

Situated Awareness Spaces: Supporting Social Awareness in Everyday Life

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Abstract

"Media Spaces" may be defined as computer mediated communication channels employing both audio and video. What distinguishes them from simple teleconferencing systems, however, is that they are always (or usually?) on, and thus provide a remote awareness as to availability. Awareness can be obtained via other media (or just audio or video, not both) however, and through a variety of synchronous and asynchronous protocols. This paper characterizes *Awareness Spaces*, starting with a brief survey of Media Spaces, to emphasize the wide range of computer interactions to create awareness. What are the costs/benefits of the various media? If awareness must be granted by explicit activity (such as sending an email) is this good or bad? What limitations do the various awareness media and technologies place on mobility? How do they impact our working and living in a world which has other tasks and other demands on our attention? What are the privacy implications, and what kinds of state can be shared with the various techniques described? Based on this analysis, this paper postulates several awareness spaces without regards to technology and bandwidth limitations, situating them in the daily life of different user populations.

1. Introduction

There has been a substantial stream of research in Human-Computer Interaction (HCI) in the past two decades towards communication and awareness techniques for distributed participants via computer-mediated interfaces. This area of research, broadly referred to as 'Media Spaces', was pioneered at Xerox PARC in the mid-80's and has led to the design of numerous systems providing ongoing forms of communication. However, despite the innovative approaches used, studies conducted and the claimed benefits of Media Spaces, these systems have not found their way into everyday usage. One reason is that the need for face-to-face interaction has generally been over-estimated, without recognizing the complexity of the social effects on participants, allowing such forms of communication to be sustainable in the long run. Recent field studies and interaction design has begun to emphasize support for the notion of *awareness* in such Media Spaces. Dourish and Bellotti define [social] *awareness* as the "understanding of the activity of others, which provides a context for your own activity" [Dourish92]. The implicit purpose of this phenomenon is closely related to the process of "social facilitation" i.e. people using other's visible activities in framing their own goals, motivations and actions [Ackerman95].

The key issue is: How does one provide appropriate forms of awareness and interruption mechanisms that support a variety of practices and social behaviors in different contexts (home, work and commuting)?

This paper does not answer this question, but attempts to lay out a framework within which we can start to better understand the key aspects for designing computer-mediated social awareness. The paper surveys the evolution of Media Spaces from notions of distributed video, continuous connectivity and face-to-face vs. peripheral monitoring of distributed participants. We examine recent work towards audio-only and asynchronous mobile-audio Media Spaces. Spontaneous encounters and peripheral awareness are often cited as key benefits of Media Spaces. We consider the social effects in Media Spaces that emphasize the role of peripheral awareness and tradeoffs in privacy and interruption. We also examine issues regarding ownership, the formation of norms and coevolution of practices in these social settings. We then propose an extension of Media Spaces to deal with low-bandwidth modalities, asynchronous communication, temporally distributed participants, and means for situating them in the social context of everyday life. This allows us to define what we now call "Awareness Spaces", that embody many such characteristics. We conclude with a demonstration of some aspects of this framework in a workplace setting and discuss an ethnographic study that allows one to begin to understand communication patterns and awareness in domestic settings.

2. Evolution of Media Spaces

2.1 Distributed Video

The notion of videophones and videoconferencing has been around since the early 1960's, when AT&T demonstrated its first prototypes called "PicturePhones" that allowed remote participants to see each other on small video monitors. Although it was considered the phone of the future, it was never widely adopted by consumers and deemed a failure for a number of reasons [Noll92]. Similarly videoconferencing has been a popular mode of conducting formal meetings between different work sites, however has generally been found to be awkward and inadequate by most participants who have used it extensively. These early distributed-video communication systems were modeled after familiar social protocols such as telephone calls and formal meetings [Mackay99]. In videophones a caller establishes an audio/video link with the recipient if she is available and decides to accept the call. The link is only active as long as both parties wish to participate and usually requires directed conversation or face-face interaction. Videoconferencing usually involves specially designed media-conferencing rooms with fixed cameras and projected wall screens typically across a meeting table. Audio is problematic if delayed and hence people often simultaneously use speakerphones in addition to live video. Most videophone and videoconferencing systems have been developed for distributed cooperative work, however there is little evidence that these models have supported such activity well. There have been numerous studies indicating why [Whittaker95] [Issacs93], and we will consider some of these issues in the discussions below.

2.2 Early Media Spaces

The concept of Media Spaces evolved by extension to such videoconferencing systems, to support ongoing communication, informal encounters and peripheral awareness. Although the technology has been similar, the difference tends to be in the way that it is designed and integrated in a specific social environment. A number of experiments have been undertaken to better understand the social issues for designing more effective Media Spaces.

The first known experiment in Media Spaces was an installation called "Hole-in-Space", created by video artists Kit Galloway and Sherri Rabinowitz in 1980 [Galloway80]. It was designed as a real-time audio/video link between New York and L.A., set in outdoor public pedestrian spaces. Each end projected full-size images of people walking by, for supporting casual social encounters. Since then, over a decade of research was conducted on Media Spaces at Xerox PARC towards the design collaborative and social environments. The term "Media Space" was coined by Stults and his colleagues at PARC [Stults86], and they defined it as:

"An electronic setting in which groups of people can work together, even when they are not resident in the same place or present at the same time. In a Media Space, people can create real-time visual and acoustic environments that span physically separate areas. They can also control the recording, accessing and replaying of images and sounds from these environments."

With the decreasing cost of video, it became possible to establish two-way continuous media links at Xerox PARC between the commons areas in Palo-Alto and Portland. This experiment, operational from 1985 to the early 90's, has been extensively studied by Sara Bly et al [1993]. The PARC/Portland link was positioned as a platform for understanding mediated presence and developing shared tools for use by distributed groups for design collaboration. The goal was to create virtual "places" where people naturally congregate informally. People on both sites adapted to the evolving social situations by developing behaviors or protocols to deal with intrusion, privacy, and awkwardness of these new audio/video spaces. They experimented with many different configurations and handled privacy issues usually by switching off microphones or turning cameras towards a wall. Bly et al mentioned how their own work and social relationships changed as a result of Media Spaces, and suggested the need for user tailorability and mechanisms for better managing privacy. Subsequent research in Media Spaces recognized the privacy concerns and emphasized informal interaction and peripheral awareness as key benefits of Media Spaces.

2.3 Recent Media Spaces

The early work at Xerox PARC influenced the next phase of research on Media Spaces at Rank Xerox EuroPARC in Cambridge, England in the early 90's. At EuroPARC all 30 researchers worked and lived in both the physical and Media Space. This extended experiment provided additional social and technical insights. The RAVE system was designed to support informal encounters and planned cooperative tasks, rather than face-to-face interaction. RAVE allowed users to switch to cameras on any Media Space node, switch to peripheral or focused views, maintain audio privacy via a foot pedal and gain greater flexibility in the user interface to customize their own services. Auditory cues via an event notification server provided awareness of planned and spontaneous events. While RAVE was designed to provide explicit video connections within a team of researchers in the same facility, this was found to be more expensive between long-distance sites. Projects like Polyscope [Borning91] and Portholes [Dourish91] allowed multiple distant nodes to share passive awareness of distributed workgroups via frequently updated images from all sites. This distributed asynchronous facility complemented the synchronous but directed video links between participants in Media Spaces. Other Media Spaces such as BellCore's Cruiser [Root88] and VideoWindow [Fish90] as well as Sun's Montage [Issacs93] focused on the role of spontaneous and informal communication based on a model of walking by and glancing others via a reciprocal protocol between users, before opening full video connections.

Use of video in these Media Spaces highlighted a number of social issues that detract from its active use for face-to-face interaction. Heath and Luff [1991] found that during long-term use the quality of video undermined the effectiveness of subtle communication gestures. Communication via video also required direct gaze awareness, which was awkward with cameras off-set from the screen. In the Clearboard system [Ishii92], gaze awareness was dealt with in an elegant manner via cameras placed behind projected mirrored screens. Finally, it was noted in experiments that given a choice of multiple views, users generally preferred context or object views rather than face-to-face views unless involved in negotiation [Gaver92]. Chapnis [1975] in prior studies has found that although users typically request video for communication, it does not seem to be required for task completion (audio seems sufficient but not always preferred). Hence, researchers have recently explored the use of audio-only Media Spaces or studied pre-existing ones.

2.4 Synchronous Audio-Only Media Spaces

Sustained use of continuous audio between distributed parties has been found to create rich social spaces as illustrated in systems such as Thunderwire which provided open microphones to a group of researchers at Interval [Ackerman97] and 'Voice Loops' for shuttle flight controllers [Watts96]. The audio channel allows participants to engage in short and lightweight interactions, where the initiation of conversation between participants does not require much overhead relative to the actual transaction. This attribute of a continuous-on media connection helps establish a sense of informal social space. The projected audio in a Media Space "opens up the space", extending the connection beyond the individuals directly involved. Others can comfortably lurk in the periphery and enter a conversation only if desired. However a number of norms must necessarily evolve to deal with the side-effects of being in a shared audio-only social space. In Thunderwire, these social norms helped in knowing when people were present or listening, reducing violations of privacy and dealing with noise [Ackerman97]. Examples of such norms cited such as having an awareness of who's in the space, required explicit singing-on/off via vocal greetings and letting people know who else is in the space. This was also noticed from audible clicks of microphones, which started to serve as a resource for group use. The use of a "highly coded language" was also noted by researchers studying use of voice loops monitored by flight controllers [Watts96]. To enable better communication, implicit protocols that used abbreviations and acronyms evolved, which provided lots of information yet took up less bandwidth in an audio-only channel.

Both video and audio-only Media Spaces comprise not simply a communication modality or interaction facility like 'desktop videoconferencing'; but rather define *social spaces* and create new *places* where certain kinds of social interaction emerge. Dourish et al mention the use of open audio/video connections in their offices as creating long-term social *spaces*, evidenced by the desire of colleagues to step into their office to meet not with the local occupants, but with the remote participants [Dourish96]. In Media Spaces participants gradually "move from an initial understanding of linked individuals to one of linked spaces". The importance of a notion of "place" has been emphasized by Harrison [1992] for contextualizing commonly understood patterns of acceptable behavior, over time. This transformation of "space" to "place" is illustrated

by emerging patterns of behavior and adaptation among Media Space participants and their physical neighbors. However, we can argue that a physically situated and live audio or video connection is not necessary for providing such a persistent sense of place. People on the move can also participate in a form of Media Space using near-term asynchronous connectivity.

2.5 Asynchronous Mobile Audio Spaces

Media Spaces can be created by intermittent audio connections that persist over time, pacing one's activities with on-going communication opportunities and awareness cues. There is evidence of such social spaces even with low-bandwidth asynchronous audio via 2-way radios [Orr93][Strub97]. In addition to directed channels of communication, audio messages provided in *space or time* to people on the move can serve to create a meaningful audio space. An augmented audio reality project at Xerox PARC, *Audio Aura* [Mynatt98], explored the use of background auditory cues to provide serendipitous information coupled with people's physical actions in the workplace. The project leveraged an existing infrastructure of active badges and distributed IR sensors along with wireless headphones to deliver audio cues to people in the workplace. The long-term goals of the system included use of multiple information sources (such as calendar and email) and multiple means for triggering the delivery of auditory information. A number of harmonically coherent "sonic ecologies" were explored, mapping events to auditory, musical or voice-based feedback. Such techniques convey events, such as the number of email messages received, identity of senders or groups, and abstract representations of group activity as a continuous backdrop. In contrast to this approach, *Nomadic Radio* was developed as a wearable audio platform for both active navigation of unified audio messages, as well as passive auditory notifications of timely messages [Sawhney00]. The use of speech recognition, spatial audio, synthetic speech and ambient and auditory cues provided a rich form of audio-only interaction and a scaleable auditory space for awareness. Continuous sensing of the user and environment as well as filtering and prioritization of incoming information, allowed the system to utilize a context as part of notification. Hence, both systems provided mobile users with a perceived sense of continuous auditory space with asynchronous awareness of location-specific or temporally paced messages presented relative to their context of interruptability. We can even begin to classify the next generation of mobile-phones with audio conferencing, messaging and awareness facilities within such Media Spaces. This requires an extension of our prior notions of Media Spaces to include asynchronous and contextual awareness, which will lead us to broadly characterize them as 'Awareness Spaces' later in this paper.

3. Social Effects in Media Spaces

3.1 The Role of Peripheral Awareness

Based on their experiments with the PARC/Portland Link, Sara Bly et al [1993] state that although peripheral awareness seems invisible, its implications for use in Media Spaces is considered the most powerful aspect. Visual glances of people walking around or sounds from either side provided clues of on-going activities, who was around and encourages spontaneous encounters. In their studies of London Underground control rooms, Heath and Luff [1992] discuss how peripheral monitoring and public disclosure of 'private' activities enable fine-grained interaction and coordination. A similar finding comes from flight controllers constantly monitoring for deviations (from known patterns) in multiple audio channels in space shuttle mission control [Watts96]. In both these environments, awareness in audio channels allowed controllers to synchronize their own activities by being able to track the tempo of the mission processes and activities generated by the "cascade of disturbances" that occurred. Such a passive awareness mechanism sometimes called preattentive reference [Woods95], allows controllers to shift their attention dynamically and opportunistically in response to changing situations, while maintaining a focus on their immediate tasks and goals. This form of monitoring or peripheral awareness requires low task overhead and attentive focus, while permitting distribution of cognitive abilities across a team and an efficient coordination of activities.

3.2 Tradeoffs with Interruption

However, the same level of awareness in an unconstrained manner also frequently leads to *interruption* as irrelevant conversations, uncontrolled or unintended acts (sneezing) [Ackerman97] and background sounds are constantly or unexpectedly heard by remote participants. The sounds of someone typing on a remote connection can easily be confused with those coming from a nearby colleague. In many cases the lack of

context from everyday background sounds leads to noise pollution, although it does convey a sense of activity on the other end [Dourish96]. The outcome is that participants have to actively ignore such interruptions, requiring greater cognitive overhead to maintain inattention or devise new norms to minimize their impact; this trades-off some of the potential benefits of awareness in the first place.

3.3 Tradeoffs with Privacy

Privacy issues are multi-dimensional and are greatly affected by the organizational culture and context where the Media Spaces are used. Gaver [1992] identifies four issues related to privacy: 1. Having *control* over who can see or hear a participant at any time; 2. To have prior *knowledge* when in fact they are observed; 3. Knowing the *intention* of the connection; and 4. Avoid *intrusions* that disturb their work. There is a trade-off between the level of privacy demanded and quality of awareness one can expect in a Media Space [Mackay99]. A desire for control, knowledge and lack of intrusion conflicts with the benefit of having spontaneous awareness and the lightweight overhead required to maintain such awareness, such as not having to acknowledge or ask every request for communication.

Despite having knowledge and control, in a continuous media system it is easy to forget that a camera or microphone is on, leading to potentially embarrassing moments. This is true in both visual and audio spaces, but is particularly characteristic in audio, as there are fewer explicit cues to prevent such situations. Ackerman et al [1997] often noticed unwanted disclosures of personal information, accidentally leaked into a shared audio space. This would usually happen unintentionally as users forgot to turn off microphones when answering the phone or responding to a visitor in their office. Conversely, avoiding other's disclosures was hard to control as all information was broadcast to everyone connected in the audio Media Space. Hence the sense of shared space provided by broadcast audio also made managing the disclosures difficult, particularly as there were few cues to distinguish whether the disclosures were accidental or intended. Ackerman also points out that people carefully manage their "face", embodying both given and given-off expressions, to others in everyday life; this is related to Goffman's notion of "audience segregation", whereby people present a different face to different audiences [Goffman61]. However, in social interactions in Media Spaces, people have less control over their "face" and any accidental or unintended communication of private information or personal habits can be disconcerting and in some cases potentially harmful in organizational settings [Ackerman97]. However, over time there is a co-evolution of norms and practices among the community of participants using the Media Space.

3.4 Coevolution of Norms and Practices

Despite the limitations and issues in Media Spaces mentioned above, people were quite adept in restructuring or devising new social practices or norms to suit extended use in their everyday environments. Meier [1990] gives a definition of norms as "group-supported definitions of expected behaviors in specific situations", as mentioned in [Ackerman97]. Both Dourish [1996] and Ackerman [1997] point to evolving communication practices arising as participants get familiar with the affordances of the particular medium. People gradually adapt new behaviors or social protocols to deal with the intrusions, privacy issues, and awkwardness related to continuous-on audio/video connections. E.g. dealing with the confusion of eye contact and gaze awareness for face-to-face communication and disembodied voices arising frequently out of view of the Media Space. In any Media Space, the participants develop shared understandings of how to behave while using such a system. The norms for behaviors having significance to the group are negotiated over time, based on people's experiences and the affordances of the Media Space.

Dourish et al [1996] mention the evolution of a set of behaviors at different levels: orientation towards the technology in Media Spaces, communicative practices to support 2-way conversations, and understanding the ways in which Media Spaces "disrupt the communal resource of space". They cite examples of such evolution in behaviors related to eye contact and gaze awareness. These behaviors went through 3 distinct phases: from initial confusion, through simulated eye contact to finally the use of gaze awareness. They also show how "place orientations" emerge out of the exploratory use of the spaces occupied by participants using Media Spaces, such as Bellotti's re-orientation of her office space to accommodate better views of public areas and third persons. Dykstra-Erickson et al [1995] document the emergence (over a relatively short period of 10 weeks) of a "local visual language" - patterns of stylized gestures developed by participants in a Media Space. Dourish points out that as the participants gain familiarity with the technology and their use of the Media Spaces increases, so does the range of activities that they can effectively

perform in such spaces. These evolving creative uses and adaptations are intrinsic to the medium and usually found only through long-term observations. Ackerman shows that the construction of new practices and their maintenance would not be successful unless the participants actively inhabit a perceived social space, and use it continuously for meaningful social interchange, as evidenced in Thunderwire and experiences at Xerox PARC.

3.5 Ownership of Media Spaces

As a pattern of regular behavior develops between participants around continuous media connections, they become concerned with joint ownership and responsibility of the connection itself. However such ownership is difficult to assume in a situation where several public spaces are connected. In the "Portland Link" mentioned by Olsen and Bly [1991] distributed communities were engaged and claimed ownership in public spaces due to common interests and working relationships. However, in BellCore's VideoWindow [Fish90], without an explicit focus between the workgroups, there was less evidence of enthusiasm and ownership. In the PARC/Portland link participants adopted the easily *accessible* technology (cameras on tripods), moving it around in their physical space to suit their purpose. The nature of open audio/video connections makes the space occupied by participants implicitly shared; hence the issue of ownership of the space becomes complex. E.g. Remote participants would be required to acknowledge local individuals visiting a connected colleague's office, hence sharing the space and its social responsibilities. Dourish noted a case of a researcher (Bellotti) that reorganized her office to support "better mutual orientation" so that her remote colleague would have a better view of her office and the periphery of the public space. Hence, there is a gradual exchange of mutual ownership in media spaces that influences social protocol and physical layout of the connected spaces.

4. Rethinking Media Spaces

We have established that the primary goal of recent Media Spaces has been to provide distributed participants with a means for ongoing peripheral awareness and spontaneous interaction. Much of the difficulties encountered have to do with social protocols around the nature of the media used for communication, rather than the awareness cues themselves. Hence, there is an opportunity to extend the framework of Media Spaces to include relevant aspects of awareness and deal with varying social context. Here we examine four specific characteristics that extend our pre-existing notion of Media Spaces.

4.1 Communication Bandwidth and Modality

It is clear that high-bandwidth video connections, although initially preferred by most, are not necessary for providing awareness to distributed parties. As seen earlier, video introduces additional challenges for dealing with privacy and social norms. In contrast, even low-bandwidth audio can provide sufficient awareness cues for ongoing collaborative tasks [Whittaker95] and social exchange [Ackerman97, Strub97]. One can extend this further to include periodically updated images (as seen in Portholes) and textual interchange such as on-line chat, Instant Messaging on PCs, and SMS messaging on mobile-phones to provide varying forms of awareness. Finally, haptic interfaces like InTouch [Brave97] and ambient media or "clam technology" like LiveWire [Wieser96] can provide rich awareness cues to remote or co-located parties. LiveWire was developed by artist Natalie Jeremijenko to show network activity over time by the movement of a dangling wire at Xerox PARC. Hence, low-bandwidth media can be used towards a form of social exchange and peripheral awareness in an existing Media Space or create a perceived Media Space on its own; we can call it an *Ambient Space* (see figure 1).

4.2 Synchronous Interaction vs. Asynchronous Awareness

Media Spaces typically provide synchronous audio/video connections between remote participants. The objective is to provide a sense of shared space or a mutual presence, commonly referred to as "telepresence". However, all the systems we have examined have utilized this shared live connection for face-to-face interaction far less than for peripheral awareness. The movement and sounds perceived on both sides serves to provide an ongoing awareness, punctuated with intermittent conversations or visual glances. Hence, it can be argued that rather than live connections, asynchronous updates as seen in Portholes can provide adequate context and ongoing awareness. There is a tradeoff between observing continuously updated cues, which can be considered distracting vs. messages transmitted infrequently

requiring a user to re-establish context and perhaps miss important cues (noted in Voice loops). Hence, the pace of awareness must be carefully balanced based on the pace of changing social context, the tasks and goals of the participants. People in domestic and office environments may find asynchronous cues adequate for social awareness, whereas shuttle control or emergency care scenarios may require near-synchronous awareness of activities. The key point is that even intermittent cues perceived over a continuous time-span, such as a flurry of SMS messages on mobile-phones between 2 or more parties over a 3-5 minute duration, can provide a sense of being in a Media Space that we will later refer to as *Awareness Spaces* (figure 1).

4.3 Spatially vs. Temporally Distributed Participants

Most Media Spaces that we have discussed are designed to provide communication and awareness between geographically distant participants (however in many cases they may be co-located in the same facility). The main emphasis is to establish a "spatially-neutral place" that these participants can inhabit or share simultaneously. In contrast to this, one can propose a "temporally-neutral place" that several co-located but temporally distributed participants can share. Here people can gain an awareness of others who leave a trace of their presence at different moments in time. Such a place is perceived by users of Audio Aura [Mynatt98], where they can hear prior ambient activity and messages from others (left in the past) or forthcoming events, as they physically pass nearby people's offices. An archived newsgroup or Instant Messaging (IM) window also serves to provide a social forum and place where people contribute messages at different times, rather than chat simultaneously. The act of participating and being aware of intermittent social activity (captured/represented on the system, such as dynamic "buddy lists" in IM) while remaining connected over time may create a similar perception of a temporally-neutral social place. A good example of such spaces include Chat-Circles [Donath99], which graphically represents traces of people's chat and lurking activity in a newsgroup over time. We will later consider an example of an augmented shared space, the Aware Community Portals [Sawhney00], designed for co-located but temporally distributed individuals.

4.4 Using Context to Manage Privacy & Interruption

There is a dual tradeoff between the level of awareness and the potential for privacy intrusion and disruption of one's current tasks [Hudson96]. Hence the benefits of awareness are minimized, as one must consciously make efforts to avoid lapses in privacy or continuously switch attention from their foreground tasks. As the resource demands of one's own tasks increase, the opportunities for undesirable disruptions can go up dramatically, and greater efforts are required to counter these disruptions. In all Media Spaces, the key challenge for their sustained use requires balancing these trade-offs in a socially appropriate manner. Although some Media Spaces allow one to switch-off audio/video connectivity at certain moments or manually set modes of availability, these are often ineffective as they require conscious effort and are easily forgotten, causing undue embarrassments. Some limited perceptual mechanisms have been developed for Media Spaces, such as reduced resolution images, low-disturbance audio [Smith95] or GarblePhone [Marti99], contextual notification [Sawhney00], shadow-views [Smith95], activity graphs [Lee97] and blurring filters [Zhao98]. CoMedi [Crowley00] is an example of a Media Space application that attempts to minimize socially incorrect gestures or images transmitted by using an Eigen-space blurring filter for privacy. The filter uses principal component analysis (PCA) to combine "socially correct" basis images with live images of a user's face; the resulting reconstruction removes gestures or background persons not in the original basis images. These techniques have not been evaluated extensively in social settings outside the lab; but more seriously, they assume highly simplified notions of people's expressive communication behaviors and complex social needs. For example, multiple levels of blurring an image or garbling audio does not provide greater perceived levels of privacy; in most cases people either prefer open channels or low-disturbance audio. However, even low-disturbance audio played over time cannot be easily ignored and becomes perceived as noise transmitted across the Media Space. Here some form of intermittent open communication or masked activity, based on the social disposition of all participants is necessary for providing meaningful awareness over time. Hence, there are greater social and technical challenges for developing perceptual mechanisms for everyday use. We shall call any such form of perceptually mediated awareness as "Situated Awareness", which we believe is a critical feature for sustaining Awareness Spaces.

4.5 Defining Awareness Spaces: Peripheral, Asynchronous and Situated

Many pre-existing but novel systems can help define the characteristic features and hence boundaries of what can be broadly conceptualized as *Awareness Spaces* (seen in figure 1). By extending *Media Spaces* to include lower-bandwidth modalities and asynchronous exchange we can introduce a variety of communication modes that utilize ongoing connectivity to enhance awareness with multiple participants. Here time-limited transactions with point-to-point modes, such as telephony, letters, fax and email are not included. Several characteristics of this space can be combined to create novel forms of asynchronous communication and awareness, informed by the social context of its participants. This redefined sub-space can be broadly referred to as *Awareness Spaces*. We now consider a new definition that embodies these main characteristics:

"The perceived effect of *Awareness Spaces* is a continuous but intermittent and peripheral awareness of contextually-relevant social activity of spatially or temporally distributed participants".

This definition identifies the continuous but asynchronous paradox of *Awareness Spaces* while firmly grounding them within a known social context that constantly informs the level of awareness, interruption or privacy provided to participants. One must also note that we define such a space primarily as "perceived" by its participants in an ongoing social context over time, rather than being specified by a particular mix of bandwidth, modalities or communication techniques.

Currently one example of a commercially available *Awareness Space* that we can consider is that created by users of Instant Messaging. IM embodies some of these characteristics in a simplified manner, such as asynchronous messaging, awareness of the status of buddy lists, and allows people to manually set their social availability. One can consider the CoMedi system close to being a visual *Awareness Space* with its context based visual filters and social cues. However, neither IM nor CoMedi provide peripheral awareness as they were designed as the primary applications for desktop users, and IM is hardly context-driven. Hence they both generally fall closer to the outer boundaries of the area mapped for *Awareness Spaces* (see figure 1).

Characteristics and Trade-offs in Awareness Spaces

Dourish [1997] points out that the primary role of awareness information is to make one's activity apparent to others. In any awareness system one can consider both the *sources* and the *representation* of activity. Sources of activity include physical inference from audio/visual activity, motion from infrared sensors, as well as computer-directed activity such as typing on a keyboard, mouse usage, file access or retrieval and so on. However to construct a meaningful representation for awareness, it is important to consider how such activity can be presented, fused, transformed or summarized. Motion sensor data captured in the homes of seniors or from infants can hardly be useful if presented in its raw form, however activity summarized and adjusted relative to normal patterns can provide better understanding of anomalous events. This transformation is also necessary to make activity less explicit and minimize privacy concerns. Although any interpretation of data obviously imposes on privacy, it must thus be easily observed, turned off or negotiated by the sender.

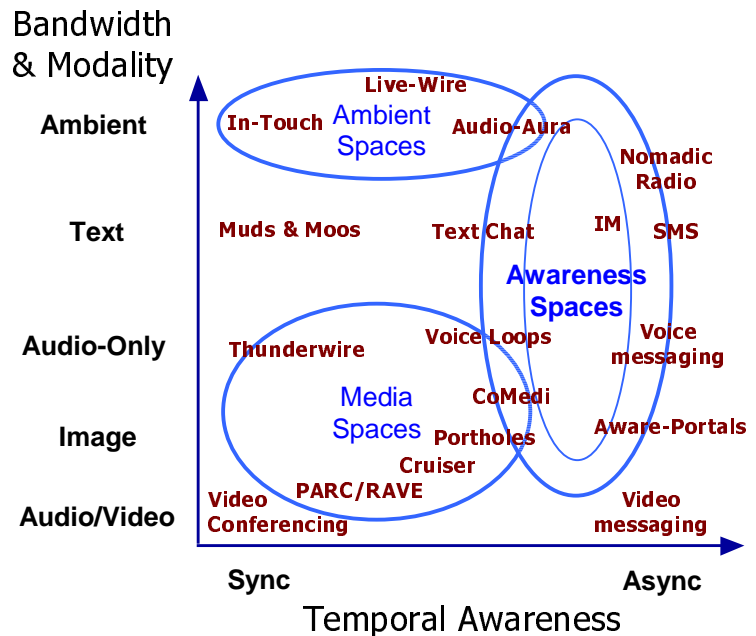


Figure 1: A taxonomy of communication systems along the lines of temporal and modal characteristics. Continuous but intermittent modes of communication across bandwidth intensive or lightweight modalities can be perceived as *Awareness Spaces*.

Awareness can be perceptible as auditory, visual or haptic feedback, rather than a dedicated audio/video media connection expected in communication. These low-bandwidth feedback cues enable peripheral access to one's activity. This passive attribute is an important notion for awareness spaces, as it allows information to arise directly as a natural outcome of one's activity rather than having to be managed explicitly. The cognitive load of interpreting awareness information should lie in the perceptual domain rather than having to be consciously resolved. Hence even if low-bandwidth and intermittent auditory or visual feedback is provided, if it requires conscious management or interpretation on the part of either sender or recipient, it cannot serve as a good awareness cue. In Voice loops and Thunderwire background conversations provided meaningful awareness only upto the point where noise or extraneous discussions made the cues hard to interpret and disruptive to foreground tasks. Here users quickly transitioned from a "perception of" communication to awareness spaces and finally to simply disruptive spaces in some cases. Another example is Instant Messaging; here intermittent communication is maintained for some duration, however the "buddy lists" act as means of notifying participants about other's state and availability. These awareness cues can then be used to trigger actual communication between parties using IM. A similar approach was developed in an earlier system called Watcher [Schmandt94]; here a user was presented with previously stored images or caricatures of others indicating their availability. When desired one could opt to establish a voice link with a party, using the system. However, it was found that most preferred to use the system primarily for awareness and such cues were rarely converted into communication opportunities. Watcher was different from Portholes in that no live images were captured and used in the representation. However, it required participants to manually set availability modes, which reduced its benefit of awareness.

The challenge is to develop low-overhead systems that utilize a number of rich modalities to provide awareness based on changing social context. A system like CoMedi uses perceptual filters to minimize socially incorrect gestures and blurring of images for privacy. An example of an audio-based communication system that plans to utilize many aspects of Awareness Spaces is a research prototype, Whisper [Lee00], a VoIP (voice over IP) communication system that augments synchronous voice connections with asynchronous voice messages screened for recipients based on their pre-designated social context. This system can be improved in the future by providing trusted callers with synchronous awareness of the called-party using privacy filters via GarblePhone [Marti99]. In Awareness Spaces previously captured media or a history of prior activity can be used to provide additional context, to aid in the interpretation of current awareness cues. In a mobile context, such techniques complemented by perceptual sensing of the users' context can provide a truly *Situated Awareness Space*. For example, a mobile phone may present awareness cues for participants within a certain geographic proximity of the user or ones deemed to be important based on an upcoming appointment. Hence, the rich characteristics of Awareness Spaces can be further explored and combined to create novel forms of asynchronous communication and awareness for specific environments, informed by the social context of the participants.

To summarize, one can argue for several essential characteristics of awareness spaces:

Lightweight and implicit capture of activity that does not impose greater effort on part of the senders to convey awareness information.

Transparency, Trust and Control over activity information made available to others. Senders should be able to recognize with minimal effort what aspect of their activity is being made perceptible to others.

Meaningful Representation of the awareness feedback that does not require greater cognitive overhead for recipients to interpret. The representation may be adjusted relative to normal levels of activity and noise to provide a better indication of novel or anomalous information.

Disjoint Sources and Representations of activity is an important aspect of awareness spaces. Many sources of information may be fused or transformed to present activity over time in a single coherent representation, and in an entirely different modality. Multiple shared representations may be useful for different contexts.

Awareness in Context - a system should represent information meaningful for a timely activity or within a given social context. This does not preclude it from capturing information at all times, however it is presented in an appropriate manner only when it is desirable for the recipient.

Passive and non-disruptive feedback which enables the recipient to attend to foreground tasks while maintaining peripheral knowledge of continuous or intermittent awareness cues.

Affordances of Awareness Spaces

Accessing Temporally or Spatially Distant activity - Awareness spaces can allow participants who are not temporally or spatially co-located to retain understanding of each other's activities.

Recognizing patterns of activity - A persistent representation allows one to view a summary of activity captured over time or recognize anomalous events, which would not be otherwise obvious.

Passive Awareness mechanisms allow people to shift their attention dynamically and opportunistically in response to changing situations, while maintaining a focus on their immediate tasks and goals. This form of monitoring or peripheral awareness requires low task overhead and attentive focus, while permitting distribution of cognitive abilities across a team and an efficient coordination of activities.

Social Facilitation - Ackerman [1995] states that people clearly use other's visible activities in framing their own goals, motivations and actions. Hence, knowledge of an operator's actions would allow another to pace her own actions accordingly. The presence and behavior of others (and even their absence or inactivity) can help define the meaning of situations for the individual and shape her own attitudes and behavior.

Challenges in Awareness Spaces

Disruption of Privacy - It is clearly important that users be able easily observe, control and negotiate their own privacy protocols. However, unintended lapses in privacy are often unavoidable and embarrassing.

Disparity in effort required vs. perceived benefit - Awareness systems that expect users to explicitly indicate their availability or level of information captured/received ensures greater privacy protection but acts as a disincentive for sustained usage. If users must be constantly conscious of doing the task of awareness relative to their own task at hand, any benefits of so called "peripheral awareness" are greatly minimized. Dourish and Bellotti [1992] state that in many cases users who provide information do not directly benefit from it. "The price of heightened awareness for the group is clearly restriction in the potential activities of individuals". Individual bears the cost of providing information without any guarantee that others will benefit.

Appropriate and Timely Awareness - Individuals will receive what the initiator deems to be appropriate; however this depends on the context of other's activities. Awareness is only relevant at the right level of specificity and at an appropriate moment relative to the recipient's current activity.

Critical mass problem - a multi-party awareness system requires the explicit participation of all; however if the system is not adopted due to cumbersome interaction or privacy concerns, then awareness effects cannot be facilitated. This is related to the *Threshold Effect*. Here if usage drops below a certain level, people will stop using such a system. People will feel that it is not worth checking for activity if they believe little exists. However, people are attracted to systems where there is considerable activity, and may be motivated to participate. Hence, users need to be convinced not only of the benefit of awareness cues but also that there is sufficient activity by others, before they can be bothered to use it [Ackerman95].

Effects Difficult to Evaluate - Extended evaluation is the key research challenge of deploying any awareness system in everyday environments. As awareness is a perceived effect and its benefits are generally socially motivated, it is extremely difficult to measure its effects. Most evaluations of awareness systems require field studies using long-term participant observations and interviews, rather than results from direct empirical or quantitative data. However, even in observations the effects are not easily seen unless carefully examined over several hours or days of usage, among multiple participants. In interviews, people will usually not articulate such effects because they are not actively conscious of them. The notion of "awareness" itself is not a *separate concept* in their mind, rather they assume that it is part of their everyday actions and acts of communication. Hence, evaluating the benefits of awareness spaces is non-trivial, making it hard to justify in many settings.

Designing a system that provides an awareness space requires careful examination of these affordances and challenges, while recognizing the unique characteristics of the social setting within which it is deployed.

5. Understanding Awareness in Everyday Life

Here we examine the notion of awareness in the workplace, domestic life and an emergency care scenario.

5.1 Aware Community Portals

In a workplace setting, people wish to maintain a level of awareness of timely information, including presence of others at different times of day. There is a need for better exchange, coordination and personal contact within the workplace, especially as people work at asynchronous times and in distributed locations. The challenge is to develop lightweight techniques for awareness, interaction and communication using 'shared information appliances'. Here, we describe the design of an exploratory responsive display projected within a shared workspace at the MIT Media Lab. The system uses visual sensing to provide relevant information and constructs traces of people's activity over time. Such 'aware portals' may be deployed in casual workplace domains, distributed workgroups, and everyday public spaces.

5.1.1 Social Setting: The Garden Workspace

The MIT Media Lab consists of both shared offices and open spaces for workgroups. The lab thrives on the interaction among and between such groups to maintain an active research and fluid social environment. However as the lab grows (physically expanding to several facilities) and people work at asynchronous times, it becomes difficult to maintain awareness and social contact with other researchers. We chose to utilize a workspace and 'social collective', called the 'Garden' as the primary environment for our exploratory project. The Garden hallway, which is frequented by many people throughout the day, faces the entire space and is visible by most people working there (see figure 1). The hallway like a street corner has a high incidence of chance meetings and spontaneous discussions [Whyte88]. This provides a good opportunity to utilize this transitional area within the Garden workspace for responsive display of situated information and awareness patterns, in trying to support long-term social interaction. Our current prototype deployed here explores these themes and serves as platform for design experiments. The system consists of a projected video display driven by a graphics-rendering engine on an Alpha workstation, live information provided by servers, and active sensing from a networked camera in the hallway.

5.1.2 Content Filtering and Shared Display

A content transcoding server (written in Perl) monitors news sources of interest to the community. *Slashdot.com*, a popular technology web-log, was chosen as an experimental news source, as many people in the Garden workspace visit the site frequently. New articles at the site are parsed and relevant information is extracted from nodes in the parse tree. The system uses this information to create a graphic rendering for each news story, optimized for the low resolution and other display constraints of the projection system (see figure 2). The portal display engine, written in ISIS [Agamanolis97] (a programming environment for responsive media), renders graphics and text as a video projection, and manages live information queued from servers. The projection periodically shows information such as clock-time, hourly cartoon-strips, and live data (news and weather) from the transcoding server. The system is being extended to incorporate the Garden mailing list and allow people to directly post timely messages to the portal.

5.1.3 Proximity and Glancing as an Interface

To maintain a casual and natural interaction, user intent is inferred as they approach the projected display. A phased approach first displays an 'information glance' when new information arrives. When a person is seen *walking-by* the space, a sequence of recent articles are shown cycling through. If the person stops to *glance*



Figure 2: *Transitional Interaction* - a weather map triggered by the user walking by vs. a news article shown when the user lingers to browse. Notice a potential design element: shadows of prior viewers, cast on the article could be used to gauge community interest in current stories.

at the display, a preview of the current story (news headlines or weather map) is shown for a short duration. If the person then continues to glance, the system assumes she wishes to *browse* the article in more detail, hence a sequence of related information is shown (see figure 2). After a person leaves, the display gradually fades away. The timing and duration of *information glances* and previews have to be carefully devised and synchronized with movement to provide fluid presentation and interaction without being overtly distracting or prolonging beyond a user's interest. A networked video camera mounted on top of the portal provides live video via a server to different processes that analyze the video. A video window on the top-right corner of the display shows the view seen by the camera both as a means of providing interaction feedback and assuring people of the purpose of the camera. Movement is detected via image differencing and thresholding techniques in ISIS. A face-detection system [Rowley98] monitors whether a person is looking at the display and triggers a close-up of the current article. A bounding box on the person's face indicates the system is tracking their face for a glancing action (figure 3).



Figure 3: Detecting a person glancing at an article and stepping closer to see more. By gazing at the camera for a longer duration, a person allows the system to capture his face.

5.1.4 Temporal Awareness Patterns

The portal is designed to allow people to maintain persistence of usage over time and provides a form of awareness of the presence of others during the day. One mechanism is to capture people's faces as they browse articles they are interested in. While glancing at an article if people choose to look directly at the camera (to indicate their interest), a bounding-box on the person's face grows gradually (see figure 3) allowing an opportunity to step back if they don't want their face captured. Once captured their face is shown on a timeline in the left corner associated with the article seen (see figure 4). This provides both an awareness of others who have browsed the article (and been around in that physical space recently) as well as a sense of the general popularity of certain articles.

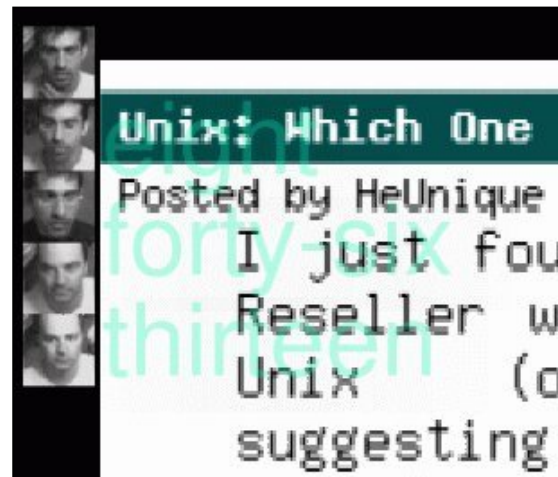


Figure 4: A timeline of faces shown on a portion of the large display indicates people's interests in certain articles and also provides an implicit sense of awareness of whose around during the day.

In addition, an activity timeline at the bottom of the portal display (see figure 5) shows an on-going pattern of usage as people walk by and use the portal. Movement in the hallway (correlated with general activity in the workspace) is shown as small traces (squares) on the timeline. Faces captured while people browse articles are also shown (as reduced thumbnails) on the activity timeline. This provides a general sense of activity in the space and who's been around throughout the day. It is important to note that the system currently does not recognize the person whose image is captured (maintaining their anonymity to the system), however in the future such recognition may enable personalization of news content or tracking of user's interests (if desired).

Hence even with lightweight transitional interaction on the portal, a range of responsive behavior can be provided. Awareness cues can be implicitly captured and represented over time. Previously stored facial images were used in the Piazza system [Issacs96] to show other users browsing the same document



Figure 5: The activity timeline at the bottom of the portal display shows traces of activity near the hallway (squares) and the presence of people (faces) who browsed articles on the portal throughout the day. The highlighted area marks the current time.

on-line, whereas the portal provides awareness of people's interests and activities in a shared physical space over time. Informal usage of the portal shows that people are curious to use such a display in their workspace, however initially desire better cues (such as audio/visual or text-prompts) to enable them to understand the different modes of interaction. The glancing interface requires some familiarization and conscious interaction, hence should be improved. Users have a strong desire to post messages to the portal easily, in addition to the current web-based content. The awareness cues in the timeline engage people, however extensive observation over time is necessary to determine their impact on everyday communication and awareness in the workspace.

5.1.5 Aware Portals as Awareness Spaces

Publicly available information is predominantly accessed through private information appliances. For information of broad community interest, however, it may be more appropriate to integrate the information within the very spaces we occupy [Dourish97]. Such systems must have an unobtrusive means for sensing user intention and activity patterns while remaining sensitive to the privacy and cultural norms within a community. Our current prototype explores these issues within a workspace using transitional interaction techniques and a representation of awareness patterns based on visual activity. One can consider techniques for extracting high-level activities of people in workspaces from motion templates [Bobick97]. By providing more personal information to a shared portal, one may get more relevant information from the system and allow known others to get better awareness, however there is also a greater potential intrusion of one's privacy [Hudson96]. We need to consider negotiated protocols and interfaces that *perceive* and retain the level of privacy one demands in different situations.

A natural and useful extension of these 'aware-portals' is to provide awareness and communication between distributed workspaces. Audio/visual interaction protocols must be developed to enable spontaneous and situated communication opportunities between distributed portals. Providing shared community-postings and annotation on the portals may allow greater engagement with people in distributed locations. We believe a transitional place for shared information access and awareness within a workspace can be a valuable means to support coordination, negotiation and a sense of belonging. Such a place embodies the many of the peripheral, asynchronous and situated characteristics of Awareness Spaces we have described earlier.

5.2 Domestic Communication and Awareness

Despite a range of communication technologies available today, it is felt that families have difficulties managing everyday communication and subsequently the relationships with members that are temporally or spatially distributed. There is a dearth of research in Human-Computer Interaction (HCI) to understand domestic communication patterns and conduct socially informed design in such settings. However there are a few recent examples of projects and studies in the domestic domain. The Presence project [Gaver99] used cultural probes to consider design for communication in elderly communities. British Telecom has done a number of larger-scale field experiments that consider the role of monitoring [Barnes98] and communication devices in homes (no studies made publicly available yet). Recent projects have undertaken the design of smart homes as test-beds for new technologies, such as the Aware-Home at Georgia Tech [Kidd, Mynatt et al 1999] and the House_n project at MIT [Intille et al 2000]. However, it is clear that a smart home does not necessarily support the cognitive demands and social relationships critical in domestic life. Let's consider the introduction of media technology in household settings; A recent ethnographic evaluation of set-top box trials for digital services to the home by O'Brien and Hughes [1999] provides some reflection on the nature of domestic activities and their implications for design. The social organization of household routines clearly affect and are influenced by the introduction of media technology. In a number of homes visited by the investigators, they found that the content and scheduling of TV and radio was often used by family members to mark their *time* and *ownership of spaces* within the home. The everyday routine activities were found to be closely interwoven with (and even constructed by) the usage of media technology; individual usage was recognized as their access priority by other members of the household. Interestingly, the role of good parent was articulated by their careful control to certain media technologies. The investigators noticed an attribution of certain "status" to technological artifacts within the social organization of the household; e.g. television was considered "antisocial" when guests were received such that furniture was arranged away from the TV (towards home stereo), and placed back later. Overall the interaction with media technology in domestic environments is socially managed in complex ways and closely linked with relationships, routines and values within the home.

Trends indicate that personal mobile devices will be far more ubiquitous as wireless services become more affordable, and an array of richer information services on these devices become available. GSM phones in Europe and I-mode phones in Japan already point towards the usage of many wireless, location-dependent and 'continuous-on' services. In addition, use of VoIP (voice over IP) via Internet devices and local phones is greatly expanding as the quality and accessibility of the services improves. Such devices and services could begin to incorporate sensing and processing to make perceptual mechanisms feasible. Despite my own personal proclaimed aversion to mobile-phones (and pagers/PDAs), one can recognize (from the limited field studies) that in conjunction with other methods mobile devices are beginning to serve as an important communication link in domestic life (it is clearly useful in business, but that's not our concern in this paper). However, to understand and enhance domestic communication and awareness, we must consider how people maintain social relationships in home and work life, and the role of technology in these settings. There is not much evidence of *published* ethnographic studies on mobile domestic communication patterns. Although companies like BT, Motorola, Intel and Telenor claim to have done studies, no results are publicly available to my knowledge.

The literature in *social anthropology* informs us about the complex notions of family and household [Yanagisko79] and patterns of domestic interaction [Aldous77]. We need *ethnographic methods* for conducting social research related to communication patterns in such settings [Hughes94]. Ethnographic approaches towards social inquiry allow us to observe and interview people in their naturalistic settings to discover their personal experience, social attitudes and relations [Lofland84].

5.2.1 Understanding Domestic Relationships: Related Work in Social Anthropology

There is much to be gained by closely examining the literature in sociology and social anthropology in regards to domestic life and communication patterns within the family. We look primarily towards social anthropology rather than studies in communication psychology as we are more concerned with human interaction with other individuals (through devices in some cases), rather their conceptions of self and interactions with the devices themselves.

Defining the Social Unit of Inquiry

Many anthropologists make a distinction between family and household along the lines of kinship (i.e. related genealogy) and geographical propinquity or common residence, respectively [Yanagisko79]. In many societies families do not necessarily form households and vice versa. There is an attempt to avoid a functionalist definition of the family, as many functions construed as "family functions" are sometimes fulfilled by groups living together (or in the community) but not related by kinship [Bender67]. It is suggested that the family be defined in purely "structural" terms related to kinship. Goodenough identifies the mother-child unit as the nucleus of all family-groups [Goodenough70], however this is problematic as it assumes the vital function of the family is in procreation and child-rearing. There is also a difficulty in defining the boundaries of households, especially as there is greater mobility in the household with a seasonal cycle of dispersal and concentration. Anthropologists suggest terms like 'domestic group' or 'coresidential group' rather than households, focusing on reciprocal interactions between individuals in the group [Bender67]. These terms are only useful for ethnographers as far as they require one to be explicit about the exact nature of the social unit one wishes to analyze. One must recognize that these units cannot be easily categorized and reduced to some universal definition. Meanings pertaining to kinship relations can be derived from observable actions and verbal statements of individuals. Categories such as family and household and relatives encompass a range of different meanings based on the cultural/political context and different phases of their history [Schneider64]. There is an acknowledgement that the units labeled as families are as much a part of the political and economic structure of the society as it is a reproductive unit. There is nothing wrong with a functional analysis of families as long as we don't assume a priori that the "diverse array of social units we call families fulfill the same set of functions or their primary function is always the same". Hence these categorical units represent "inherently complex, multifunctional institutions imbued with a diverse array of cultural principles and meanings" [Yanagisko79]. We are more interested in the network of interactions and *relationships* within the family and outside (the nature of relationships may be more nearly universal [Bender71]) rather than defining categories of the family or household. We hypothesize that perhaps there may be communication hubs in such a family network, a "knot" that historically links the different social units, and hence may serve as resourceful and 'key informants' about patterns of interaction.

Understanding Patterns of Domestic Interaction

Anthropologists see family interactions as an indicator of how families organize themselves to perform activities that give them the characteristic of being enduring groups [Aldous77]. As structural supports to families seem to be weakening, the persistence of family units depends upon the solidarity of relationships within the group. Examining these relationships can center on either *process* or *outcomes*. There has been a steady shift in interest from correlates of interaction outcomes to delineating the processes. The process perspective is more useful for us as it takes into account the distributive aspects of family interaction i.e. who initiates actions, individuals involved, proportionate amount each members act constitute towards the interaction. The variables cited as affecting the process include *complexity*, *conflict* and *reciprocity* in the interaction. It is found that some couples "even appear to organize their marriages around conflictual interaction" [Cuber65], and despite disagreements continue to stay together. It is suggested that researchers have to go beyond the interaction units of action and response to determine how conflicts escalate and die down. Raush suggests use of Markov chain models to determine probabilities of certain behaviors followed by others, perhaps showing a phase pattern and turning points in disagreements [Raush72]. Interaction sequence analysis can potentially help understand some aspects in processes of communication over time.

Family communication can be broadly concerned with behavior such as exchange, power (influencing behavior, exchanging resources), task assignment, and expression of affection or disapproval [Aldous77] as well as non-directed given-off impressions [Goffman61]. An important concern is how does one evaluate impact or benefit of such communication processes. It is clear that the quantity of transactions is not as important as the quality of the interaction. On a related note, it must be observed that all communication cannot be considered beneficial. Undesirable communication can be disruptive. Moreover there is some evidence that communication openness can even exacerbate marital disagreement, especially when it reveals irreconcilable differences [Aldous77]. Restricted communication in working-class families is cited as an outcome of the number of problems they face; no amount of problem solving ability can increase the few alternatives available [Straus68]. Results from a small study suggest that television watching served as a device for families to avoid interaction in tense situations when spatial separation was not possible.

Overall this again points to the fact that even in conflict resolution the quality of communication rather than quantity seems to be important. This notion of 'quality' has been attributed to dimensions such as "families' problem-solving effectiveness, their coordination of individual solutions, and their ability to delay solution closure." [Reiss71]. An important dimension pointed out by Neidhart considers "system transparency" in family interaction [Neidhart76]. This reflects one's knowledge of other's needs and satisfactions; a form of social awareness leading to reciprocity in behavior. There is a need to examine the role of extra-familial social network in relation to the interactions within the family. It is speculated that conjugal task sharing, external network and shared social contacts outside serve as alternatives for household help, emotional support and is attributed to generally positive attitudes [Nelson66]. Overall though, there seems to be a lack of research on the external influences on family interaction patterns; in studies it is usually assumed that conditions outside the family are relatively constant.

5.2.2 Communication Patterns in Domestic Life: Pilot Ethnographic Study

In the Speech Interface Group, our interest is in deploying expressive communication and awareness technologies in both the workplace and domestic setting. A hypothesis is that providing some form of continuous-on and asynchronous connectivity within a meaningful social and physical context can foster better relationships and awareness among distributed family members. Existing technologies like phones already provide synchronous voice communication and to some extent asynchronous messaging. However it is not clear how these modalities are used in maintaining such relationships. A key concern for us is not to focus only on the pattern of communication within a co-residential social unit, but that with distant members and within the extra-familial network.

To examine the role of communication technology in maintaining domestic relationships, a short six-week pilot ethnographic study was undertaken in summer '2000. The study was designed and conducted by the author and a social anthropologist, Herve Gomez from the Dept. of Ethnology and Comparative Sociology, University of Paris X Nanterre, France. The goal of this pilot study was to gain an understanding of communication patterns in distributed domestic relationships and within the extended social and community network. The fieldwork consisted of interviews with 18-20 informants from immigrant families in the local

Cambridge and Boston area. A team of 2-5 investigators including the author, conducted the fieldwork in July-August, 2000. The informants were approached through personal contacts and local community centers. All interviews were audiotaped for subsequent transcription and analysis.

A Note on Methodology

It is important recognize the qualitative nature of a such ethnographic studies. The goal of the study was to better understand people’s interpretation of their social patterns and conception of the role of communication in their relationships. The study did not attempt to collect quantitative data from a statistically representative sample of the population. But we feel that even with small set of interviews across informants with different backgrounds, gender, ethnicity and social status, an ethnographic study can provide an understanding of broader patterns in society. Generally, such fieldwork requires participant observation, however the short time-frame and nature of the study required the use of intensive but unstructured interviews with all informants (usually lasting an hour or so each). In the intensive interview the emphasis is on obtaining narratives or accounts in the person’s own terms. The interview guide serves as a primary reference, but the investigator is free to change topics based on the responses heard. A series of *probes* (often connected to a specific question) may be asked to engage the participant to discuss issues not mentioned or only slightly disclosed earlier. E.g. “You have mentioned that... Why? What does it mean for you?”. Overall we must recognize that such a social inquiry in the field requires flexibility on the part of the investigators to refine goals, methods and tasks, based on the emerging characteristics of the people and environments studied.

Preliminary Analysis: Case Study of Two Indian Families

The interviews were summarized and categorized initially based on family groupings or ethnicity of the immigrants, and later based on their time of arrival in the U.S., to understand common meanings, traditions, practices and relationships. For each group we examined their *migration profile, domestic and social relations, and communication modes and practices*. Later additional categories and typologies can be developed, based on distinctions in gender, single/married status, early/late technology adopters, and so on. As the analysis work is not complete, below we summarize a case study of 4 interviews from two Indian families (husbands are brothers) from Bengal (East-India) who immigrated to the U.S. in the 70’s and 80’s. The nature of their relationships and communication patterns are fairly typical of other families we examined.

Migration: The two families migrated to the U.S. for better opportunities, and clearly had support via friends and family who were settled there previously. They have managed to maintain links with the local Bengali community as well as close interaction with work colleagues. They have chosen to stay in different suburbs for different reasons, but maintain contact with each other. There is correspondence with family abroad, however it gradually decreases over time as they lose shared context and especially if their immediate family no longer resides there.

Role of Mother as the Distant Communication Hub:
 All informants have strong links with their mothers abroad, with whom they would correspond frequently both by letter and phone. The mother serves not only a parental or emotional link, but also provides news and information about others in the family. All informants found an efficient means to keep in touch with their families abroad. They feel less inclined to call all siblings living abroad, preferring to speak more often with one main hub such as the mother (see figure 6). This point is emphasized by the diminished communication pattern of the brothers (with their families abroad) after the loss of their mothers.

Role of Wife as the Local Communication Hub:
 The husbands in both families keep in touch with their wives throughout the day, both for routine home-related tasks, but also to inquire about the children (living near or away). In fact, the wife also acts as a link to their friends in the local community in their case. Hence she maintains an important communication role in the family. From closer examination of all interviews, we have subsequently discovered that the wives also maintain ties with their husband’s families in India, via a

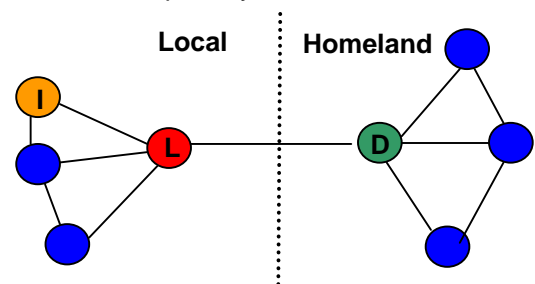


Figure 6: The graph here depicts a social network with local (L) and distant (D) hubs using several modalities for frequent communication, while providing an ongoing channel of awareness to others, such as the informants (I), in their respective networks.

cousin there (through email) who now serves the role of a distant hub in the social network. Hence, there is some evidence that the network reorganizes itself around new hubs, via new communication channels.

Diminished Letter Writing: Writing letters is considered less convenient and is clearly being displaced by phone and email, as the costs and accessibility improves. However, some still prefer to write every 1-3 months, partly as a habit with the older generation and also for a more personal expression. There is still much evidence of festive cards being regularly exchanged by families.

Email vs. Voice: All informants were enthusiastic about email and its benefits, particularly for long-distance contact. They all claimed that they would keep in touch with folks abroad more so if they had email accessibility. However, it was not perceived to be a replacement for voice conversations, which was still considered essential for most on a regular basis. There is an anxiety if some informants not have regular voice contact; it also provides emotional support.

Ownership of home PC affects email usage: Despite availability and familiarity with email at work, it is claimed to be used less frequently for personal contact in these families (informants worked in a busy doctor's office or used a restrictive military network for email). Both families have acquired PCs for the home, but their sons primarily use them, especially in the evenings when they come home. Hence, the PC is perceived to function as a learning tool for the child and owned by him, but not considered a communication appliance. It clearly reduces their ability to have email correspondence with friends or family abroad.

Coordination and awareness with family on the move: Both families do not currently own personal cell-phones but claim that they would be beneficial for use within the family. They mention 2 key reasons: Coordination with wife and children while on the move, and to minimize their concern for their whereabouts and safety when they are out late. They seem frustrated that their children do not communicate about their whereabouts or respond to messages at certain times, This seems to be a strong point of contention in their cultural or generational attitudes which may often lead to concern and misunderstanding. They feel that providing them a cell-phone may alleviate some of these issues (However, we must note that many other informants who used cell-phones stated greater aversion to its increasing use). They do recognize their need for privacy and not being able to call their parents in the presence of others. For this purpose, a simple 2-way messaging device may be useful. They also mention a need for some form of awareness of elderly or sick relatives abroad. Clearly a convenient and socially appropriate mechanism for awareness is desirable.

The analysis work for this study has not been completed hence the results discussed here are preliminary and not comprehensive. The data from the other 14 transcribed interviews needs to be more carefully examined. Overall, the study has enabled us to get a better understanding of communication patterns and the use of technology in domestic life. Further analysis may yield deeper insights towards the use of communication modalities in maintaining relationships. An extended study can be designed to pose questions regarding awareness issues via follow-up interviews and participant observations.

5.3 Awareness in Emergency Care

One can argue that examining communication patterns in the workplace and domestic life can yield mostly surface issues and subtle utility for ongoing awareness. Hence, one may wish to examine a domain where the communication and awareness patterns are highly pronounced, and more easily observed among the participants. Some examples studied in the past include air-traffic control [Mackay99], subway controllers [Heath92], and space shuttle mission controllers (Voice loops) [Watts96]. However, another life-critical domain not well studied in HCI is Emergency Care in hospitals or clinics. Here a team of doctors, nurses, administrators and support staff must constantly remain aware of the status of events and the presence of others for completing life-critical operations. Doctors-on-call are usually provided with one-way pagers that allow them to be reached for emergency care. However, doctors and nurses are often found to be overworked and there are many lapses in communication where a doctor who may be unavailable or resting from a long operation is contacted rather than one more easily available and in closer proximity. There is no evidence of any published work in analyzing the communication patterns in this domain. However, it seems to be a rich area for future ethnographic work. Study of such a domain may reveal stronger patterns as these participants can be considered lead informants with extremely urgent needs. Any design solutions proposed for this domain may provide meaningful insights in broader settings.

6. Conclusions

In this paper we have reviewed the literature on Media Spaces, outlining the evolution of research in the area and studies indicating the social effects of ongoing communication between distributed participants in workplace settings. It has been recognized that peripheral awareness continues to serve as a key benefit of such computer-mediated environments. To better support awareness, we have proposed consideration of low-overhead modalities, emphasis on asynchronous communication, support for both physically and temporally distributed participants and finally the incorporation of social context (via perceptual mechanisms) in such systems. We broadly refer to systems that embody such characteristics as *Awareness Spaces*. We have shown an illustration of some aspects in the *Aware Community Portal*, designed to support co-located inhabitants of a workspace at the MIT Media Lab. A key area for ongoing research is supporting communication and awareness in domestic settings, to help maintain personal relationships in the family, household, or community. There has been a lack of published research or studies conducted in this area. We briefly mentioned some recent HCI projects for domestic settings and related work in social anthropology on domestic interaction. To gain a better understanding of the role of communication in domestic relationships we conducted a short 6-week ethnographic study with immigrant families. The goals, methodology used, and some preliminary findings from a case study of two families, was summarized in the paper. Although our analysis is incomplete at this time, it is clear (to me personally) that social anthropology and ethnographic fieldwork must play a vital role in informing the conceptual framework and guide the design of future communication environments. The paper closes with a proposal for an extension of the ethnographic studies in both domestic and emergency care settings for gaining meaningful insights in this area. Awareness Spaces can be beneficial to enhance everyday communication in workplace and domestic settings, however their design must be firmly grounded in the social and cultural settings of the participants.

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