example, the computer, in order to remember to pay them online. Once the bills have been paid, they are moved to a third location for storage, a filing cabinet for example. This is true of much information that moves through the home—postcards and pictures may be placed in one location until everyone has looked at them, then in another place **for** long term storage or display.

For example, in one household, members left phone messages as sticky notes on the outside of a cupboard door above the main household phone (Figure 4a). After dealing with a message, the member may throw it out. However, if the member needs to keep the message, e.g., contact information that one does not wish to lose, it may be placed on the inside of the cupboard door for a kind of longer term common archive (Figure 4b). The household knows that messages on the inside of the door are there for storage, while those on the outside still need to be dealt with. In this way, locations provide a sense of the dynamics of the information.

Figure 3. *Envelopes placed with keys*

Figure 4: *Information dynamics*

5.2 Ownership

One of the most important and most pervasive ways in which we saw location used was to implicitly or explicitly attach

Figure 5: *Spatial Ownership*

ownership to information. Not all information within the home is relevant to all members, so households use locations to define who information belongs to. This allows people to not only manage complexity, but to answer the questions whose information is this and what needs to be done with it.

5.2.1 Spaces

Each location within the home has an owner—this could be either the person who the space explicitly belongs to (e.g., a child's bedroom) or an implicit owner (e.g., Mom always works in that spot at the kitchen table, so it has become her spot). The knowledge of who a space belongs to is used to not only decide where to leave messages. It also gives family members an understanding of which messages belong to them, and which information they are expected to act upon. Ownership of the space implies ownership of the information and responsibility for it.

We found four main subtypes of location ownership within homes: public spaces, public subset spaces, personal spaces, and private spaces. *Public spaces* are those owned by everyone in the home. For example, the main house phone or the fridge door are usually considered public spaces, and messages affixed to them or near them may be for anyone. Everyone can see the fridge door (Figure 5a), place items on it, and interact with those items.

Public subset spaces are those that are public, but only to a subset of household members. Couples within a household of other room mates or parents in a family home typically have public subset spaces: spaces that are public and shared by them, but that do not belong to others in the home. For example, consider the desk in Figure 5b shared by parents in one of our participant homes. The parents leave a shared calendar for each other to see and use on the desk, but they know that their two adult sons do not look at, write on or otherwise interact with it. The sons know that this calendar is just for their parents because it is located in their parents' space. However, if they have events that they want their parents to note, they may leave a note for them next to the calendar.

The other two types of spaces belong to individuals, where information within them are understood to be for the owner only. The first type is *personal spaces*: publicly visible spaces intended for only one individual. These could be the door to a

bedroom, a placemat at the kitchen table, etc. Other members of the house will leave information in these places for the owner, and the owner will leave information there for themselves. For example, one person had a 'personal placemat' that contained items placed there by that person for their own use (Figure 5c). Yet because it is publicly accessible, others may leave things there for this person to see and act upon.

The final type is *private spaces*, intended for only one individual and not publicly visible or usable by others: day timers (Figure 5d), purses, bedroom bulletin boards, etc. Information left in a private space by its owner are usually personal reminders, personal scheduling and contact information. Its owner typically does not expect others to see information in these locations.

Knowing who the space belongs to gives household members a quick way to understand whether or not the information located there is something they should pay attention to. It also helps them decide where to leave information that others need to be aware of or take action on. Spatial ownership (implicit or explicit) indicates or implies information ownership or information action responsibility.

Spatial ownership may also vary by time or activity. For instance, O'Brien et al. [20] found that users of a technology would often 'own' or control the space around it. For example, someone watching TV in the living room temporarily controls that space, and may displace other activities taking place in that room, such as a noisy board game, or someone wishing to study. We found that if this shift in ownership is routine, information placement may become a part of it. We saw our earlier example of a mother leaving an urgent note for her son on the screen because she knows that he will watch TV soon after he gets home from school. He owns the TV space at this specific time, so notes needing to be seen at that time and pertaining to him will be left there. He also knows that notes stuck on the TV screen at this time are his. Spatial ownership may have routine variations based on time and activity.

5.2.2 Visibility and Privacy

We also found that the visibility of the different locations within the home implies not only information ownership but also the privacy level of the message. Information that household members do not need or necessarily want others to see will be placed in locations that are less visible and therefore more private. Information to be shared with others (e.g., awards, pictures, messages to all) is put in the highly visible and publicly accessible locations. Household members use this in order to protect their own privacy and to protect that of others when it is needed. For example, a husband may leave a message for his wife from the doctor tucked in her purse, rather than on the kitchen table where their houseguest may see it. They use this knowledge to know when information has been placed somewhere for sharing, or when this information is more personal and sensitive. The visibility of the location of a piece of information implies its privacy level.

5.2.3 Actions

The location of a piece of information implicitly attaches intended or expected actions to it. Often information is placed in a certain location so that a member of the household will know they are expected to do something with it (also observed by [3]). Using previously mentioned examples, this may be a letter to be mailed placed by car keys, or a stack of bills to be paid placed by the computer.

Seeing a message in a certain location lets people know what they are expected to do with it. This may be a simple reminder to oneself, as in the example of a person putting a DVD to be returned by the door, so they can see it as they leave and infer that it is ready to be returned. This is one direct way space is interwoven with action, as in Crabtree et al's Coordinate Displays [2,3].

Location ownership indicates responsibility for these actions. People will place information for others in locations that "belong" to that person as a request for action. For example, a child may place a school notice for their parent to sign on the parent's desk. Personal reminders are often left in personal or even private locations. Action triggers placed in public areas, such as the DVD return example above, can be taken care of by any household member. The location of information implies intended actions and responsibility for those actions.

Figure 6. *Slippers show presence and location.*

5.3 Awareness

Finally, locations include meta-data for communication information by providing awareness information for family members. Awareness information for home inhabitants is very important to people for scheduling, coordination and comfort [19].

5.3.1 Presence

The presence or absence of an object from its routine location provides information, especially awareness information. For instance, many of our participants mentioned knowing whether or not someone was home by the presence or absence of their cars in the garage or on the street. What shoes were in the entry way or what keys were on the key rack were also frequently cited as a way of knowing who was around, including whether or not guests were there.

For example, one of the participant households evolved a particularly rich system for handling awareness information. Each member of the household would

wear different colored slippers while in the main floor of the house, as it was tiled and cold on bare feet. These slippers would be left in the main entryway when the wearer was not in (Figure 6a), or at the foot of the stairs when they were upstairs in the carpeted area of the home (Figure 6b). In this way, family members always knew who was home, and their general location in the house. Thus, the presence of an object in a routine location can provide information to household members.

5.3.2 Monitoring

The above assignment of actions through locations combined with the information gathered through the presence or absence of artifacts also works as a form of internal monitoring. Household members know whether others have completed their tasks because they can see what information is present in which locations. This is discussed by several previous authors, e.g. [11,12,26]. Harper et al. [11] calls this workflow control or workflow management. While the home is definitely not as work oriented as the office, there are still jobs that must be done to keep the household running smoothly. One example is a wife seeing that her husband has not paid the bills yet since they are still in a pile on the corner of the desk, instead of being filed. She knows he has been busy, so she takes on the job of paying them herself. He then knows she has done this because the bills have been moved. A second example [11] is parents placing their teenager's cell phone bill in the doorway to his bedroom to make sure he sees it. Once they know he has been home and has therefore seen it, they can then ask if he has paid it—he has become accountable for it because they know he has to have seen it. Household members use locations to monitor and help each other.

6. CONCLUSION

This article is just a first attempt at explicating the nuances of awareness in the home. We defined the notion of interpersonal awareness, where the differing relationships that people have with others both within and outside the home imply different awareness needs. We then narrowed in on communication information between home inhabitants within the home, where we considered how the home mediates communication through contextual locations and its interplay with time, ownership and awareness.

This description of awareness in the home can be used in many ways. First, it provides a framework that lets us analyse existing technologies to understand why they succeed or where they fail at providing awareness for family and friends. In [19] and [16], we show how such an analysis can be applied to awareness appliances and instant messaging systems. Second, it provides a framework supporting requirements analysis and design. In particular, the model lets designers ask questions about exactly what social relationships are being supported, what the particular awareness needs are, and what affordances of the home exist and should be exploited as part of the design. An example of how this is done is described in our analysis of the family calendar as a coordination and awareness medium [16,18],

and the subsequent design of the LINC family calendaring system [17]. Another example is the development of the StickySpots messaging system [7], which exploits contextual locations to embed technology in the social practices of the home. Third, the framework can be used to compare and contrast awareness needs of different contexts. For example, Neustaedter et. al. contrasted the differences between awareness in the workplace *vs.* awareness in the home, where they explain why one could not simply take what is known about workplace and apply it to the home setting [19].

Of course, much is left to do. There are many subtleties and immense variations in home life. Many factors come into play that will influence the awareness needs of a particular home: the social relationships of people within it, the relationships these people have to those outside the home, the socio-economics of home inhabitants, the physical properties of the actual home, the artifacts and furnishings within it, and so on. Our work is just a beginning.

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