

# Telemurals: Linking Remote Spaces with Social Catalysts

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## ABSTRACT

*Telemurals* is an abstract audio-video installation that seeks to initiate and sustain interaction between and within two remote spaces. Our goal is to improve the social aspects of casual mediated communications by incorporating events into the design of the communication medium that encourage people to engage in interaction when they otherwise would not. We call these events social catalysts, for they encourage people to initiate and sustain interaction. In this paper we discuss the design process and goals of our first *Telemurals* link between two public spaces, the building of *Telemurals*, and an ethnographic study describing how the system affected interaction between and within these two spaces based on the theories discussed in this paper.

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**General Terms:** Design, Human Factors

**Keywords:** social catalysts, social interaction, ethnography

## INTRODUCTION

In this work, we create an audio-video communication link between remote spaces for sociable and casual interaction. Some drawbacks to current systems that have been studied include lack of privacy, gaze ambiguity, spatial incongruity, and fear of appearing too social in a work environment [14][17]. We believe that many of these problems stem from designing interfaces that directly map to face-to-face interaction. A window of straight video appears distancing and, over time, mundane. Audio-video connections between spaces should be designed as an alternate form of communication that is possible over a distance.

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With this work, we are diverging from the approaches of current audio-video connections and focusing on encouraging social interaction by designing a series of social catalysts that evolve with the interface. We are not creating a substitute for face-to-face interaction, but rather new modes of conversational and physical interaction within the spaces.

## SOCIABLE SPACES

This work is situated in the study and design of sociable spaces. Looking around at sociable spaces from town squares to office lounges, it becomes apparent that some spaces attract people much more than others, and some remain consistently barren. Why is this? This question lies at the root of this research.

In our quest to create usable, sociable connected spaces, we begin by looking at sociology and urban planning literature and field studies of traditional public spaces. One of the most comprehensive studies on the social use and design of public spaces has been the work of William H. Whyte. In this section, we briefly describe his approach and his observations.

We then proceed to look at projects that have linked spaces for communication using audio and video. These fall into two main categories: telecommunication art and computer supported cooperative work. The telecommunication art projects focused more on connected cultural dispersion of the arts: people in disjoint locations performed concerts together, poetry readings were viewed from many different locations. Technologists approached the problem as how to enable people in disjoint spaces to work and collaborate on projects together. We will describe these projects and see how we can relate them to the design of sociable spaces.

## Observing Public Spaces

*William Whyte: rediscovering the center*

*I am not, heaven forfend going on to argue for places of maximum gregariousness, social directors for plazas. Anomie would be preferable. What I am suggesting, simply, is that we make places friendlier. We know how. In both the design and management of spaces, there are many ways to make it much easier for people to mingle and meet.*

-William Whyte

In 1969, William Whyte began a sixteen year observation study of the workability and use of public spaces within New York City and other cities [23][24]. Using time-lapse cameras, 35mm cameras, tele-photo lenses, and interviews, his group documented patterns of traffic and behavior in selected public spaces.

He observed people at street corners, hidden plazas, open plazas, building atriums, market places, alleyways, and mega structures. Within these spaces, he documented climate, lighting, density of people, where they stood, sat, and walked, carrying capacity, and public events in the spaces.

One early hypothesis was that light was a key component in the desirability of a public space. He was not wrong - he was mostly surprised that sittable space was a much more overwhelming factor. The observation that people tend to sit most where there are places to sit may not appear intellectually ground breaking, and yet, it is so often overlooked! From his observations he concluded that there were seven key features that were necessary for designing a successful public space. These features are: sittable space, street, sun, food, water, trees, and triangulation. Subtler features such as change and personalization have been further observed in frequented public spaces [16].

Of these features, the most interesting with respect to a mediated space, however, is what Whyte termed triangulation. By this he meant events in public spaces that focus the attention of the diverse inhabitants of the space on a common object and facilitate communication among otherwise disconnected strangers. Common triangulation examples are public performances, kinetic or interactive sculptures, magicians, the “know-it-all”, etc. Such features are missing in many current audio-video linked spaces, and we believe that this has been detrimental to their functioning as social media. The key question here is how can this concept be translated into a mediated public space connecting two separate physical spaces?

By extending the concept into a computer mediated environment, the triangulation can become much more abstract and transformable: the interface may spew questions to the people in the space, it may combine both spaces to create a surreal jointly cohabited space, and so on. This concept of interfaces as catalysts begins to deviate from Whyte’s triangulation examples that we have so far discussed. From here on, we refer to these stimuli as social catalysts<sup>1</sup>.

We have briefly addressed some of the physical challenges in designing sociable spaces. Now we will look at how spaces have been connected using audio and video and how these spaces are perceived.

1. The term triangulation is used extensively in computer graphics, vision, and ethnography work. We wish to eliminate ambiguity and stress that we are using its catalyst property for sociability, hence, the term social catalyst.

## Connected Spaces

### *Telecommunication Art*

The early seventies showcased a growing number of artists creating telecommunication art, often focussing on performance and cultural dispersion of art [11]. The artists used telephone lines to send and receive audio, slow-scan images, and telefax messages. In 1977, the first live two-way audio-video satellite connection by artists, “Two-Way Demo” was presented. It connected the east coast and west coast via the US/Canadian Hermes CTS Satellite.

One of the most successful projects was a communication event called Hole-in-Space, unveiled on November 13, 1980 by video artists Kit Galloway and Sherrie Rabinowitz [8]. Hole-in-Space was a real-time audio and video connection between Lincoln Center in New York City and “The Broadway” department store at Century City in Los Angeles. A person walking past Lincoln Center would hear and see a life size television image of passersby in Century City. The interaction was reciprocal to those standing in Lincoln Center.

Hole-in-Space is one of the seminal works in telecommunication art. It was bright, it let people look and speak out across the country, and it provided an unfamiliar power. At first glance, it was a stunning display. There were, however, some complaints from users at the opening. One of these was confusion with symmetry in the display. Others were gaze discrepancy, camera location, and difficulty communicating [25].

Attempts to create similar audio-video connections today have proved less effective. More work needs to be done to understand the attraction of Hole-in-Space. It only ran for three nights. Due to satellite transmission costs, it was not a twenty-four hour connection that would always be there. Its limited timing in the evenings may have been advantageous. Its setting and time in history most probably played a role. Lincoln center is a very public place where one often expects to see something new and out of the ordinary; the same experiment done in 1980 may not be as novel or engaging in 2004.

### *Media Spaces*

The original media spaces project was created by researchers at Xerox PARC [2][7]. Miles of cable for audio and video were placed between Palo Alto and Portland to connect offices, conference rooms, and several public spaces within and between these two sites.

One motivation behind the creation of media spaces was maintaining the culture of collaboration in the labs when people were geographically separated. The goal was to find means to support cross-site work and maintain the necessary social connections [2].

Media spaces were set up in common areas and offices. There were various media space displays. Some were television screens of various sizes. Others were desktop displays with various configurations. Modifying access permissions to private spaces was possible using a desktop application.



**Figure 1:** Current *Telemurals* implementation. The two images correspond to the two connected spaces. In each space, the local participants are rendered in orange, the remote participants in red.

Many similar projects have evolved since the original media spaces and now the term media space refers to any environment created using video, audio, and networked computers to support interaction between distributed groups of people. One example that was designed for social interaction linked three kitchens within an organization. It was an audio-video wall that contained four windows. It displayed windows to the local and connected kitchens and used a cable television feed in the fourth window as a catalyst for interaction. Observations of this system stressed the users want for control of privacy [17].

Evaluations for audio-video media spaces have thus far focused primarily on comparison with face-to-face interaction, and, therefore, fall short of expectation. New social cues that are perceived from the interfaces and new behaviors that evolve are neglected [6]. By incorporating abstraction and social catalysts into *Telemurals*, we emphasize the social role of the interface in encouraging interaction.

### SOCIAL CATALYSTS

The main idea of the social catalyst is to initiate and create mutual involvement for people to engage in conversation. For example, in a public space, it is not customary to initiate conversation with random strangers. However, there are events that act as catalysts and connect people who would not otherwise be communicating with each other.

Such a catalyst may be an experience, a common object like a sculpture or map, or a dramatic event such as a street performer. Sociologist William Whyte terms this phenomena triangulation: "A sign of a great place is triangulation. This is the process by which some external stimulus provides a linkage between people and prompts strangers to talk to each other as if they were not." [23]

Our hypothesis is that the creation of a social catalyst as an integral part of the social environment will aid mediated

communication between spaces by providing a spark to initiate conversation and the interest to sustain it.

The social catalysts of our installation extend Whyte's triangulation principle into the display, interaction, and interface of the connected space. The form of our catalyst is abstract. It alters the space and communicative cues between the two spaces. One such catalyst is a connection where current conversation of the users appears as graffiti in the environment. This allows the occupants to see they are affecting the space and might encourage them to alter it. While the possibilities are infinite, the challenge is determining which agents on the interface are effective as social catalysts and why.

In our linking of two spaces with the *Telemurals* installation, we are augmenting the appearance of the familiar audio-video wall interface with stimuli that are initiated at either end of the connection. The wall is intended to be not only a display and conduit for interaction, but also a motivator; the system becomes both medium and catalyst. We further emphasize the design of the interface as a complement to the space. We want the communication link and display to blend into the physicality and aesthetic of the space and to make the interactions sociable and intuitive.

This project extends the design of social space to include computer mediated social spaces. It addresses what features are necessary to sustain a healthy connected sociable space across two remote spaces. We have looked at some features that help create physical spaces through the work of William Whyte, and specifically stressed the use of social catalysts.

### TELEMURALS

*Telemurals* is an audio-video connection that abstractly blends two remote spaces. The initial setup is straightforward. Two disjoint spaces are connected through an audio-



**Figure 2:** Snapshots of an evolving silhouette. A participant is never completely invisible, however, more details begin to appear as they participate more through the audio channel and through movement.

video wall. Video and audio from each space is captured. The two images are then rendered, blended together, and projected onto the wall of their respective space. The difference between *Telemurals* and traditional media space connections are the image and audio transformations that evolve as people communicate through the system and the blending of the participating spaces. Another difference is that many existing media spaces are task-oriented [15][21], whereas *Telemurals* is designed for casual, sociable interaction.

Duplex audio is transmitted between the two locations. To provide feedback and comic relief, the audio is passed to a speech recognition algorithm. The algorithm returns text of the closest matching words in its dictionary. This text is then rendered on the shared wall of the two spaces. The goal here is to make it clear that the users' words are affecting the space without necessarily requiring 100% accuracy of the speech recognition system.

A current implementation of the *Telemurals* rendering is shown in Figure 1. Silhouettes of the participants in the local space are rendered in orange. The participants at the remote end are rendered in red. When they overlap, that region becomes yellow. The aim of this cartoon-like rendering is to transmit certain cues such as number of partici-

pants and activity level while preserving privacy by not initially revealing too many social cues about the identity of the participants.

To reinforce a sense of involvement, we provide the system with some intelligence to modify its space according to certain movements and speech patterns. That is, the more conversation and movement between the two spaces, the more image detail will be revealed to the participants at each end. The silhouettes evolve to show more detail (see Figure 2). This prompts the participants to move closer into the space to see. If conversation stops, the images fade back to their silhouette rendering. We want the participants to choose their own level of commitment in this shared space [16]. The more effort they exert, the more they see of both spaces.

Much thought has been given to the design of the renderings in *Telemurals*. We wanted to maintain the benefits of video in their simplest form. Adding video to a communication channel improves the capacity for showing understanding, attention, forecasting responses, and expressing attitudes [14]. A simple nodding of the head can express agreement or disagreement in a conversation. Gestures can convey concepts that aren't easily expressed in words; they can express non-rational emotions, non-verbal experiences.



**Figure 3:** The two *Telemural* installation sites.

Yet these cues are not always properly transmitted. There may be dropped frames, audio glitches. Lack of synchronicity between image and audio can influence perceptions and trust of the speaker at the other end. Other challenges include equipment placement. For example, camera placement has long been a reason of ambiguous eye gaze in audio-video links. A large camera offset gives the impression that the person you are speaking to is constantly looking elsewhere.

With *Telemurals*, we are creating an environment where rendered video maintains subtle cues of expression such as posture and hand motion, yet also enhances other cues. For example, changes in volume alter the style of the rendered video. By adding another layer of abstraction into the video stream, we can enhance cues in a manner that is not possible in straight video streams.

In this project, the abstraction of person, the blending of silhouettes, the graffiti conversation, and the fading from abstract to photorealistic provide social catalysts for the experience. This new wall generated by filtering creates an icebreaker, a common ground for interaction, and an object for experimentation. How will one communicate in this abstracted space? How will their behavior affect their appearance and the appearance of the setting? How different is communication using photorealistic vs. non-photorealistic video? The goal here is to create new styles of movement and speech interaction by providing a common language across the two spaces.

*Telemurals* currently connects two common area halls of MIT graduate dormitories. In the first dormitory, the *Telemural* is placed in a high traffic cross-way connecting the gym, the laundry room, and the elevators. In the second dormitory, the *Telemural* is located to the right of the main lobby (see Figure 3). This connection came about as one committee of an under-construction dormitory was looking to put public art in its public areas and create spaces to encourage students to gather. The second graduate dormitory was similarly undergoing renovations to create public spaces for social gatherings, and the two dormitories were open to the idea of creating a shared communication link. The sites within the dormitories were chosen because they have traffic, are public to the community, and because a large video wall aesthetically blends into the space. Although there was much traffic through these spaces, there was little interaction. By installing *Telemurals* in these transient spaces, we were interested in seeing if people would stop, take notice, and interact in this linked space.

## EVALUATION METHODOLOGY

This work combines the disciplines of technology, communication, and design. Evaluation of this work is therefore threefold.

### Engineering

We evaluate if the system functions. Does it work? That is, does it transmit audio and video? Is the sound quality acceptable? Is the video quality and speed acceptable? Are the interface and networks reliable?

## Ethnography

We observe and evaluate how the people use the system. The field for this observation study is the semi-public space within the two chosen dormitories. The participants are graduate students who live in the respective dormitory and their friends. We are primarily interested in seeing, (1) how people use *Telemurals*, (2) if the catalysts attract them, and (3) how we can improve the system.

We performed three different types of observations:

- Observation while immersed in the environment
- Observation from mounted camera video
- Observation from abstract blended video

The footage from these tapes was used to annotate patterns of use for this study and were then discarded. We were interested in observing:

- How long people speak using *Telemurals*
- The number of people using the system at any one time
- The number of people present but not interacting
- The number of unique users (if possible)
- The number of repeat users (if possible)
- The number of times and the duration that people use *Telemurals* in one space only
- Repeated patterns of interaction: gestures, kicks, jumps, screams

These are factors that we believe are indicative of levels of interaction. However, one must always be open to the unexpected and attempt to find other underlying patterns as well in studying the social catalysts.

## Design

We evaluate if the system interface is well-thought-through, coherent, and innovative. This was in the form of a studio critique. Professors from various architecture and design departments and research scientists have been invited and have volunteered to participate in a series of critiques.

## DISCUSSION

### Technical

As an engineering project, *Telemurals* works. It runs on the school network and typically uses less than 1MB of bandwidth with audio latency varying from 500ms to 1 second depending on network usage. The networking audio and image libraries are all written in C over UDP, and we use the Intel *OpenCV* library for image segmentation.

The video was reliable, the audio had acceptable lag, and the system ran continuously for over three months. The one technical challenge that could use improvement is the audio. Using just one microphone does not cover the intended space and the acoustics of each space play a huge role. We are experimenting with microphone arrays and with physical objects that one interacts with that contain the microphone.

*Telemurals* was evolving throughout its construction and connected installation period. We experimented with several different renderings of people at each end, we changed the fading algorithm, changed the hours of operation, and changed the *Telemural* wall site at one of the dorms. These changes were made according to suggestions and critiques of the residents of the two dormitories and professors within the lab throughout a five month period.

### Social: comparisons and contrasts

Time-schedule, social events, signage, interface, trust, site selection, and a changing environment proved to influence population mass at the *Telemurals* sites. The motion of people, ambient noise, and the speech-to-text graffiti created from the users' own words kept people at the site.

### Hours of operation

The *Telemurals* observation took place in May and June of 2003. During the initial two weeks, *Telemurals* ran for two hours each Wednesday and Sunday night in conjunction with a coffee hour/study break. We had requests from both spaces to increase the hours of the connection. *Telemurals* then ran every night for two hours over a two week period and then ran continuously, twenty-four hours a day.

We discovered we had a larger population of use per hour and longer linked interaction times when *Telemurals* was up for shorter intervals of time (two hours, two days a week and two hours every night vs. twenty-four hours a day). We believe it became more of an event - something that should not be missed. Nevertheless, we continued getting requests to run it continuously.

During the twenty-four hour a day use, there was an increase in the time the system was used at one end and not the other compared to the shorter time intervals of use. Many more people used it as a mirror when they thought they were alone.

### Events

Dormitory events such as meetings and social hours attracted large crowds to the *Telemurals*. Sometimes it was for comic relief; other times it was because of the quantity of people. One person at the *Telemural*, whether at the local or remote end, tended to attract more people. A wedding party proved to be the most interactive period, with children repeatedly running back and forth across the wall. Food associated with these events also attracted people. Moving food in the field of view of the mural provided an object for interaction and made the *Telemural* a popular spot.

### Signage

Signage was placed in the entry ways of both spaces to describe what was being transmitted, where it is being sent, and to inform people of the presence of the camera, microphone, and the ubiquitous link. Of over twelve hundred people living in both dorms, we had one complaint asking that we shut off the microphones between both spaces. This person felt the system was eavesdropping on them as they

waited for the elevator. The abstracted images were not a concern in this case.

The link signage was more problematic. People were not entirely convinced there was a link connecting the two dormitories. This may be because there was no one at the other end at that time or because the interface was unfamiliar. There were several instances of students arranging meetings at each mural and calling each other on cell phones to verify the connection.

Others didn't read the signage and thought it was simply an abstracted mirror. People were often confused when another silhouette appeared and sometimes left that space of the screen so as not to be in the way.

It was three weeks before we noticed a significant amount of interaction across the link. Prior to that point, people were gesturing and moving, but very few people were speaking across the link.

We added more specific signage labelling the microphone and speaker. The presence of speech at either end of the mural increased five-fold. The speech recognition then became more apparent. It became a positive feedback loop whereby people kept speaking and staying in the space until what they said was recognized adequately.

Ideally, we wanted to avoid all instructional signage and let the interface guide the interaction. This did not work. Perhaps as the interface becomes more commonplace, we could remove the labels.

### Interface

The interface went through several iterative design phases. We first began with a connection that linked two spaces with straight video and audio. After a period of observation, we wanted to make the wall more approachable. People were not attracted by it; in fact, some people deliberately avoided it.

We wrote an edge-detection algorithm to render the video at both ends so that the video appeared as a real-time moving comic (see Figure 4). This effect was described as "fun" by students. It added a layer of abstraction and increased participation in the link compared to the straight video. We received many requests to provide this filter as a "mirror" with which to look at oneself as well as a link.

People wanted to see how they were presented at the other end. Providing a picture-in-picture image or segmenting the screen into two rectangles appeared to emphasize that the spaces were remote and distinct. To create a shared space, we blended the two spaces in the same scale and form. When people saw themselves as well, they preferred more abstracted renderings and silhouettes to photorealistic images in order to protect their privacy.

We now had our mirror and our link. The mirror helped make the wall interactive even when no one was at the other end, sometimes even attracting someone to the space. Simple silhouettes were enough to depict the presence of a person or persons at the other end and a sense of activity in the space. This provided an environment for safely starting interaction.



**Figure 4:** First departure from straight video feed. Each site viewed the other space as a moving comic.

We had many interactions between the spaces, however, they were not sustained for a significant period of time. The next step was to provide a motivation for staying in the space. We had the ice-breaker; now we needed people to use the channel in more interesting ways than simply saying “Hello” and “Where are you?”.

We altered the image over time to become more detailed, approaching the detail of our cartoon rendering, the longer a person moved or made noise in either space. By doing so, the length of discussions increased slightly and people spent more time in the shared space.

#### Site Selection

The two participating dormitories have an interesting history. A good number of the inhabitants of the newer dormitory had previously lived in the other. This meant that some of the students had a higher likelihood of knowing someone at the other end. We don’t know to what extent this played a role, but we know there already existed a social connection. Oftentimes, students arranged meeting times and spots at their respective *Telemural* either as a “rest-area” or a social break.

One day we arrived in one of the dormitories to find that our white projection wall had been painted dark olive green. We improvised and put up an easel with a white canvas and projected onto this. This proved more frustrating than useful.

During the time when the *Telemural* ran for two hours at a time, or when no one was at either end, the screen looked bare and abandoned. When one sees a large canvas on an easel, they expect to see something on this canvas. We moved our site to a different location near the elevators and projected onto the white wall. The new space provided more of a surprise, better mural visibility because the surroundings were not as bright, and more time to interact while one waited for the elevator. The empty wall was not as disturbing when it was white because that was its default

state - and it provided this surprising reward - when one did see something there that was not in the norm. The wall also eliminated the distancing effect of framing that is common with projection screens and picture frames.

#### Observations

There were many trade-offs among the three different observation methods that we used. When observing and taking notes while immersed in the environment, we originally thought participants would be self-conscious about being watched. On the contrary, we found that having a person present at either end is a big attractor, even if it is a note-taker. People would sometimes come over just because someone was watching the wall.

As with the immersed observation, we expected the live video captured from the camera mounted on the wall would cause people to behave differently. In this case, we believe it did. People were not very comfortable with the idea of being taped.

The final observation method involved capturing the abstracted video from *Telemurals*. This was the easiest because the image was reciprocal from both sides and did not cause any objections from the occupants of the dormitories. This did not provide data outside the camera field of view, as did the immersed observation, but it did not upset anyone and even encouraged some to perform in front of the camera as if hoping to be watched.

By combining these three methods, we hope to have gained a better understanding of the use and interactions in the space and with *Telemurals*.

#### Design

*Telemurals* has been critiqued by three professors while in use at each installation site. It was noted that the abstraction not only enhances certain social cues such as gesture, but also mitigates the confusion associated with gaze and audio-video synchronicity in teleconferencing systems. The interface was described as “evocative and fascinating” by one design professor. This evaluation is not enough. We will be holding another series of critiques in the coming months.

#### Privacy

Privacy control was one of the major forces behind the design of *Telemurals*. The privacy gained through abstracting people in the setting allowed for participation with less risk and without a covert feeling of surveillance.

However, in observing such an interface, we did record some video of the interactions and of the people. If straight video directly from the camera was captured, there was a large sign saying this might be happening. Abstracted video was captured at random times every day. All of the audio and video captured in the *Telemurals* interface was annotated, analyzed, and then destroyed.

#### Summary

This work bridges the space between telecommunications art and media spaces to create a connected space for casual, sociable conversation. Whether there is a person at the remote end or the local end, *Telemurals* attracted more peo-

ple. William Whyte was right: “What attracts people most is other people.” With *Telemurals*, we aim to facilitate that attraction, remotely, as well as locally.

## FUTURE DIRECTIONS

### Engineering

We would like to improve the sound recording in each space by providing several microphones in an array to capture audio evenly so that people don't crowd around the one microphone. We found that those near the microphone spoke more than those further away.

### Design

We would like to further continue with the design of the interface and experiment with abstracted renderings of people. Scott McCloud stated:

*When we **abstract** an image through cartooning, we're not so much **eliminating** details as we are **focusing** on specific details. By **stripping down** an image to its essential “**meaning**”, and artist can **amplify** that meaning in a way that realistic art can't.*

The renderings could be even more evocative of the activity in the space. For example, if someone yells or speaks loudly, their scale would increase and tower over the other participants.

### Ethnography

We would like to create a *Telemurals* link between another pair of sites. This would provide a comparison among a number of sites, how public they are, as well as a study over a longer period of time. An outdoor mural would be exciting and more representative of a public space.

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## REFERENCES

1. Agamanolis, S. Westner, A. and Bove, V.M. Reflection of Presence: Toward More Natural and Responsive Telecollaboration. *Proc. SPIE Multimedia Networks*, 3228A, 1997.
2. Bly, S. and Irwin, S. Media Spaces: Bringing people together in a video, audio and computing environment. *Comm. ACM* 36,1, 28-47, 1993.
3. Boyle, M., Edwards, C., and Greenberg, S. The Effects of Filtered Video on Awareness and Privacy. *Proceedings of CSCW 2002*.
4. Buxton, W. Telepresence: integrating shared task and person spaces. *Proceedings of Graphics Interface 1992*.
5. Clifford, J. and Marcus, G.E. *Writing Culture: The Poetics and Politics of Ethnography*. Berkeley: University of California Press. 1986.
6. Dourish, P., Adler, A., Bellotti, V., and Henderson, A. Your place or mine? Learning from long-term use of audio-video communication. *Computer Supported Cooperative Work*, v.5 n.1, p.33-62, 1996.
7. Finn, K., Sellen, A., and Wilbur, S. *Video-mediated communication*. Erlbaum. 1997.
8. Galloway, K. and Rabinowitz, S. Hole in Space. Available at <http://www.ecafe.com/getty/HIS/>
9. Goffman, E. *Behavior in Public Spaces: Notes on the social organization of gathering*. New York: The Free Press. 1963.
10. Grudin, J. Why CSCW applications fail: Problems in the design and evaluation of organizational interfaces. *Proceedings of CSCW 1988*.
11. Grundman, H. *Art+Telecommunication*. Vancouver: A Western Front Publication. 1984.
12. Harrison, S. and Dourish, P. Re-place-ing Space. *Proceedings of CSCW 1996*.
13. Hollan, J. and Stornetta, S. Beyond Being There. *Proceedings of CHI 1992*.
14. Isaacs E. and Tang J. What Video Can and Can't do for Collaboration: A Case Study. *Multimedia '93*.
15. Ishii, H., Kobayashi, M., and Grudin, J. Integration of inter-personal space and shared workspace: ClearBoard design and experiments. *Proceedings of CSCW 1992*.
16. Jacobs, J. *The Death and Life of Great American Cities*. New York: The Modern Library. 1961.
17. Jancke, G., Venolia, G., Grudin, J., Cadia, J., and Gupta, A. Linking Public Spaces: Technical and Social Issues. *Proceedings of CHI 2001*.
18. Krueger, M. *Artificial Reality II*. Addison-Wesley. May 1991.
19. McCloud, S. *Understanding Comics*. New York: Kitchen Sink Press. 1993.
20. Pederson, E.R. and Sokoler, T. AROMA: abstract representation of presence supporting mutual awareness. *Proceedings of CHI 1997*.
21. Tang, J. and Minneman, S. VideoWhiteboard: video shadows to support remote collaboration. *Proceedings of CHI 1991*.
22. Whyte, W.F. *Learning from the Field: A Guide from Experience*. Sage Publications. 1984.
23. Whyte, W.H. *City: Rediscovering the Center*. New York: Doubleday. 1988.
24. Whyte, W.H. *The Social Life of Small Urban Spaces*. Project for Public Spaces, Inc. 2001.
25. Personal communication between author and public art critic. 2002.