Chapter X

DESIGNING DISPLAYS FOR HUMAN CONNECTEDNESS

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Abstract: How can we design displays that foster a sense of presence and awareness… that enhance a sense of community and togetherness… that enable human bonds to grow and flourish? Using five prototypes from the Human Connectedness research group at Media Lab Europe as a context for reflection, this chapter attempts to assemble a framework of questions and strategies for designers to consider when working to achieve these kinds of effects. The prototypes discussed include a media space that connects several physical locations in our organization, a video conference system based on the metaphor of a magic mirror, a video installation that displays layers of recorded social interaction, an ambient display for hospital patients in isolation wards, and a "sports over a distance" application with an "exertion" interface.

Key words: displays, presence, awareness, community, togetherness, connectedness, design principles

1. INTRODUCTION

Although not the only means of interfacing with digital information, bit-mapped visual displays are certainly one of the most common. Advances in display technology have enabled them to take an increasingly wider variety of forms that depart from that of a general purpose computer monitor sitting on a desk in an office behind a keyboard and mouse. Displays of radically different shapes and sizes can now be embedded in or projected onto unexpected surfaces in unexpected places, and they can incorporate a variety of new sensing technologies that enable new kinds of interaction. Many of the chapters in this book illustrate the advantages of *situating* displays in particular kinds of configurations and in particular kinds of spaces that might

be more appropriate for supporting certain applications, especially those that are focused on background communication or that work to foster enhanced awareness or a sense of community among different groups of people.

What constitutes a good or bad design choice with respect to these kinds of displays? What questions should we be asking during their development? What general rules or guidelines are we operating with, if any? Can these be articulated so they might inform future efforts?

Some insight into these issues is being gained in the Human Connectedness group at Media Lab Europe. This chapter is an attempt to distill some broader design principles that are noticeable across several of the group's endeavors (as well as others in related research programs, past and present). I begin with a short background of the group itself and follow with descriptions of five of our most display-centered prototypes. Using these as a context, I then present an evolving list of design "nuggets" that appear to run across these projects and that could be useful in guiding future undertakings.

2. THE HUMAN CONNECTEDNESS GROUP

In addition to other basic requirements, humans have a biological need for contact with other humans. Our interactions and relationships with other people form a network that supports us, makes our lives meaningful, and ultimately enables us to survive. Authors like Lewis, Amini, and Lannon [20] describe in detail the critical regulating effects that social contact and healthy relationships have on human mental and physical well-being, as well as the sometimes devastating consequences that arise from a lack of these necessities. House, Landis, and Umberson [13] discuss developments that suggest that a lack of social relationships constitutes a risk factor for health that rivals that of other well-established factors such as cigarette smoking, obesity, and lack of physical activity.

A variety of factors threaten our ability to form and attain balance in the kinds of relationships that we want and need to have with others. In addition to unavoidable personal factors, such the need to travel or live in a different place apart from family and friends in order to fulfill work responsibilities, trends that exist at a societal level also have an impact. Putnam [27] describes how people in American society increasingly lack social interactions, and how this loss of social interconnectedness jeopardizes health on both a physical and civic level. A study undertaken by Carnegie Mellon University suggests the use of computers and the Internet may contribute to social isolation and individual stress levels [19].

The Human Connectedness research group explores the topic of human relationships and how they are mediated by technology, with the ultimate mission of conceiving a new genre of technologies and experiences that combat the effects mentioned above and allow us to build, maintain, and enhance human relationships in new ways. It also aims to enable new kinds of individual bonds and communities that were not possible before but may be beneficial or fun.

Beyond imagining new forms of social interaction, the group explores how new technologies change the way people can *be related* to each other—in the same way that, for example, we feel *related* to people in our families, *attached* to things that are important to us, or *bonded* to friends and loved ones. Some other key research questions for the group as a whole are: How can we convey a sense of presence and togetherness over space and time? How can we promote and support collaboration between different groups of people? How can we achieve greater balance in our relationships with others? How can we share a sense of intimacy and closeness in new ways? How can we enable new forms of cultural exchange?

The group aims to build a technological framework for applications in this domain, taking advantage of the infinite bandwidth and processing-rich computing environments of the future and the opportunity to extend these networked media environments into our physical and architectural surroundings. It is equally interested in forming a design framework that includes an understanding of sociological and psychological factors to help shape these systems in a fashion that reflects the needs and sensibilities of the groups within which they operate.

The group gains inspiration for the development of its prototypes from a variety of channels that include the results of scientific studies, observations of people and how they interact, ongoing dialogues with potential users of new technologies, as well as personal experience in relationships. While we want to project ourselves into the future to the greatest extent possible in imagining new technologies, we place emphasis on building working prototypes, the use of which we can study and learn from.

3. SURVEY OF PROJECTS

The following sections present descriptions of five different research projects underway in the Human Connectedness research group, each of which consists of a significant display component. These projects range in development from an early prototype stage to having undergone a formal evaluation. The purpose of these brief descriptions is to provide a context for a discussion later in the chapter concerning general design strategies for

display-based applications in this domain. Additional details and background may be found in the accompanying references.

In addition to these five projects from our laboratory, there are many projects in other organizations that have explored or are exploring different angles on the general theme of forming and sustaining human relationships that the reader may wish to follow up on, such as the interLiving project and their work with "technology probes" for inspiring design for families [14], the Digital Family Portraits project at Georgia Tech for supporting cross-generation interaction and awareness [25], and the Casablanca work on media space designs for home environments [12]. Additional related work is cited in the sections below.

3.1 iCom

A media space, a notion pioneered at Xerox PARC in the late 1980s, could be described as an electronic media environment that supports a shared activity between people who may be physically or temporally distant from each other. The classic PARC media space connected several offices and common areas in multiple geographic settings via audio and video links, enabling awareness, chance encounters, group meetings, and other kinds of functionality [2]. Many others since then have explored different aspects of the concept of media space. The RAVE system investigated different levels of engagement as well as issues of access and privacy [22]. The Portholes project specifically delved into the topic of awareness [7]. Some, such as Montage [30] and Piazza [15] with their "glancing" mechanism, particularly explored the notion of reciprocity.

Building on this past research, iCom explores ways of integrating awareness, conferencing, and community messaging functionalities into a situated architectural media installation. The prototype, which has provided a continuous link between several workspaces at the MIT Media Lab and Media Lab Europe for over two years, has provided a platform for exploring notions of foreground and background and their impact on fostering a sense of presence and community between distributed work colleagues and friends.

The development of iCom was motivated by a desire to maintain a basic sense of awareness and cohesiveness between people at the newly established Media Lab Europe and its parent MIT Media Lab. We wanted some kind of system that would convey an ongoing impression that we were all working together as part of a larger whole, that we were working in one large laboratory and not two different ones separated by thousands of miles. Bridging physical distance between different areas of just one of the labs was also a part of our thinking. From a foreground communication

perspective, we were interested in making ad-hoc meetings between researchers at these two organizations as easy as possible to accomplish, but more importantly we wished to build some kind of electronic venue that would motivate the activity of "hanging out" with people from the other locations, something we felt was not particularly well supported by other communication media.

At each iCom location (of which there are currently 4) there is a large-screen projection and seating area integrated within a larger work space such that the screen is visible from as much of the room as possible [Figures 1 & 2]. The characteristics of each connected space are similar and the inhabitants of these spaces generally know each other. We tried to design these locations to motivate their use as informal socializing areas, places to take a break and maybe chat with others. Specifically, a sofa and coffee table are placed in front of the screen, and other elements, such as an oriental rug at one location, serve as markers of the station and give it an aesthetic identity different from that of a dedicated work area.

The screen displays several streams of video from each location as well as the subject lines from recent messages and announcements sent via email to community bulletin boards at both laboratories [Figure 3]. Listed in chronological order, these subject lines are varied in size based on how old the message is and how many times it has been selected recently. There are two cameras at each station, one mounted above the screen with a view of the surrounding work area, and the other situated on the coffee table. A trackball enables people at the station to rearrange the windows, read the messages, or enable audio connections for meetings or casual interaction with the remote sites. The system addresses some potential privacy issues by synchronizing the screen projections at each site. What you see on the screen is what the other sites see on their screens, and nothing is recorded or displayed in other venues or on the Web. The system is turned on 24 hours a day, which makes it similar to such systems like the Bellcore VideoWindow [10], and other more recent experiments, such as that at Microsoft Research [18], which both emphasized connecting public or semi-public spaces in an always-on fashion.

In addition to being a long running example of an Internet-based multi-point media space, iCom experiments with the addition of a community message tracking element as well as connectionless peer-to-peer networking strategies to achieve low latency and enhance stability in congested or problematic network environments. The system conserves bandwidth by reducing frame rates where no activity is detected and by adjusting transmitted resolution to reflect the size of each video window.

It is difficult evaluate whether iCom has been successful in its overall goal of enhancing a sense of community between the connected locations,

mainly because there is no way to know how the culture may have developed in the absence of it. Our strategy for studying it thus far has included keeping a written record of observed behaviors, collecting personal accounts from those in contact with the system for various lengths of time, and distributing questionnaires requesting feedback of various sorts. Beyond the types of activities supported in earlier media space experiments, there are some other behaviors we have noticed that may be worth reporting. For one, persons on travel from one lab to the other appear to be drawn to the iCom to a greater extent and spend more time near it than others normally do, at least initially. One such person commented that it made her feel like she wasn't "so far away" from home. A certain amount of flirting between remotely-located persons has been noted as well, the extent of which seems intuitively greater than what might have happened if these persons were co-located, leading us to wonder if perhaps some aspect of the interface or the distance involved made this kind of activity somehow easier to engage in or "safer" than it would have been in person.

In addition, over the course of the project thus far we have engaged in a couple of "tea party" events synchronized between both laboratories to offer an opportunity for new members of either community to get acquainted with each other, with the specific goal of taking early steps to minimize the occasionally-reported discomfort of not knowing who is at the other end possibly peering into one's space. But we have also noticed that many who use the iCom regularly to keep in touch with friends will, on their own, introduce those friends to new researchers inside their own site or others who are standing or passing nearby, which suggests there might be a quorum of regular users with established remote relationships that would support the formation of new acquaintances and a reduction in discomfort in a more organic way.

Figure 1: An iCom station at Media Lab Europe.

Figure 2: An iCom station at the MIT Media Lab.

Figure 3: Screen shots of iCom showing it in a background state and in use for a live meeting between Media Lab Europe in Dublin and the MIT Media Lab in Boston.

3.2 Palimpsest

In contrast to the iCom, which aims to facilitate chance encounters between people at different points in space, Palimpsest tries to enable chance encounters between people at different points in *time*. The project is partly motivated by some shortcomings of iCom in the time domain, such as the inability to tell if someone was in one of the locations recently and the difficulty in conveying a sense of community between locations in different time zones without some kind of recording functionality, around which privacy concerns often arise.

In a manner similar to a real palimpsest (a manuscript consisting of a later writing superimposed upon an original writing), our Palimpsest superimposes layers of recorded video activity and presents them as a single visual as a way of expressing the recent social history of a place. The installation consists of a rear-projection screen and camera aimed across an interaction area, which could be a hallway or passage inside a building, or a special area dedicated to the project. Images of passers-by or participants are extracted from the background and layered into a video loop that repeats itself every few seconds.

Because the video is looped, if passers-by linger in the space, they will see a delayed copy of themselves entering the space from several seconds ago, and even more layers if they remain longer, together with the layers generated by other passers-by from earlier points in time. These layers accrue on the screen over several minutes, hours, even days, creating a visual that collapses time and compresses the recent social goings-on of the given space, allowing the viewer to witness the human crowd that has intersected with it. Even if totally alone in a seemingly quiet and empty space, a passer-by is able to "transcend time" and become a part of this community and to interact with its members, including possibly oneself [Figures 4 & 5].

Experience thus far with Palimpsest has included leaving it running for long periods of time in a dedicated space in our laboratory and showing it at a local digital film and art festival. Both resulted in much feedback, including suggestions to vary the loop duration, make the layers fade over a certain interval of time, and to add sound capability. In both instances the installation was arranged so that people could clearly walk around it if they did not wish to be captured. At least one person at the film festival, once he figured out what the system was doing, used it to leave a visual message for someone who he expected to arrive later. On a few occasions passers-by made obscene gestures, and interestingly, after realizing their gestures were repeating themselves in a loop, some of these perpetrators returned to conceal their gestures, while others seemed to gain great enjoyment from trying to fill the screen with as many looping obscene gestures as possible. This playfulness aside, several people became interested in using the Palimpsest for a new form of theater in which a single actor could play all the parts of a short play asynchronously, layering in each performance after the last. This idea sparked a new research project at our lab.

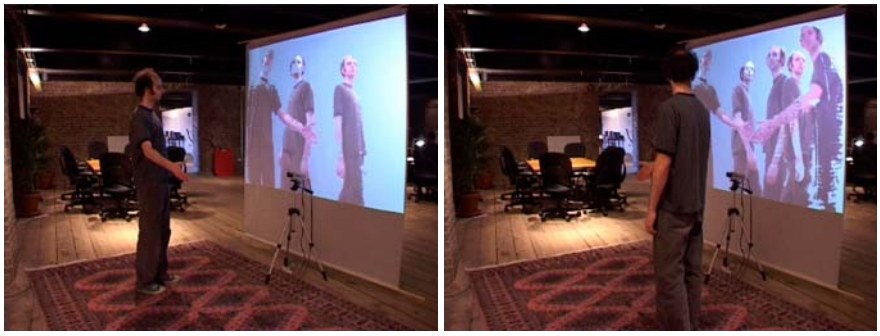

Figure 4: A passer-by interacts with himself from an earlier point in time in the Palimpsest space at our lab.

Figure 5: A girl dances with delayed copies of herself (and other earlier passers-by) in a public installation of Palimpsest.

3.3 Reflexion

Traditional multi-party video conferencing systems often display participants in separate screens or windows, sometimes using a grid pattern reminiscent of the title sequence of the classic American TV show *The Brady Bunch*. We think the visual separation characteristic of these multi-window designs may introduce a confrontational or divisional dynamic that can have a negative impact on a meeting or interaction even before it begins. In the absence of a multi-window design, some systems employ audio-based camera selection algorithms to switch between views of the active participants. We believe this approach can result in an even greater sense of separation since individual users do not appear on the screen together, and it also limits awareness of the inactive participants.

Reflexion is a multi-point interpersonal communication system that broadly aims to address these issues and create a more intimate dynamic that fosters an enriched sense of togetherness between its users. The system

employs an interface design based on the metaphor of a "magic mirror" in which you see a reflection of yourself layered together with the reflections of other participants in remote locations. The system responds to auditory cues and adjusts the graphical composition to emphasize the center of attention while trying to preserve a sense of background awareness among all participants [Figure 6]. Participants can view and discuss documents, slide shows, or movies that appear in the background of the mirror.

Each participant, of which there may be several, uses a separate Reflexion station consisting of a camera and video display connected to a computer that extracts an image of the participant from the background and transmits a mirror image of it to the other stations [Figure 7]. The current prototype uses a peer-to-peer multicast networking strategy for audio and video transmission to help achieve lower latency. A central server handles control messages that synchronize the screen compositions at each station so that each participant sees the same thing. Active participants, as judged from audio levels, are rendered opaque and in the foreground to emphasize their visual presence while other less-active participants appear slightly faded in the background in a manner that attempts to maintain awareness of their state without drawing undue attention. The system smoothly transitions the layering and appearance of the participants as their interactions continue.

Reflexion expands on the work of an earlier interface prototype known as Reflection of Presence [1]. Some references to other key related work include: an early system for "voice voting" to determine camera views in a video conference [9], the Clearboard system for shared drawing and interpersonal spaces [17], and the HyperMirror system which has experimented with blue screen technology to layer one participant into a scene consisting of another [23].

Our experience with Reflexion thus far consists mainly of testing it on ourselves and exhibiting it for visitors of our laboratory. A number of first-time users report that seeing themselves on the screen is distracting, and some report becoming overly obsessed with their appearance. However, these effects appear to diminish with continued use. On the other hand, some report liking this feature because of the increased awareness and peace of mind it provides about how one is being portrayed to the remote participants, an awareness that isn't necessarily possible in a regular face to face encounter. Some participants also feel it is difficult to use their fingers to point to things in the backdrop because, rather than point to something directly on the screen surface, it is necessary to maneuver a finger in mid-air while watching its reflection in the image to make it point to something in the virtual backdrop. A formal study is planned to compare the effects of Reflexion against more traditional conferencing interfaces for supporting

various kinds of activities ranging from focused work tasks to informal social interaction.

Figure 6: Screen shots of a three-person Reflexion session.

Figure 7: Scene of a Reflexion station at our lab, illustrating the mirror effect of the display.

3.4 Wellness Window

Extended-stay hospital patients often feel isolated from the outside world and disconnected from the people that love them, and these factors can lead to depression and a reduced potential for healing. The Wellness Window project aims to counteract these effects by creating an always-on ambient visual portal from the patient's room to a familiar place or environment with which the patient has a strong positive relationship. The project is still in a development and installation phase at the time of this writing, but is worth discussing in this context as a design concept.

A collaboration with a cancer unit at a local hospital, the scenario under consideration involves bone marrow transplant patients who must undergo a difficult chemotherapy program and are allowed only a limited number of visitors for several weeks while their immune systems recuperate. As a first step, interviews were conducted with former patients of this ward, and the characteristics of the ward itself were studied in depth. The rooms the patients inhabit are small and filled with various foreign medical technologies. Most have only a small window with a very limited view of the outside world. The drugs used in the therapy often cause patients to have

difficulty focusing on simple foreground mental tasks like reading a book or watching television. All of these factors contribute additional mental strain and feelings of isolation to an experience that is already very physically challenging.

The Wellness Window prototype in development involves creating a projection on a wall of the patient's room that displays a live yet low frame-rate video stream from a place chosen by the patient in advance of treatment, such as a window facing the patient's garden, a room in the patient's house, or a favorite hilltop view. These video images will be captured with high quality web or security camera technologies set up in the desired places. We are aiming for an ambient design that conveys an ongoing impression of the place while not drawing attention to itself and, most importantly, not overwhelming the patient's senses. The patient will see a single moderately static image projection that will update itself once every few seconds or minutes. Instead of a jarring cut, the transition from one image frame to the next will be a slow dissolve over several seconds.

With its focus on ambience, the Wellness Window concept is distinguished from more foreground social technologies for hospital settings, such as HutchWorld [3] and CHESS [29], which incorporate elements like chat rooms and discussion groups as well as access to sources of medical information. It has perhaps more in common with the AROMA project [26] or the ambientROOM [16], though these ambient media systems dealt more with abstract representations of activity rather than realistic imagery as in our concept.

The hope is that the ongoing presence of this connection will have a positive and strengthening effect on the patient's mental state and healing potential. Our prototype design includes just a one-way connection into the patient's room, because patient interviews revealed they felt relatively less comfortable with the idea of imagery of themselves being conveyed to the outside world, even if it was only to their families or other patients. Given that they have telephones available to them, they speculated just the continuous unidirectional link would be the most helpful.

3.5 Breakout for Two

Traditional sports foster bonding and team spirit through the sharing of a physically taxing competitive activity. This project aims to build the same sense of community over a distance, partly through the use of an *exertion interface* – an interface that deliberately requires intense and potentially exhausting physical effort.

In Breakout For Two, two participants in remote locations compete in a game that is a cross between tennis, soccer, and the classic video game

Breakout. Each player has a real soccer ball and must repeatedly aim and kick this ball against a wall consisting of a video projection of virtual "blocks." A live video feed of the other player appears layered behind this wall of virtual targets. The effect is one of a virtual game "court" in which the participants are separated by a boundary over which they may see and talk to each other [Figures 8 & 9]. The blocks on each player's screen are synchronized—when one player strikes and breaks through a block, the same block disappears from the other player's screen. The player who breaks through the most blocks wins. Games typically last several minutes and can incorporate varying levels of difficulty or multiple players [Figure 10].

Our hypothesis is that augmenting an online sport or gaming environment with exertion will greatly enhance the potential for social bonding, just as playing an exhausting game of squash or tennis with a new acquaintance or co-worker helps to "break the ice" and build friendships. The heightened state of arousal induced by the exertion also potentially makes the interaction more memorable.

We conducted a formal study to test these hypotheses and evaluate the effects of exertion interfaces, and the results were encouraging [24]. In brief, 56 volunteers were recruited, none of whom had any prior experience with the system. These volunteers were matched randomly into pairs. No such pair of participants knew each other prior to participating in the experiment. Each pair of players played one of two different versions of the game for about half an hour—either the real Breakout for Two exertion game, or a alternate form of the game that was as similar as possible to the original (same wall-size video conference and game strategy) except that it employed a traditional non-exertion keyboard interface and a virtual ball and foot. Afterwards, the players completed a questionnaire designed particularly to gain insight into their impressions of and feelings toward the other player. In a nutshell, the results of this questionnaire were that players of the real Breakout for Two game said they got to know each other better, became better friends, felt the other player was more talkative, and were happier with the audio and video conference quality than those who played the non-exertion form of the game. After completing the questionnaire, the pair of players were taken to a room where they met in person for the first time and were interviewed together on video tape so that we could observe the way they interacted after their remote sport experience as well as gain additional thoughts from them on how to improve the prototype.

As more and more people work and live at a distance from colleagues and friends, sports over a distance applications may hold potential in replacing some important types of interpersonal contact that are missed because of this distance. Instead of a traditional gym or sports club, players might go to a "virtual sports club" in their geographic area that consists of

several exertion interface environments like the one in our prototype, as well as appropriate post-sport online socializing spaces.

Figure 8: Scene of a game of Breakout for Two, illustrating the "playing court" effect of the display design.

Figure 9: Remote participants appear layered together with translucent "blocks" representing the targets that must be struck during the course of a game of Breakout for Two.

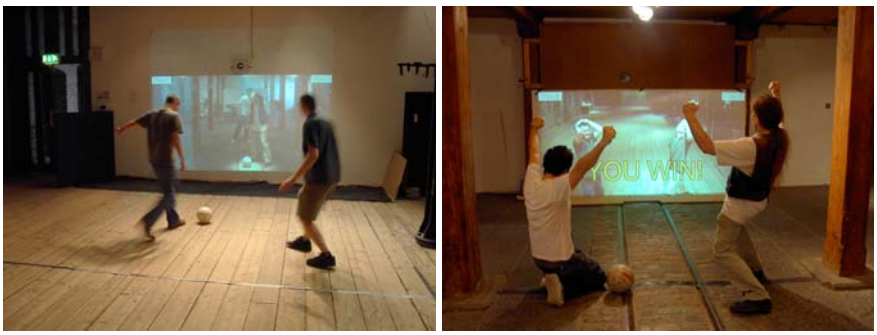

Figure 10: Scenes of a four-player Breakout for Two game.

4. DESIGN NUGGETS

The experience of developing the specific projects described above (as well as others not mentioned) has highlighted a few general questions and suggested a few general strategies that could be helpful in guiding future undertakings involving public, community, and situated displays for "human connectedness" applications. These are expressed below as a collection of design nuggets, some of which might be more obvious and well-understood than others, and some of which might be applicable more broadly than others. Some have been raised by other authors, and some important issues have probably been missed or have yet to be identified. In any case, these nuggets are not intended to be viewed as verified and established design principles. Rather, they are presented to provoke discussion and further inquiry.

4.1 Think beyond the screen

Designing a display includes more than just designing the imagery formed by its pixels. What is the best position, orientation, size, shape, aspect ratio, and so on, to support the application? How does the display integrate with the surrounding space? How does it meld with yet have its own identity within its architectural context? How does it make best use of the constraints presented by the environment within which it is set? In addition, the word "display" must also include a sense of input as well as output. What kind of interaction is desired, if any, and what input devices or sensors would be most effective to achieve that interaction and complement the theme of the display?

All of the prototypes described earlier raise some of these points, but the iCom project in particular highlights the importance of thinking about

physical and architectural design as much as graphic and information design. The configurations of each station were developed around (in some cases severe) constraints on the usage of space in each laboratory area, and the challenge was to have the screen visible from as much of the room as possible yet also to create a defined space that would motivate casual gatherings and social interaction. Proximity to natural foot-traffic lanes was also favored to enhance the potential for chance encounters between sites.

4.2 Engage the periphery

At any moment in time our senses are showered with a variety of different stimuli. Thankfully, our brains filter these stimuli and bring only the bits and pieces that matter the most into the foreground of our consciousness. To avoid perceptual overload, displays, especially those that are intended to be near us all the time, must engage and appropriately manipulate these different levels of attentiveness and our innate ability to seamlessly shift between them as needed.

For example, Reflexion attempts to visually steer our attention toward the person who is speaking while at the same time offering a peripheral awareness of the other less active participants. The Wellness Window scenario is especially interesting since patients are often not capable or desirous of concentrating on a foreground source of stimuli, like a book or television program, for any length of time. Therefore, the real challenge lies in exploiting the background in the most effective way, and possibly responding to passively-sensed cues from the patient to judge what levels of engagement are suitable. Others have explored the theme of ambient and peripheral awareness as well [8][16][26].

4.3 Instill a sense of reciprocity

If multiple displays are connected in some way, as they often are in awareness or conferencing applications, the design should attempt to instill a sense of reciprocity and equal access. For example, there should be a feeling that participants at one site do not have some special benefit or, alternately, an added risk that those on the other side do not.

iCom and Reflexion address this issue by synchronizing the screen projections at each location to create a sense of shared space, and by providing exactly the same controls over that space at each site. What you see is what the other sites see, and nothing is recorded or displayed in other venues, such as on the Web. Similarly, we deployed iCom in physical spaces that are similar in character and in which the inhabitants generally know each other as research colleagues and friends—we didn't attempt to

connect the Director's office or the lobby of the building to the lab areas, for example. The importance of reciprocity was also explored by much of the media space work cited earlier [2][15][22][30]. Reciprocity is also a significant issue in Breakout for Two, in which players would complain if they believed one side had a competitive advantage, such as more space with fewer obstacles or a larger projection with larger screen targets.

4.4 Transcend time

Good graphic design can merge information gathered over the course of a possibly very long temporal interval and reflect it back in a way that increases awareness of the passage of time and changes that have occurred, an awareness that perhaps isn't possible through simple human recollection. Given their potential for remote control and for making dynamic changes based on complex analyses of real-time input factors and stored data, computationally-mediated display technologies offer opportunities to transcend time in new ways—to express a richer history of use for example, or perhaps to provide a more meaningful temporal context for a collaborative activity.

Palimpsest, for example, gathers layers of video as passers-by walk through its interaction area, slowly building up a visual that reveals a hidden community of the many mobile humans who have intersected with a certain place over an extended period of time. iCom tries to express the recent history of the community as well as a history of interaction through its list of bulletin board messages, the titles of which vary in size depending on the age of the message and how many times it has been selected to be read recently. The Aware Community Portals [28] and Edit Wear/Read Wear [11] projects, among others, explore different ways to reflect a history of use that may be of interest.

4.5 Motivate interaction

Half the battle in designing an interactive situated or public display is designing how the display will *invite* that interaction. What makes us glance at a display when we might normally not have? What turns a glance into a more extended gaze? What makes us walk over to it? What makes us want to interact? Going beyond eye-catching graphics and other techniques from the domain of advertising, a useful way of thinking about this problem is through the notion of creating mystery. Can a display entice our natural curiosity to reveal or clarify things that are hidden or ambiguous?

iCom does this in a simplistic way by displaying the often cryptic subject lines from community announcements, attempting to motivate passers-by to

click and reveal their full text. Similarly, if there is strange or unusual activity in one of the smaller video windows, a passer-by may be more likely to approach the station and click to enlarge those views to figure out what is going on. In Breakout For Two, the initial motivation to interact is perhaps based on the curiosity of what would happen if the clearly kickable projectile were to strike the targets displayed on the screen. Some other ways of attracting attention, especially with motion, have been explored in projects like AttrActive Windows [4].

4.6 Design for investment and growth

Once the initial gratification and novelty factors wear off, what makes us want to come back to the display? One hypothesis is that humans will continue to share things if they believe they will gain something in return at some point in the future. How does the system motivate and reflect this long term investment? People may exhibit greater attachment to a display that knows and respects them—for example, by remembering who they are when they return or by being open to their influence in various ways. How does the display adapt to and grow along with the community within which it is situated?

This nugget partly relates to the notion mentioned earlier of reflecting a history of use, but at another level it is about setting a stage for and tracking the growth of the user and the changing character of the relationships the display may be there to help build and enhance. For example, Breakout for Two demands investment in the form of intense physical exertion, but with the potential reward of having fun, making a new friend, and over the course of multiple encounters, building a richer relationship with one's competitor than might have been possible using other communication technologies. In contrast, having the display *itself* grow with and adapt to the way it is used calls into play techniques from the domain of machine learning.

4.7 Balance togetherness and uniqueness

Observation suggests that at the same time we like to feel like we are part of a group (we join clubs, eat meals together, live in communities), we also have a desire to establish and maintain our own identity within those groups (we define and defend territories, purposefully dress and decorate in unique ways, cultivate individual styles). This suggests, in turn, that at the same time displays in connectedness applications aim to enhance awareness and togetherness, they should also enable users and groups to assert their individuality, their desire to be different from the rest. A display that combines the offerings of many people should convey a sense of sharing and

of contributing to a larger whole while also preserving a sense of ownership over one's own offering.

For example, iCom displays postings from both Media Lab Europe and the MIT Media Lab together in the same chronological list, which helps to convey a sense of a single larger community, but each side's message titles appear in their own assigned color so that the origin of any contribution is immediately identifiable. Reflexion and iCom aim to build a sense of shared space through the synchronization of each site's display, but at the same time they try to offer each participant their own visual identity or terrain within that space. Competitors in Breakout for Two share a single virtual game court and targets while at the same time possessing their own distinct territory within that court.

4.8 Embrace the creativity of your users

Any display will have to impose constraints of different kinds on its users, for example on the amount of information that can be presented, their physical configuration, the bandwidth and types of transfers possible between connected displays, and so on. Fortunately, humans are creative and often invent ways to triumph over constraints and use them to their advantage, to display more information in less space or to send richer messages than originally imagined. Display makers should encourage and try to provide avenues for this kind of community creativity, as it may result in significant operational improvements or inspire ideas for new applications.

For example, several lab denizens who were intrigued by Palimpsest began co-opting the system occasionally to enact short pantomime plays in which actors would layer their performances into the video scene asynchronously. This strategy also enabled a single actor to play multiple parts and overall suggested a new form of improvisational theater. As another example, for privacy reasons, iCom does not enable recording of the audio and video captured by the system, but its users quickly discovered they could leave humorous decorations in front of its cameras to asynchronously joke around with the inhabitants of the other sites. We also found that, after the introduction of a new iCom station, inhabitants who work near it would gradually reconfigure its physical surroundings to suite preferences and give it a unique personality, and this is a behavior that we embraced and later tried to encourage. Other media space experiments echo the importance of "affording appropriation" [2][6]. While this overall nugget is largely about embracing a certain flexibility and open-endedness in design, it also relates to notions of tailorability and openness in software systems as explored by authors like Mackay [21] and Dourish [5].

4.9 Be patient

New behaviors are not created overnight. To really understand if and how a public or situated display will change a community, you need to study it over more than just a few days or even weeks. There must be time for the novelty factor to wear off, for its users to come to terms with its presence, to reject and hate it, to later reflect on how it can benefit them, to take ownership and integrate it into their lives and spaces, to gradually take it for granted.

The timing and duration of academic terms and funding contracts makes long term cultivation and study of this kind more difficult, yet it is essential if we wish to more deeply understand the effects these displays have on us. Our experience specifically with iCom and Palimpsest, as well as accounts from other research programs [2][6], confirms this suggestion. After more than two years of continuous operation, we are only beginning to notice certain evolving behaviors related to the iCom system, as well as revisions of previously observed behaviors, especially as new members join the community and others leave.

5. CONCLUSION

Below is a recap of the design nuggets presented in this chapter:

1. Think beyond the screen
2. Engage the periphery
3. Instill a sense of reciprocity
4. Transcend time
5. Motivate interaction
6. Design for investment and growth
7. Balance togetherness and uniqueness
8. Embrace the creativity of your users
9. Be patient

As discussed earlier, these nuggets are not meant to be considered as recognized and verified design principles. Rather, they are intended to serve as a collection of possible questions to ask and strategies to consider when developing display-centered “human connectedness” applications. Not all of these nuggets will be applicable in all situations all of the time. One can easily imagine, for example, scenarios in which it would be most appropriate for a display to not identify its users, not store a history of its use, or not try to draw attention to itself.

This particular compilation of nuggets is largely inspired by our experience in building the five prototypes described in earlier sections, though they clearly relate to many other projects in other research programs. The list is certainly not complete and will evolve as our collective understanding about this realm grows, but hopefully it can serve as a starting point for helping applications in this domain reach their full potential.

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