# Media Spaces in the Mobile World

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## INTRODUCTION

Media spaces have had a tremendous impact on HCI and CSCW research. The idea of conceptualizing "real-time visual and acoustic environments that span physically separate areas" [30] as flexible assemblages of people, technology, and practices (as opposed to technology alone) has been extremely productive. Hundreds of research papers cite the standard entry points into the media space literature (e.g., [7]).

Given this positive impact, it is surprising to find little mention of media spaces in the fast-growing literature on mobile communication systems. For example, in the most prominent edited collections on everyday use of mobile phones [8,10,14,15,17-19,23-25], the standard media space references do not appear at all. This is undoubtedly due, in part, to the prevalence in this area of anthropology, communication and sociology researchers whose expertise lies in areas other than HCI and CSCW. However, even in the HCI and CSCW literature on mobile communication, there are surprisingly few references to media spaces. Here, the issue is more likely that the canonical image of an open desktop audio/video environment doesn't seem to have much relevance to mobile phones – one imagines "mobile media space" to mean something akin to the wearable, always-on Nomadic Radio system [29].

Looking beyond such images, however, it is immediately clear that insights from media space research do have much to offer to the design of mobile communication systems. We have tried to leverage these insights in our own research agenda, in which we have explored the question: *What does it mean to have an "off the desktop" media space?*

In this paper, we sketch out some arguments for the mutual relevance of media space research and mobile communications research. We first discuss the connections between media space research and mobile communication research. We then describe how we have tried to take advantage of the legacy of media spaces in our own research agenda in mobile communication.

## MEDIA SPACES AND MOBILE PHONES

We asserted above that media space research is relevant to research on mobile communication, and vice versa. This is based on two lines of argument. First, we observe that it is quite possible to use today's mobile communication technology in a way that essentially follows the original uses of media spaces. Hence, in these usage scenarios, one would expect the lessons of media spaces to carry forward. Second, we argue that there is demonstrable overlap between the findings of these two research areas – enough that it is clear that we should be looking for more connections between the two in any case.

### Can a Mobile Phone be a Media Space?

Most descriptions of media spaces make it clear that they are configured through emergent collective practice rather than through pre-established policy, and this is typically true of mobile phone communication as well. But aren't there obvious key technical differences by which we can distinguish a media space from other systems? Why should we expect any similarity in use between the two?

Scanning the most frequently cited paper on media spaces [7] and other early work, one might get the impression that a media space can be technologically characterized as a system that

- connects *fixed locations* such as office desktops,
- uses continuous *audio and video* media, and
- enables both awareness and communication by means of *always-open* channels.

Such a characterization (which does describe many uses of media spaces, such as "office shares" or "windows" between common areas) comes close to ruling out a mobile instantiation.

However, the characterization above is also an over-simplification. If one considers subsequent research on presence and awareness, a more accurate characterization of the key properties of a media space is that it

- is associated with an understood *spatial/social context* (as opposed to fixed locations; see, e.g., the lightweight reconfigurability of the original media spaces [7], or the mobile Awarenex system [33]),
- uses *continuous or discrete* media (as opposed to continuous media alone; see, e.g., Portholes [9]), and
- enables awareness by providing an ongoing stream of *awareness updates* and enables lightweight communication by providing an ongoing state of *incipient interaction*.

One might object that this characterization seems over-broad – after all, instant messaging, or even texting, one's friends frequently on a mobile phone fits this description. But again, the claim is that the core properties of a media space lie in its use, not in the specifics of its "delivery" technology. Open audio and video channels do make some aspects of the experience more lightweight, since one does not have to compose messages. However, we would claim that open media channels are not strictly necessary to creating a sense of presence and awareness; it is more important for the network to be available than for data to be passing through it at all times. In other words, "always on" in the network-level sense (always connected to the network) is more critical than "always on" in the application-level sense (always running). It is important for mobile communication researchers to understand this point, because it makes clear why the experience gained from media space research often apply in this domain as well.

**The Interplay of Media Spaces and Mobility**

If one accepts that media space research and mobile communication research ought to have mutual relevance, the natural question is: what is this relevance? We argue that the earlier research on media spaces serves as a useful conceptual foundation for a great deal of mobile communication research, and further suggest that many general phenomena described in the last two decades of media space research have in some sense been rediscovered in the last five years of work on mobile phones. However, it is also true that the understanding gained of the nuances of mobile communication practice extends and refines the insights gained from media spaces as well. It could hardly be otherwise when one considers how connectivity has extended from the workplace into everyday life, and the great increase in expectations of connectivity [16,20]. By way of example, we detail a few areas of commonality below.

*Sustaining relationships*

One area of commonality is a predominance of use for coordination and awareness within relatively small, pre-existing groups. It has long been clear that media spaces are a tool for sustaining relationships ([7], p.42) – that initial trust is necessary for stable sharing practices to develop, and that this trust occurs most readily in already-formed groups. Given that, it is arguably unsurprising that, across societies, mobile communication is overwhelmingly used to maintain existing relationships within small groups [13,16,20,21]. Although one frequently sees empirical reports of overflowing contact lists, it is also typically found that the bulk of mobile phone interaction occurs within core groups of 10 or fewer. This is captured by notions such as "full-time intimate community" (cited in [21]), "tele-cocooning" [13] and "selective sociality" [21].

In both cases, what passes through channels is intermittent and is often unimportant and uninformative in itself. The commitment to availability itself reinforces relationships. Further, even if awareness updates – seeing a coworker in an office, receiving a text message from a friend complaining "I'm tired" – do not provide immediately-relevant or actionable activity awareness, updates from members of the group over time do provide "local resources" for talk [27], material for "noticings" in subsequent interaction.

In the mobile case, notions such as "full-time intimate community" and "ambient virtual co-presence" [16] do differ from prior notions in degree. Mobile communication extends into everyday, on-the-street life, and core groups are typically made up of friends (as opposed to co-workers – who might be, but need not be, friends). Indeed, a key reported use of mobile communication is maintaining connections with friends who one no longer sees regularly at school or at work [21].

*Keeping company*

A second area of commonality is the ability to enable a particular kind of presence or "connectedness." Users of the original PARC media space – users who were not collaborators – were observed connecting their offices to keep each other company while working at night ([7], p.39). Mobile phone users have been observed making periodic contact (e.g., updates by mobile email) with selected friends to create a sense of connectedness as they go through their daily routine (which for city dwellers often involve extended periods of walking or travel on public transportation) [16]. In our own design fieldwork of users of mobile push-to-talk, we have observed what we termed "extended remote presence" [35], or intermittent communication with a specific "companion" while in transit or doing errands – a way of creating an audible version of what Goffman called a "with" [11] using mobile communication.

In both cases, as in the previous subsection, the contact need not be continuous or particularly informative in a semantic sense. It is the implicit commitment by a specific person or persons to availability for an extended period (rather than a general sense of availability within a group) that creates this kind of connectedness.

In the mobile case, the sense of connectedness is threatened by several challenges that do not arise (or arise to a much more limited degree) in the media space case. One set of challenges has to do with obstacles to the use of mobile communication in different physical environments that arise from social sanctions, legal restrictions and physical safety implications (see, e.g., [26]). These vary not only across societies but even as one moves through (e.g.) a city. A second set of challenges has to do with finding suitable partners. A media space provides relatively simple mechanisms for browsing for active system participants; more abstract presence mechanisms, or an absence of presence mechanisms altogether, can reduce users to "polling" their friends to find "companions" (e.g., [35]).

*Temporality*

A third area of commonality relates to awareness of temporal rhythms and patterns. Such awareness is a key resource (along with explicit presence data) in knowing whether it is appropriate to make contact. This appears in at least two different forms that work on different time scales. The first involves synchronic events, typically on a diurnal scale. In the PARC media space studies, a wave and a "good morning" and "good night" would be sent through the media space ([7], p.39). Similarly, "good morning" [34] and "good night" [12] messages are often reported in mobile phone studies, particularly those of text messaging. These let others know that one is "signing off" from contact. The second involves detailed understanding of daily routines. Individuals within work groups who are able to observe each other (whether through media or co-presence) are able to form mental models of each others' schedules and potential availability [6]. Similarly, in a college environment, students' schedules may be very structured in the sense that friends have detailed awareness of each others' class and work schedules [35].

In both cases, information about activities can be gathered by passive observation (watching) or information sharing. Where awareness/presence information is ambiguous (as with buddy-list presence mechanisms) or infrequently or irregularly updated, difficulties can arise in interpretation.

In the mobile case, practices around temporality may diverge from those seen in conventional media spaces. First, users may simply accept more interruptions. Because awareness in the mobile case is much less likely to be based on high-fidelity observation (e.g., video) and more likely to be irregularly updated (e.g., manual text messages, or presence information based on handset status), it is recognized that predictions of others' availability may be unreliable. Second, users may use more evolved, graduated contact strategies that involve communication media that are less "interruptive." In most societies, textual communication media are considered less of an interruption than a voice call; the practice often arises of texting before calling.

## SOCIAL, MOBILE AUDIO SPACES

Having discussed a few of the general ways in which media space research and mobile communication research can interact fruitfully, we now turn to the question of how this might be accomplished. In this section, we provide an overview of our own mobile communication project. In doing so, we illustrate some of the ways in which this work has drawn inspiration from media space research.

From a design perspective, our point of departure becomes obvious from the name: Social, Mobile Audio Spaces (http://www.parc.com/audiospaces/). From the beginning, we explicitly focused our design efforts in two ways: first, by designing specifically to facilitate sociable interaction within small groups, and second, by emphasizing audio communication over visual communication to facilitate eyes-free and hands-free mobile use (hence the allusion to the Interval Research series of *audio spaces* [1]).

From a social science perspective, we explicitly framed our research in terms of interactional engagement, albeit at several levels of granularity. Our previous research on wirelessly-connected handheld audio guides [2] taught us that we could design mobile systems that engendered states of connectedness and activity awareness within small groups through wireless audio sharing. However, it also showed us that it was difficult to get people "back in" once they began separate in-the-world activities.

Drawing on our prior experiences and on our design fieldwork conducted using mobile push-to-talk as an approximation of a future lightweight audio communication system [35], we have conducted a variety of explorations of the processes of engagement, dis-engagement, and re-engagement of interaction:

- Managing engagement of floor participation within a given conversational encounter [3,4]
- Managing engagement within a state of incipient talk [32,35,36]
- Managing relational or associational engagement [5]

We discuss each in turn.

### Within a Conversational Encounter

If multiple mobile users want to be able to "keep each other company," what needs to change in audio communication technology for such users to be able to hold spontaneous conversations in an audio space? Is "sociable" conversation within a small group different from other kinds of conversation?

To understand some of the issues behind these questions, we have conducted a number of applied conversation analytic studies of small-group sociable talk [3,4]. In face-to-face interactions in such social groups, conversational floors change frequently, e.g., two participants split off to form a new conversational floor, a participant moves from one conversational floor to another, etc. In our studies, we have examined the mechanics of multiple simultaneous conversational floors – how participants initiate a new floor amidst an on-going floor, and how they subsequently show their affiliation with one floor over another. It is clear that the practices that participants use in face-to-face conversation are disrupted in a monaural audio conference environment, not just because of the lack of non-verbal cues, but (more significantly) because the *cost* of speaking simultaneously is so high – overlapping speech is extremely difficult to understand through a monaural channel.

Drawing on our understanding of spontaneous talk-in-interaction, we prototyped a mobile audio space [3] tailored for the specific issues raised by sociable conversion within tightly-knit social groups. The audio space monitors participant behavior to identify conversational floors as they emerge. The system dynamically modifies the audio

delivered to each participant to enhance the salience of the participants with whom they are currently conversing.

### Within a State of Incipient Talk

When mobile users are faced with a growing array of media for mobile communication – full-duplex voice, half-duplex push-to-talk voice, mobile IM, texting, etc. – each with its own uses and affordances, how should they choose between them? Is the medium used to begin an interaction the right medium to continue explicit "media-switching" [22] always the right answer?

Our design fieldwork suggests that media-switching is more problematic than one might think, with users continuing interactions in an initial medium even when a "switch" seems warranted [35]; an alternative might be to try to smooth the media-switching process. Consider that physical presence or a conventional media space can create an instance of what has been called a "continuing state of incipient talk" [28]. That is, participants, once they enter such a state, dis-engage and re-engage [31] from talk-in-interaction without explicitly re-greeting each other, re-introducing themselves, or otherwise re-"opening" the conversation. (Such states also arise in IM [22] and in mobile push-to-talk voice messaging [32,35].) If we could construct a system to estimate the level of the users' engagement in an ongoing remote conversation, we could use these estimates to (e.g.) increase or decrease the "richness" of a communication session. For example, if two users are speaking in a push-to-talk (half-duplex audio) session and become highly engaged, the system could switch over to a telephony (duplex audio) connection. (A longer discussion can be found in [35].)

To understand some of the issues behind these questions, we have conducted machine learning experiments in which we attempt to differentiate between states of conversational engagement and non-engagement using acoustic features extracted from audio [36]. These experiments, while preliminary, have had a degree of success comparable to that of similar studies of emotion recognition from audio.

### Within a Relational Context

When mobile users wish to prune their contact lists, what resources are available to them? One's sphere of frequent social contact evolves over time, but once contact information has been exchanged, how does one dis-engage from such people?

Our design fieldwork (as well as others') suggests that it is difficult to navigate the social process of avoiding unwanted interaction as one's social relations evolve. This is perhaps one of the most important open areas in which research on workplace-oriented media spaces has offered the least amount of explicit guidance.

After reflection on some of the issues behind these questions, we have offered some preliminary thoughts on resources that system designers can provide to users that might be of use in such efforts [5]. Specifically, we point out that ambiguity can be a useful aspect of communication system design when it affords relevant resources for social interaction.

While we have discussed (briefly) a range of design, prototyping and social science activities, we hope it has been clear how the framing of the various problems has been rooted in the deep explorations of presence, awareness, availability, mediated communication, and small-group dynamics pioneered by the research on media spaces.

## CONCLUSION

Because the uses of media spaces and mobile phones are often similar, the findings of media space research are often closely related to those of later mobile communication research. While we have pointed out that one should not dismiss media space research as being irrelevant to mobile communication research based on spurious technological distinctions, we have also described some areas where the findings of the earlier research have been echoed in those of the later. Some areas where common phenomena and practices have arisen include their use in sustaining relationships, in enabling remote "companionship," and in the employment of temporal patterns. However, mobile phones are used in a more physically diverse environment, both organizationally and physically. As such, research on mobile communication can be seen as not only building upon but significantly extending media space research. We have discussed a few cases where this is true, as well as our own attempts to explore these connections.

## REFERENCES


1. Ackerman, M., Starr, B., Hindus, D. and Mainwaring, S.D., "Hanging on the 'Wire: A Field Study of an Audio-Only Media Space," *ACM TOCHI 4*, 1 (1997), 39-66.
2. Aoki, P.M., Grinter, R.E., Hurst, A., Szymanski, M.H., Thornton, J.D. and Woodruff, A., "Sotto Voce: Exploring the Interplay of Conversation and Mobile Audio Spaces," *Proc. CHI 2002*, ACM (2002), 431-438.
3. Aoki, P.M., Romaine, M., Szymanski, M.H., Thornton, J.D., Wilson, D. and Woodruff, A., "The Mad Hatter's Cocktail Party: A Social Mobile Audio Space Supporting Multiple Simultaneous Conversations," *Proc. CHI 2003*, ACM (2003), 425-432.
4. Aoki, P.M., Szymanski, M.H., Plurkowski, L.D., Thornton, J.D., Woodruff, A. and Yi, W., "Where's the 'Party' in 'Multi-Party'? Analyzing the Structure of Small-Group Sociable Talk," *Proc. CSCW 2006*, ACM (2006), to appear.
5. Aoki, P.M. and Woodruff, A., "Making Space for Stories: Ambiguity in the Design of Personal Communication Systems," *Proc. CHI 2005*, ACM (2005), 181-190.

6. Begole, J., Tang, J.C., Smith, R. and Yankelovich, N., "Work Rhythms: Analyzing Visualizations of Awareness Histories of Distributed Groups," *Proc. CSCW 2002*, ACM (2002), 334-343.
7. Bly, S., Harrison, S. and Irwin, S., "Media Spaces: Bringing People Together in a Video, Audio and Computing Environment," *CACM 36*, 1 (1993), 28-47.
8. Brown, B., Green, N. and Harper, R. (eds.), *Wireless World*. Springer, Berlin, 2001.
9. Dourish, P. and Bly, S., "Portholes: Supporting Awareness in a Distributed Work Group," *Proc. CHI 1992*, ACM (1992), 541-547
10. Glotz, P., Bertschi, S. and Locke, C. (eds.), *Thumb Culture: The Meaning of Mobile Phones for Society*. Transcript, Bielefeld, Germany, 2005.
11. Goffman, E., "The Individual as Unit," in *Relations in Public*, Harper & Row, New York, 1971, 3-27.
12. Grinter, R.E. and Eldridge, M., "y do tngrs luv 2 txt msg?," in *Proc. ECSCW 2001*, Kluwer, Dordrecht, the Netherlands, 2001, 219-238.
13. Habuchi, I., "Accelerating Reflexivity," in Ito, M., Okabe, D. and Matsuda, M. (eds.), *Personal, Portable, Pedestrian: Mobile Phones in Japanese Life*, MIT Press, Cambridge, MA, 2005, 165-182.
14. Hamill, L. and Lasen, A. (eds.), *Mobile World*. Springer, Berlin, 2005.
15. Harper, R., Palen, L. and Taylor, A. (eds.), *The Inside Text*. Springer, Berlin, 2005.
16. Ito, M. and Okabe, D., "Technosocial Situations: Emergent Sructuring of Mobile E-mail Use," in Ito, M., Okabe, D. and Matsuda, M. (eds.), *Personal, Portable, Pedestrian: Mobile Phones in Japanese Life*, MIT Press, Cambridge, MA, 2005, 257-273.
17. Ito, M., Okabe, D. and Matsuda, M. (eds.), *Personal, Portable, Pedestrian: Mobile Phones in Japanese Life*. MIT Press, Cambridge, MA, 2005.
18. Katz, J.E. and Aakhus, M.A. (eds.), *Perpetual Contact*. CUP, Cambridge, 2002.
19. Ling, R. and Pederson, P.E. (eds.), *Mobile Connections*. Springer, Berlin, 2005.
20. Ling, R. and Yttri, B., "Hyper-coordination via Mobile Phones in Norway," in Katz, J.E. and Aakhus, M.A. (eds.), *Perpetual Contact*, CUP, Cambridge, 2002, 139-169.
21. Matsuda, M., "Mobile Communication and Selective Sociality," in Ito, M., Okabe, D. and Matsuda, M. (eds.), *Personal, Portable, Pedestrian: Mobile Phones in Japanese Life*, MIT Press, Cambridge, MA, 2005, 123-142.
22. Nardi, B.A., Whittaker, S. and Bradner, E., "Interaction and Outeraction: Instant Messaging in Action," *Proc. CSCW 2000*, ACM (2000), 79-88.
23. Nyíri, K. (ed.), *Mobile Democracy: Essays on Society, Self and Politics*. Passagen, Vienna, 2003.
24. Nyíri, K. (ed.), *Mobile Understanding: The Epistemology of Ubiquitous Communication*. Passagen, Vienna, 2006.
25. Nyíri, K. (ed.), *A Sense of Place: The Global and the Local in Mobile Communication*. Passagen, Vienna, 2005.
26. Paragas, F., "Being Mobile with the Mobile: Cellular Telephony and Renegotiations of Public Transport as Public Sphere," in Ling, R. and Pederson, P.E. (eds.), *Mobile Communications*, Springer, Berlin, 2005, 113-129.
27. Sacks, H., *Lectures on Conversation, Vols. I & II*. Blackwell, Oxford, 1992.
28. Sacks, H., Schegloff, E.A. and Jefferson, G., "A Simplest Systematics for the Organization of Turn-Taking for Conversation," *Language 50* (1974), 696-735.
29. Sawhney, N. and Schmandt, C., "Nomadic Radio: Speech and Audio Interaction for Contextual Messaging in Nomadic Environments," *ACM TOCHI 7*, 3 (2000), 353-383.
30. Stults, R., *Media Space*. Systems Concepts Lab, PARC, Palo Alto, 1986.
31. Szymanski, M.H., "Re-engaging and Dis-engaging Talk in Activity," *Language in Society 28*, 1 (1999), 1-23.
32. Szymanski, M.H., Aoki, P.M., Vinkhuyzen, E. and Woodruff, A., "Organizing a Remote State of Incipient Talk: Push-to-Talk Mobile Radio Interaction," *Language in Society 35*, 3 (2006), 393-418.
33. Tang, J.C., Yankelovich, N., Begole, J., van Kleek, M., Li, F. and Bhalodia, J., "ConNexus to Awarenex: Extending Awareness to Mobile Users," *Proc. CHI 2001*, ACM (2001), 221-228.
34. Taylor, A.S. and Harper, R., "The Gift of the *Gab?:* A Design Oriented Sociology of Young People's Use of Mobiles," *CSCW 12*, 3 (2003), 267–296.
35. Woodruff, A. and Aoki, P.M., "How Push-to-Talk Makes Talk Less Pushy," *Proc. GROUP 2003*, ACM (2003), 170-179.
36. Yu, C., Aoki, P.M. and Woodruff, A., "Detecting User Engagement in Everyday Conversations," *Proc. ICSLP 2004* (2004), 1329-1332.

**From Media Space to MySpace?**

Sara Bly

As a participant in the Xerox PARC Media Space in the late 80's, I found it a magical experience. I could enjoy "usual" encounters in an "unusual" way – with people who were 600 miles away from me. The stories abound. "Where's Sara?" someone might ask. And the answer that I'd been seen recently in the Commons was as likely to come from Portland as from Palo Alto. Today, according to a recent article in "New Scientist", people are "connected like never before". They report that "the younger crowd go online to live. The boundaries between private and public and between offline and online are blurring…."

In reflecting on the media space, a natural question to pose is whether or not it is alive and well in the social networking so prevalent in 2006. Are the IM sessions, the blogging, and the use of social websites a present manifestation of the PARC audio/video environment of the 1980's? And, if not, what happened to that media space?

I believe the answer to the first question is "no". The media space was an extension of a space. It allowed people within the space to interact or not but it was not an activity itself. One didn't go to the media space to make connections; we made connections because we were in the media space. Today, IM'ing, blogging, and finding links on MySpace are all extensions of ways to connect with one another that require a deliberate action on the part of the participant. Important but different.

So what did make the PARC Media Space technology work for a group of us and why isn't it alive today? Could a media space be created today and what would ensure its success? Could it be realized in a systematic way?

Factors that we considered critical to the success of our media space is that it was not an end in itself but rather a means to an end, that it was a way of interacting more regularly and easily than was otherwise possible when geographically separated. The technology was under the control of the participants and easily accessible; cameras and microphones could be moved or turned off just as office doors can be shut. There was a commonality of purpose and a degree of openness about work. Though it did not and was not intended to replace face-to-face interactions, it provided an environment for work and socializing that was otherwise not possible. It was always 'on'; it simply provided an extension of the space in which we worked. The creation of the media space was by evolution; the work practice and the technology co-evolved.

Certainly there are other instances of such extensions to spaces – in our physical world, neighborhoods allow interactions beyond the home. Technically, a MUD is an environment most like a media space. In particular, the Argonne National Laboratory Math and Computer Science (MCS) Division has used a text-based MUD for over five years by MCS staff working on joint projects (see Churchill). But none of these technology environments have been widespread. Why not?

I suggest three possible reasons: a rather complicated technology set-up is needed, a media space does not easily scale to a larger community, and little research has focused on what worked well.

**Complicated equipment**

The equipment used in the PARC Media Space comprised a set-up of wired analog cameras, microphones and monitors connected through a crossbar switch with a 9.6 kb/sec link between the site networks. This was certainly complicated and expensive and now out-dated. Today, the equipment is much more readily available and fully digital but it would still require a fairly complex set-up. One could not instantly set up multiple locations with connected audio and video so that a person in one place could seamlessly see and talk to persons in other places.

**Inability to scale**

Though rarely discussed, the media space (much like a physical neighborhood) does not readily expand to a larger population. Each media space is created specifically for the space to which it belongs. One could imagine possibly expanding a media space from a group to a division to a building. While this meets many of the same needs of those spaces, it does not expand to encompass all colleagues or friends of any one individual (see Salvador). The media space does not replace the need for audio or video conferencing, for example.

**Research focus**

The PARC Media Space project was stopped before much substantial research evaluation had been completed (see Bly, Irwin, and Olson). External research tended to focus on how the Media Space technology did not provide the affordances of face-to-face interactions (e.g. gaze) and on cross-site meetings. Those aspects of the media space that useful to on-going group relationships have never been seriously studied.

So is there a need for a media space today and what does it take to create that experience? The media space was envisioned as a way of bringing a geographically split group into a shared space. It allowed members of the group to be more aware of one another's comings and goings. It provided an opportunity for chance encounters unlikely to occur otherwise. It aided interactions by allowing members to see one another and, often artifacts, in a manner not like face-to-face but richer than video or phone conferencing. For geographically distributed groups with a need and desire to work closely together, the media space provided opportunities for connection not realized in other ways, even today.

Given the growth of broadband Internet that is 'always on', it appears that technical challenges may be reduced within the near future. Creating a simple

technical solution is a first and necessary step in reintroducing a media space. A more critical step will be identifying places that are "media space ready"[1]. That is, the inhabitants of the places need to want to be in closer proximity to one another, need to have a commonality of purpose and an openness about work, and need to be motivated to expand not only their space but their way of connecting. If technology and a ready community come together, a media space might again emerge.

**References**

Bly, S., Harrison, S.R., and Irwin, S. Media Spaces: Bringing people together in a video, audio, and computing environment. Communications of the ACM, Volume 36 Issue 1 (1993).

Churchill, E. and Bly, S.A. Virtual environments at work: ongoing use of MUDs in the workplace. ACM SIGSOFT Software Engineering Notes, Proceedings of the international joint conference on Work activities coordination and collaboration WACC '99, Volume 24 Issue 2 (1999).

Irwin, S. Technology, talk and the social world: A study of video-mediated interaction. Ph.D. dissertation. Michigan State University, 1991.

Olson, M.H. and Bly, S.A. The Portland Experience: A report on a distributed research group. International Journal of Man-Machine Studies, Volume 34 Issue 2 (1991).

Salvador, T. and Bly, S. Supporting the flow of information through constellations of interaction. Proceedings of ECSCW'97 (1997).

[1] Judy and Gary Olson discuss "collaboration readiness" in much of their work about the successes (and failures) of collaboratories. I think it's an important concept to embrace in media space specific collaboration. See G. Olson and J. Olson, Distance matters. Human Computer Interaction, 15, 2-3, 2000, pp. 139-178.

# From Media Spaces to Emplaced Media: Digital Poster Boards and Community Connectedness

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**ABSTRACT**
In this paper, we offer a brief overview of our work on interactive digital community bulletin boards, highlighting the influence of media space and video communication portal research on our thinking. Following a short introduction, we describe 5 installations of interactive poster boards focusing on similarities and differences in design, setting and use. We conclude with a short discussion of public space communication, reflecting on past models and elaborating future models of "informated" environments that are designed to promote social connection.

**Keywords**
Media space, communication, coordination, community, digital bulletin boards, public installation, community computing, awareness, social computing, plasma poster

**INTRODUCTION**
Media spaces are about connecting people. Experiments beginning in the 1980's demonstrated how an A/V connection between rooms with large displays and between desktops with video windows could enrich social connection, allow close collaboration, and create a sense of being-in-place-together (for early descriptions and discussions see [1,15,22,36,41,42]). As Gaver articulates, much of the design work on media spaces drew clear analogies to everyday spaces, suggesting they offer "virtual copresence", allowing '"tailorable office-spaces," "meeting rooms," and "hallways"' [17, see also 18]. Part of the power of media spaces is that they are "always on", and it is in this regard that they can be compared to physical spaces [1]. In this conception, "connections are a means of changing the arrangement of that space and access controls determine which connections are possible" [1].

Papers published through the late 1980's and early 1990's explored aspects of connection, communication and collaboration offering discussions of:

- *awareness* of others through peripherally sensed movement and activity (e.g., [14,15])
- *access control* to preserve privacy and prevent snooping, "peeping Tom" and surveillance behaviours. Tested models for access control were based on social protocols familiar in the physical and embodied world – "glancing" to simulate a look in someone's direction [42], cruising hallways [16], and knocking on doors. (e.g., [15,16,42])
- *close collaboration over content*, exploring the assertion that design documents are more important for collaboration in their making than in their exchange [22]. These explorations led to a body of work on embodied conversation, considering how bodies orient to each other and to content when collaborating or simply working in parallel, and the importance of things like gaze direction and deictic reference for conversational flow and the creation of shared understanding [e.g., 24]. Notably, research into video conferencing [40] and the design of embodiments in collaborative virtual environments [25] fed into and drew on this body of work.

These explorations involved largely synchronous video feeds, but other forms of media space were also designed and evaluated (e.g., work on audio only spaces also explored how togetherness can be achieved by only sharing sound, [26]).

**Theorizing media spaces**
Media spaces proved an excellent grounding for exploring the ramifications of different philosophical approaches to social being – from Gaver's reworking of Gibson's ecological psychological notions of "affordance" [17], to Goffman's ideas on face-work [20], to conversation analytic and ethnomethodological analyses of embodied interaction [19, 24] to Goodwin's broader notion of environmental and social "semiotic resources" [21], and to cognitive models of conversation and "common ground" [11]. Fascinating debates on the nature of privacy, attention, awareness, social presence and so on continued in papers, panels and discussion groups.

Questions posed included: What does it take for people to feel connected? How is connection maintained on a moment-to-moment basis through conversation and body

orientation [24]? How do people cognize in concert when not face to face but given rich cues of each other's behaviour, and how can we evaluate the effect of different levels in the "richness" of cues [13]? How do people establish shared or "common" understandings through language and paralinguistic cues in mediated communication contexts [11]? These questions and studies intersected with considerations of connectedness in other media. Can we combine video with other data streams to create greater possibilities for sharing [12]? How do different kinds of and amounts of perceptual stimulation relate to the degree of social presence people experience [34]? Do we need visual cues to feel connected or will textual cues do [5]?

### Our work: foregrounding content not co-presence

In our work we have focused on a particular aspect of communication through technologies, including media spaces. Rather than seeing content as secondary to creating connection, we have made content primary. There are several reasons for this: first we were designing for cross time zone connections where the synchrony that is entailed with video-based media spaces was practically not possible. Secondly, our research agenda has largely been about how objects mediate relationships [33], what objects tell about a culture and how people orient to that culture [29], and how our relationships are built around and upon the exchange and sharing of objects [32]. We have also drawn on notions of objects as social actors [33], and on anthropological work on biographical objects [29]. This approach – the primacy of content – was also explored in our work on collaboration where we chose to subjugate the people to the content through rich, fluid annotation of content [6].

In the next section we briefly describe our work on community bulletin boards as tools for information/rich-media exchange. Given our focus information encountering of socially tagged content in physical social places, rather than on human-human communication between spaces, we refer to these technologies not as media space technologies but as "emplaced media" technologies. A key aspect of understanding how these emplaced media technologies operate is to comprehend the settings into which they are introduced. Our descriptions below are necessarily short, but we have tried to raise issues for further discussion at the workshop.

## COMMUNITY AS EXPRESSED THROUGH CONTENT

We have created a number of installations of interactive community bulletin boards. These bulletin boards are an exploration in both informating the physical world with social content, a form of social book-marking in public rather than online space (e.g., deli.ci.ous.com). They are also intended to provide a window onto online community activities and interests, offering a leakage between the world of single user at the screen contributing to a community and the encountering of information serendipitously in shared physical space (Figure 1). These boards are not intended to be anonymous, broadcast message bearers; they are intended to host content generated by community members, for the community itself. Therefore content may be highly specialized unlike general announcements and advertising content.


**Figure 1: Information flows in online and physical public spaces.**

Given FXPAL is well known for research into audio/video innovation, why did we choose not to use video as central in the designs we created? There were several reasons. First, at the incept of the interactive community board design, we were working to connect places in different countires and across time zones. This made video impratical. Staring at a darkened room with only minimal overlap in inhabited space time would not achieve our goal of increasing a sense of connection. Secondly, language differences, and especially low competence in speaking Japanese on the US side, meant a video plus audio space would perhaps prove more frustrating than enabling. Thirdly, we had a strong agenda in rich annotation as noted above. Finally, we were keen to pursue our other research trajectory in "polite" technologies and ambient installations. This was inspired in part by our explorations along an elaborated design continuum in shared physical space technologies, a continuum between ambient and abstract social sharing resources [30, 39], "realist" co-presence tools like rooms augmented with media spaces, and technologies for co-present focused collaboration like shared whiteboards [38]. It seemed to us that socially annotated content nicely into this continuum, by (1) being physical, public space technologies, by (2) allowing peripheral awareness of other's presence and engagement in a community, and by (3) inviting but not insisting upon active engagement on the part of the reader when reading and annotating content.

In the next section, we briefly describe 6 installations we have created over the past 6 years, each of which had slightly different characteristics. The last installation, YeTi, combined posted multimedia content with ad hoc video annotations to that content. Although still exploring asynchronous sharing, this installation brings us almost full circle to media spaces in their original incarnation, but preserves our notion of the content itself as being central, with the interaction over that content as secondary.

### The beginning: Plasma Poster Network

The Plasma Poster Network is a distributed information sharing architecture with a number of interfaces, designed for a number of platforms – cell phone, PDA [3] and most importantly for the current paper, large screen interactive public displays. Content supported for display on the interactive poster boards are text, html, images and videos. On personal devices where media format is not supported, readers see summarized meta-data about format, as well poster network generated meta-data (e.g., date of posting) and meta-data that the author creates (title, comment, etc).

The Plasma Poster network was originally envisioned to be a way of sharing content between FXPAL in California and a sister research lab outside Tokyo in Japan. However, it's primary use was within the FXPAL research lab (see [7] for more details of posting activities including measres of use and analysis of posted content). Figure 2 shows the three posters that were installed at FXPAL.

**Figure 2: Three Plasma Posters installed at FXPAL; hallway, foyer, kitchen**

Our naivete about the power of content to transcend social boundaries and create a bridge between labs was revealed in the failure of our transnational experiment. Despite the fact that many of our colleagues in Japan read English well, and our encouragement to them to post content in Japanese, they did not use the Plasma Poster - they neither posted content nor read our posted content. On a visit to Japan to investigate what had "gone wrong", we discovered that the interactive poster was first placed in a non-conducive location. It was located between two (somewhat estranged) departments in a space that was only nominally a "lounge" – the lounge was in fact a corridor between the departments that led to the restricted area for smoking. The nature of this social place acted to exclude the interactive poster as a useful social sharing tool; it simply raised issues and concerns about maintaining "face". However, on moving the poster to a more sympathetic location (firmly in one department, and near a printer where people idled awaiting printouts), we discovered yet again that it was *apparently* not used. That is, not used by our indications from a distance monitoring of the shared database we had set up between FXPAL and the sister lab. Another visit to Japan and more data gathered revealed that in fact the Plasma Poster **was** in use, but that a separate database had been created, creating a local poster board. People posted only locally relevant content. This was not the transnational social technology we had envisaged but it made perfect sense in hindsight (as things often do).

### A Moving Show: CHIplace and CSCWplace extended

Having successfully installed three poster boards at FXPAL and on at our Japanese location, we investigated the possibility of creating moving installations that built on and connected an online community space. The questions we posed in this experiment were technology, business and socially related. Technologically speaking we were interested in how swiftly we could repurpose an interface and redesign it for a new context [37]. We also wanted to integrate the Plasma Poster infrastructure with that which already existed for the CHIplace online community (which was appropriated and reimplemented for CSCW to create CSCWplace). Finally we were interested in creating a connection between online community participants who were interested in CHI 2002, but could not attend, and people who were physically attending the conference [8]. Figure 3 shows the installation of the poster boards at CHI 2002 in Minneapolis and at CSCW 2002 in New Orleans.

**Figure 3: CHIplace poster installation at CHI 2002 in Minneapolis and CSCWplace installation at CSCW 2002 in New Orleans**

By far the most popular use of these installations were the shared photos; attendees uploaded images taken at events during the conference for others, online and offline, to see. Announcements of upcoming events and impromptu gatherings (e.g., journal editorial board meetings, special interest group and "birds of a feather" sessions) were also popular. Notably some but not all of these were documented in the materials all attendees received at registration so the boards and the online community space acted as an additional information dissemination mechanism.

### Governmental communications: Mitaka City

An installation of the Plasma Poster Network was created for and deployed in a government building in Mitaka City in Japan (Figure 4). Here the basic technological infrastructure and the interface remained as it had been for the FXPAL installation, but the social use changed. Instead of supporting a community of content creators who posted directly to the board, government officials and associates from the local community were encouraged to send potential content to a person, an official "poster", who exercised some editorial control and posted the content to the board itself. Communications from the government officials to the visitors of the municipal building were clearly scripted, a singular and consistent "face" from the

group to the community, not community members informing each other directly. The poster was physically located at the entrance of the public offices; amongst general posting for the local area were postings about how the building itself functioned – what events were coming up and what meetings (albeit closed to the general public) were taking place. This was an interesting form of awareness – "we are working hard on your behalf" was the message, but the details of those actions were not of import.

**Figure 4: Mitaka City Plasma Poster**

### Café Conversations: eyeCanvas

Another major installation was the eyeCanvas display, designed for and deployed in a local café/art gallery. Details of the installation can be seen elsewhere [9], but here again there were social setting issues that made this installation very different from the others we had created. In this instance the café/gallery owners controlled the content that was posted, community members (artists, musicians, café visitors) were never invited to the online community space we created. However, we deployed an interactive finger-scribble application that allowed patrons to create messages that were then posted to the board itself, thus enabling some form of participation. Figure 5 shows one of the local artists creating a drawing with an onlooker. These "scribbles" proved very popular, creating a flow of information into the public space from patrons (for more details see [10]).

### Who's Reading: Video Annotations on Content

Finally, we created a version of the interactive poster to encourage the sharing we intended with the first Plasma Poster installation – sharing with colleagues in Japan (Figure 5).

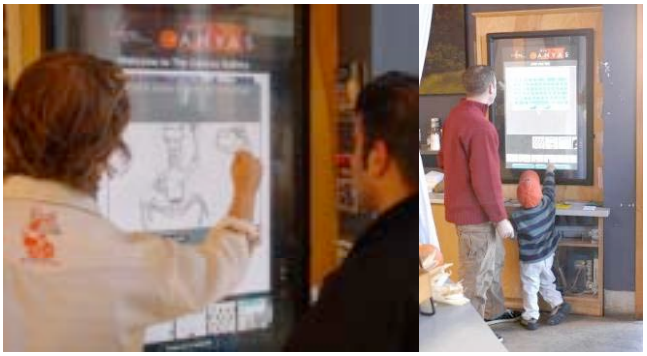

**Figure 5: eyeCanvas public board at the Canvas Gallery in San Francisco**

Called the YeTi interactive board (for Yesterday Today Interface, an allusion to the time zone differences between the locations), the interface was designed explicitly as a shared digital space between two departments – space on the board itself was visually dedicated to each department. In addition we added a video annotation capability – when people touched content, a short (soundless) video of their interaction with the content was captured and associated with the viewed content (see [43] for more details).

**Figure 5: YeTi poster interface, with text and video annotations illustrated to the side**

### Summary points

In this paper we have described briefly several installations of a public space interactive community bulletin board and online community sharing space. In all instances the basic infrastructure was the same, but the interface and placement differed. Our poster technology is now a product in Japan from Fuji Xerox, the "Collaboposter". This product is intended to be sold as part of a consultancy package, part of improving information flow in customer sites. Our work is continuing in this area; an installation of loosely coupled poster boards inspired by the Plasma Poster technology is also planned for deployment at PARC.

From a product or technology perspective the exploration has been successful. However, we are only just beginning to return to our original research questions, the questions that underpinned the original design. The basic design we have presented here was envisioned to be just one design instance in a broader design space focused on exploring human-human interaction in physical and digital social locales, on exploring sociopetal "polite" technologies, and on exploring interactions in media enriched physical,

embodied place and space. So: What have we learned? And what questions remain firmly on the table?

## LOOKING BACK AND FORWARD

We now briefly reflect on what we have learned and how it builds on and contributes to previous work. We also speculate on what media spaces are becoming, and the future of emplaced media. First, for some general thoughts:

- *Place matters* – there has been much written about space and place (e.g., [2, 4, 23, 35] and frequent restating of the fact that places are socially constructed, with space in some debates presented as the superset container from which places derive (see [4] for elaboration of this argument). Our installations have shown clearly the co-construction of technology and place – people adopt and adapt the technology by posting content, which is in turn saved, annotated, forwarded, and printed, moving on to play a role in conversations that are woven away from the boards themselves. Studies in the anthropology of space and place have long stressed the fluid nature [2], but also the primacy [4], of place. For us, place is not bricks and mortar; it is not found in buildings and streets; it is not simply the artifacts placed within or posted on walls. Place is the invisible tension of social protocols, shared things and personal identities that results in a feeling of being together; seeing each other and sharing media contribute to create the sense of cohesion.
- *Media matters* – the form of media that are shared is determined by the setting. Sanctions, tests, creations all play a role in what is put on the boards, and over time a norming of what is acceptable occurs. The effect of setting on content type and the norming over time of content style is evident in the very different forms of adoption and adaptation in each of the deployment.
- *People matter(s)*: The adoption and adaptation of the boards and the media they host affect and are affected by the evolving practice if public media sharing. A with observations of media spaces use we have seen clearly that "to tie together the community work practices with media space technologies, we must let them evolve together" [1]. This is clearly what we also see with emplaced media.

Put explicitly, each setting determined how the interactive poster boards would be used by a subtle often unspoken interchange between the "hosts" and "users" of the technology.

A thought-piece paper often ends with what were "surprises". Perhaps the surprise is that we could have predicted, from the 10000 ft view, that the technologies would create a stir, would provoke interest, would be adopted and adapted in different ways by different social groups in different settings. However, for us the "devil was in the details", and we *were* surprised where 'surprising' means entrancing rather than shocking. The difference in content that was posted to the boards in the different settings, the editorial controls that were exerted on content, the ways people envisioned using the devices in other settings – these were all entrancing and exciting and a wonderful indicator of how "disruptive" technology interventions reveal hitherto unseen aspects of a social setting. Perhaps this reflects a science and design project located in celebrating the details of what makes a social setting a place to share, and the ways in which content posted to social places can be read in multiple ways, and the ways in which people *want to* reach out and share content with others.

So what is next for media spaces and emplaced media? Certainly video conferencing on mobile devices is going to increase the sense of mobile co-presence people can enjoy (or not). We are already sharing content on urban displays, and texting to public and private devices. Further, video annotation over content on personalized devices is set to move forward. Finally, the domestication of media spaces is another rich area of research (e.g, see [27]). We have outlined proposals for poster-like interfaces as part of home installations on refrigerators, for example. Homes are settings with particularly close ties between people, so these are perhaps where the sharing of rich content can have deepest impact.

In this workshop we would like the opportunity to elaborate and populate further the design dimensions of placed technologies mentioned above. We would also like to discuss the role of emplaced media as reflecting and underpinning the sociopetal aspects of a social setting.

## REFERENCES


1. Bly, S., Harrison, S., and Irwin, S. Media spaces: Bringing people together in a video, audio, and computing environment. Communications of the ACM, 36 (1), 28 – 47, 1993.
2. de Certeau, Michel. The Practice of Everyday Life. Berkeley, California: University of California Press, 1984, 2002.
3. Carter, S., Churchill, E.F., Denoue, L., Helfman, J., Nelson, L., Digital Graffiti: Public Annotation of Multimedia Content, CHI 2004, 2004.
4. Casey, Edward S.: The Fate of Place – A Philosophical History, University of California Press, 1997.
5. Churchill, E. F., & Bly, S. Virtual environments at work: ongoing use of MUDs in the workplace. Proceedings International Joint Conference on Work Activities Coordination and Collaboration, 99-108, 1999.
6. Churchill, E.F., Trevor, J., Bly, S., Nelson, L. and Cubranic, D. Anchored conversations: chatting in the context of a document. CHI 2000, pages 454 – 461New York: ACM Press, 2000.
7. Churchill, E.F., Nelson, L. Denoue, L., Murphy, P., Helfman, J., The Plasma Poster Network Social Hypermedia on Public Display, In Public and Situated Displays. Social and Interactional Aspects of Shared Display Technologies. K. O'Hara, M.Perry, E.

Churchill and D. Russell (Eds) London: Kluwer Academic Publishers, 2003.

8. Churchill, E.F., Girgensohn, A., Nelson, L., Lee, A., Blending Digital and Physical Spaces for Ubiquitous Community, Communications of the ACM, February 2004, Vol. 47, No. 2, pp. 38-44, 2004.
9. Churchill, E., Nelson, L., Hsieh, G. Café Life in the Digital Age: Augmenting Information Flow in a café-work-entertainment Space. In Proceedings of CHI 2006, Extended Abstracts, pp.123-128. New York: ACM Press, 2006.
10. Churchill, E.F. and Nelson, L., Interactive Community Bulletin Boards as Conversational Hubs and Sites for Playful Visual Repartee, To appear in Persistent Conversations Track at HICSS 2007.
11. Clark, H. H. Using language. Cambridge: Cambridge University Press, 1996.
12. Curtis, P., Dixon, M., Frederick, R. and Nichols, D. A. The Jupiter Audio/Video Architecture: Secure Multimedia in Network Places. ACM Multimedia 1995: 79-90, 1995.
13. Daft, R.L. & Lengel, R.H. Organizational information requirements, media richness and structural design. Management Science, 32(5), 554-571, 1986.
14. 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.
15. Dourish, P. and Bly, S. Portholes: Supporting Awareness in a Distributed Work Group. Proceedings of ACM CHI'92 Conference on Human Factors in Computing Systems, pp.541-547, May 3-7, 1992.
16. Fish, R., Kraut, R., Root, R., and Rice, R. Evaluating video as a technology for informal communication. Proceedings of CHI'92. ACM, New York, 37 – 48, 1992.
17. Gaver, W. The affordances of media spaces for collaboration. Proceedings of CSCW'92, 1992.
18. Gaver, W., Moran, T., MacLean, A., Lovstrand, L., Dourish, P., Carter, K., and Buxton, W. Realizing a Video Environment: EuroPARC's RAVE System. Proceedings of ACM CHI'92 Conference on Human Factors in Computing Systems, pp.27-35, May 3-7, 1992.
19. Garfinkel, H. Studies in ethnomethodology. Englewood Cliffs, NJ, USA, Prentice Hall, 1967.
20. Goffman, E. On Face-Work. Interaction Ritual New York: Anchor Books, 1963.
21. Goodwin, C. Pointing as Situated Practice. In Pointing: Where Language, Culture and Cognition Meet, edited by Sotaro Kita. Mahwah, NJ: Lawrence Erlbaum, pp. 217-41, 2003.
22. Harrison, S. and S. Minneman. The Media Space: A Research Project into the Use of Video as a Design Medium. PaloAlto, CA: Xerox Corporation, 1990.
23. Harrison, S. & Dourish, P. Re-Place-ing space: The roles of place and space in collaborative systems, 1996.
24. Heath, C., and Luff, P. Media space and communicative asymmetries: Preliminary observations of video mediated interaction. Human-Computer Interaction, 7, 315 – 346, 1992.
25. Hindmarsh, J., Fraser, M., Heath, C. & Benford, S. Virtually Missing the Point: Configuring CVEs for Object-Focused Interaction. In Churchill, E. F., Snowdon, D. N.et al. (Ed.) Collaborative Virtual Environments. Springer, London, pp.: 115-42, 2000.
26. Hindus, D., Ackerman, M., Mainwaring, S. D., Starr, B. Thunderwire: A Field Study of an Audio-Only Media Space. Proceedings of CSCW 1996, p.238-247, 1996.
27. Hindus, D., Mainwaring, S.D., Leduc, N., Hagstrom, A.E. and Bayley, O Casablanca: Designing Social Communication Devices for the Home. Proceedings of CHI 2001 p.325-332, 2001.
28. Hollan, J., S. Stornetta, Beyond Being There, Proceedings of CHI'92, pp. 119-125, 1992.
29. Hoskins, J. Biographical Objects: how things tell the stories of people's lives London: Routledge, 1998.
30. Ishii, H. and Ullmer, B. Tangible Bits: Towards Seamless Interfaces between People, Bits and Atoms, Proceedings of CHI '97, ACM Press, 234-241, 1997.
31. Kendon, A. Conducting Interaction: Patterns of Behavior in Focused Encounters. Cambridge: Cambridge University Press, 1990.
32. Komter, A.E. Social Solidarity and the Gift. New York: Cambridge University Press, 2005.
33. Latour, B. Reassembling the Social: An Introduction to Actor-Network-Theory. Oxford: Oxford University Press, 2005.
34. Lombard, M., & Ditton, T. At the heart of it all: the concept of presence. Journal of Computer-Mediated Communication,3(2). http://www.ascusc.org/jcmc/vol3/issue2/lombard.html, 1997.
35. Low, S. and Lawrence-Zuniga, D. The Anthropology of Space and Place, Blackwell, Publishing, Oxford, 2003.
36. Mantei, M., Baecker, R., Sellen, A., Buxton, W., Milligan, T., and Wellman, B. Experiences in the use of a media space. Proceedings of CHI'91. ACM, New York, 203 – 208, 1991.
37. Nelson, L., Churchill, E.F., Repurposing: Techniques for reuse and integration of interactive systems, Proceedings of the 2006 IEEE International Conference on Information Reuse and Integration, September 2006.
38. Pedersen, E., McCall, K., Moran, T. and Halasz, F. Tivoli: An Electronic Whiteboard for Informal Workgroup Meetings. Proceedings of InterCHI, Amsterdam April 1993, 1993.

39. Pedersen, E. and Sokoler, T. AROMA - Abstract representation of mediated presence supporting mutual awareness. Proceedings of CHI 97 conference, Atlanta, ACM Press, 1997.

40. Sellen, A.J Assessing video-mediated conduct: A comparison of different analytic approaches. In K. Finn, A. Sellen, & S. Wilbur (Eds.), Video-mediated Communication, NJ.: Erlbaum, 95-106, 1997.

41. Stults, R. Media space. Xerox PARC technical report, 1986.

42. Tang, John C., Ellen A. Isaacs, and Monica Rua, Supporting Distributed Groups with a Montage of Lightweight Interactions, Proc. CSCW `94, pp. 23-34, 1994.

43. Yamada, T., Shingu, J., Churchill, E.F., Nelson, L., Helfman, J., and Murphy, P. Who Cares? Reflecting Who is Reading What on Distributed Community Bulletin Boards. Proceedings of UIST 2004, pp 109-118, 2004.

# Using Media Spaces to support collaborative research in the computational sciences

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## ABSTRACT

The domain of computational science is rapidly evolving. Advanced computation, computer simulations, large scale storage systems, high resolution scientific sensing devices, and networking technologies provide scientific researchers with a wealth of mechanisms with which to explore complex scientific phenomena. This is especially true in the academic research community where large-scale computational consortia provide an extensive range of advanced technologies to their researchers. Large-scale scientific problems, such as those explored in the particle physics and medical communities, involve large research teams with members from around the world working on projects that span months and sometimes years.

At the same time, the technologies used in the media space domain have also been changing rapidly. Many of the technologies that were pushed to their limits in the early media space research are now approaching the commonplace. With the commoditization of large-scale displays, touch screen interaction, wireless devices, and advanced networking, what we once considered advanced media spaces are beginning to be deployed and used on a day –to-day basis.

This position paper describes our research exploring the intersection of media space technologies and advanced computational science. In particular, we are focusing on the human interactions that are involved in distributed, artifact-centric collaboration. We define an artifact as the digital representation of a complex scientific phenomenon. We are interested in trying to develop a better understanding of the human-to-human communication needs that are required for facilitating such interactions at a distance. In particular, we want to study these groups in modern media space collaboration environments. In order to develop this understanding, we believe that it is important to employ naturalistic, ethnographic methodologies to observe users using media space environments that make use of these advanced technologies.


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## Categories and Subject Descriptors

H.5.3 [**Information Interfaces and Presentation**]: Group and Organization Interfaces – *computer-supported cooperative work, collaborative computing.* H.5.2 [**Information Interfaces and Presentation]:** User Interfaces – *input devices and strategies, interaction styles.*

## General Terms

Measurement, Performance, Experimentation, Human Factors.

## 1. INTRODUCTION

Scientific research is rapidly becoming a global endeavor. Today's complex scientific problems not only require a wide range of technologies to solve them, but they also require a wide range of expertise. More and more often, researchers are working with collaborators at institutions that are across the country and/or around the world. In addition, the increasing amount of scientific data that is available to scientific researchers, using high-resolution instruments and/or complex computational simulations, means that collaborative scientific visualization is becoming an important tool to the scientific research community.

The focus of this research is on distributed, collaborative, scientific visualization. In particular, we are interested in the problems that arise when a complex digital artifact, such as the visualization of scientific data, is the focus of the collaboration. The goals of our immediate research is to identify the communication needs for such a collaboration task (what is the explicit information that needs to be communicated – pointing at an artifact for example), to determine how those needs are affected by distance (what information is difficult to communicate at a distance), and to determine mechanisms to mitigate and possibly eliminate the effects of distance on the collaboration.

## 2. COLLABORATION IN COMPUTATIONAL SCIENCE

Scientific communities form through two fundamental mechanisms, from pressure due to the needs of a group of scientists exploring a specific *research area* or from pressure due to a general *community need*.

Examples of research area based collaborations are the Network for Earthquake Engineering Simulation (NEES) [6] and Atlas (a global particle physics research effort) [1]. It is worth noting that

many of these communities have evolved naturally over time, primarily because of a need for that community to collaborate.

The *community need* approach is driven by the need to provide a research computing infrastructure (advanced computational, storage, network, visualization, and collaboration technologies) to a range of scientific communities. The community approach typically results in computational consortia [10][11] that provide computational environments that service a wide range of users and communities. Their formation is often driven by the fact that a consortium can provide a wider range of services without duplicating the cost and effort that would be necessary if the individual institutions attempted to provide those same services for their local users. These consortia are often based on regional geographies.

Many of these collaboration communities are formed through ad-hoc mechanisms that meet an immediate need rather than from rigorous planning from a social perspective. Scientific communities are social networks of people, typically working at a distance, that are trying to accomplish a common goal. It is through an understanding of the needs and goals of these communities that we will be able to build successful collaboration environments.

Supporting collaborative scientific research presents a system designer with a set of relatively unique problems. Not only is the scientific data the focus of the collaboration, but the data is typically complex in structure, dynamic in nature (e.g. changes over time), and poorly understood (little *a-priori* knowledge about the data is available). Thus, interactive exploration and investigation is one of the key tasks for this kind of collaboration.

**Figure 1: A scientific media space**

## 3. TECHNOLOGY AND MEDIA SPACES

The early research in media spaces (e.g. [3][5]) created some truly compelling communication and collaboration environments, particularly if one considers the technology available at the time. The technology we use today has changed drastically since that time.

Advances in computation allow us to perform computational tasks that were impractical a short time ago. Display technologies are becoming ubiquitous, with collaboration rooms in the academic community commonly having two to four display surfaces. These displays are often included as part of the collaboration space in novel ways (e.g. tabletop, high-resolution, or 3D displays). Sensors and other interaction technologies allow us to work within these environments in increasingly rich and complex ways. Touch sensitive displays, 3D tracking of devices and people, and RF ID tags that identify people and objects all add to the capability, and the complexity, of our collaboration environments. Last, but certainly not least, networking technologies provide us with the ability to connect these devices together in novel and exciting ways. Wireless networks allow laptops and handheld devices to be integral parts of a collaboration environment, while optical networking allows us to connect remote locations together with multi-gigabit networks that can be dedicated to the collaboration task.

These advances in technology mean that what was once only conceivable in an advanced research lab is now available at the commodity level. This has brought the media space world to a range of real users, doing real work. Users are beginning to expect, and sometimes demand, the type of always on, always-connected collaboration environment that media spaces represent.

It is our belief that there are significant opportunities in the naturalistic study of users in these new collaboration and communication spaces. Much of the early research in media spaces consisted of ethnographic studies of researchers using these technologies. Recent research in the media space domain has focused on quantitative experimental studies (although certainly not exclusively). Our approach is to revisit the ethnographic approach of studying users as they engage in their normal work practices using modern media space technologies. We are fortunate in that we have access, through the WestGrid [11] and IRMACS [6] research projects, to a number of meeting rooms that are designed for advanced collaboration (see Figure 1). Although these rooms are not used as “always on” environments, they are designed to be “connected at the touch of a button” and therefore can be used to provide a media space environment for our users. It is our belief that using naturalistic, ethnographic studies to explore the use of such modern, turnkey media space environments has the potential to provide new insights into how we communicate and collaborate at a distance using these technologies.

## 4. ARTIFACT-CENTRIC COLLABORATION

We define distributed artifact-centric collaboration as collaboration that focuses on digital objects (objects represented digitally on a computer). The computer mediates the collaboration by communicating information about the artifact, and the actions on that artifact, to remote users. Previous research on face-to-face collaboration suggests that our interactions are naturally multimodal [2][8][9]. People bring “things” to meetings (physical objects such as a paper document and digital artifacts such as a data set) and refer to these objects on a regular basis. In particular, the coupling of deictic statements with gestures is an important component of most face-to-face collaborations involving artifacts (e.g. look at this, it was this big).

Gestures are often used for other purposes, such as pointing to indicate the next speaker or to enhance a statement that is being made, but gestures are elevated in importance when an object or artifact is the focus of the collaboration. In face-to-face meetings

that involve the design process, up to 14 gestures per minute have been recorded [2]. The question then arises, what happens to these communication modalities when collaboration is performed at a distance? Indeed, in their 1995 paper, Bekker calls for a "…concerted empirical attack on the question of what happens to gestures during design meetings [when the users are not co-located]" [2].

Despite this call to action, there has not been a significant amount of research performed exploring the impact of distance on gesture in distributed, artifact-centric collaboration. Both gesture and artifact-centric collaboration have individually been explored in some detail, but relatively little recent research has been performed on the use of gesture in artifact-centric collaboration. As Ou points out in [9], there are some fundamental differences between how gesture is used in human-computer interaction and how it is used in computer-mediated human-to-human communication. Some of the issues that Ou raises are:

1. Gesture support in CSCW is different from gesture support in human-computer interaction (HCI). Gestures in HCI communicate information to a computer while gestures in CSCW communicate information to other people. One cannot overlook this important role change when creating artifact centric collaborative environments.
2. Gestures may play a role as both an HCI and an HHI (human-human interaction) mechanism.
3. There are few theoretical guidelines to direct researchers in the construction of collaborative environments where gestures play either a HHI or a combined HHI/HCI role.

These observations are very astute ones, as much of the research performed in the area of gestural interaction has occurred in a HCI context as opposed to an HHI context. It is not clear how much of the gesture research that has been carried out in the HCI community can be applied to human-to-human artifact-centric collaboration.

## 5. ETHNOGRAPHIC STUDIES IN MODERN MEDIA SPACES

Our research explores the importance of gesture in co-located and distributed scientific collaboration. In particular, we are interested in collaboration that involves computer-mediated interaction with, and manipulation of, complex scientific data (or digital artifacts). We have recently carried out a longitudinal, naturalistic ethnographic study of a scientific research group while using an advanced media space environment. The media space used in this study is similar to that shown in Figure 1 and includes multiple plasma displays mounted on the wall with Smartboard touchscreen overlays. The goal of this study was to better understand the research group's communication needs while performing artifact-centric collaboration tasks.

During the study, we observed a mathematical modeling group consisting of 14 individuals as they worked on a variety of projects over a four month period. Over 15 hours of video tape was recorded and analyzed. Both co-located and distributed meetings were observed, with distributed meetings having most users present in the media space environment and one or two remote users (in a non-media space environment). Our goal was to understand the impact of distance on the rich communication that the media space users were utilizing.

Although the results of this work are beyond the scope of this position paper, we provide a summary of our results below. The results of this research are reported on in more detail in [4].

- Collaboration tools need to support meeting processes. They must be able to switch between supporting the collaboration needs of different meeting tasks (description, discussion, problem solving) swiftly and effectively.
- Artifact-centric collaboration is an important component for some, but not all, meeting tasks.
- Gestural interaction appears to be important in artifact-centric collaboration.
- Users adapt quickly to their environments. When gestural interaction is supported, users will typically use it extensively once they determine how it works.
- Most gestural interactions are coupled with participant utterances. It is therefore important to support the communication of both utterance and gestural communication channels in distributed collaboration.
- Different users utilize gestures in different ways. Some users appear to be more comfortable interacting directly (physically or with the SmartBoard) while other users appear to prefer interacting through a proxy (like the mouse). Because some participants had more familiarity with the SmartBoard, it is not clear whether this resulted from individual preferences or familiarity with the technology.
- When participants are highly engaged in an artifact-centric meeting, they appear to prefer direct physical interaction to interaction that is provided through a proxy such as a mouse pointer. This implies that direct interaction technologies such as the SmartBoard or the DiamondTouch table may be fruitful areas of future research.
- When participants are highly engaged in an artifact-centric meeting, more than one user often wants to interact with the artifact at the same time. It is therefore important to support seamless multi-user interaction for both collocated and distributed users.

These results provide an excellent basis for us to move forward, both with our continuing observational studies and the development of collaboration tools for artifact-centric collaboration. Although this work provides useful insights into gestural interaction and artifact-centric collaboration, much work remains. In particular, our future work includes the application of the guidelines presented above in developing collaboration tools for artifact-centric collaboration and the testing of the validity of these guidelines in their effectiveness for developing these tools.

## 6. ACKNOWLEDGMENTS

I would like to thank my various colleagues, who have contributed to this work through years of collaboration. These people include Peggy Storey, Todd Zimmerman, Andrew Patrick, Sylvie Noel, Janice Singer, Steve Marsh, and Pierre Boulanger. Much of this research was carried out using the facilities provided by WestGrid (www.westgrid.ca) and IRMACS (www.irmacs.sfu.ca).

## 7. REFERENCES


[1] Atlas Project, www.atlas.ch

[2] Bekker M, Olson J, and Olson M (1995), Analysis of gestures in face-to-face design teams provides guidance for how to use groupware in design, In: *Proc. of Symposium on Designing Interactive Systems (DIS 1995)*, ACM Press, New York.

[3] Belloti, V and Dourish P (1997), Rant and RAVE: Experimental and Experiential Accounts of a Media Space, in *Video Mediated Communication*, K Finn, A Sellen, and S Wilbur (editors), Lawrence Erlbaum Associates, Mahwah, New Jersey.

[4] Corrie B, and Storey M. (2007) Towards Understanding the Importance of Gesture in Distributed Scientific Collaboration, to appear in the *International Journal of Knowledge and Information Systems*, Springer.

[5] Harrison V, Bly S. Anderson S, and Minneman S (1997), The Media Space, in *Video Mediated Communication*, K Finn, A Sellen, and S Wilbur (editors), Lawrence Erlbaum Associates, Mahwah, New Jersey.

[6] IRMACS – Interdisciplinary Research in Mathematics and Advanced Computational Science: www.irmacs.sfu.ca.

[7] Network for Earthquake Engineering Simulation, www.nees.org

[8] Olson J, Olson G, and Meader D (1995), What mix of video and audio is useful for small groups doing remote real-time design work? In: *Proc. of the Conference on Human Factors in Computing Systems (CHI 1995)*, ACM Press, New York.

[9] Ou J, Fussell S, Chen X, et al (2003), Gestural Communication over Video Stream: Supporting Multimodal Interaction for Remote Collaborative Physical Tasks, *Proc. of the 5th International Conference on Multimodal Interfaces (ICMI 2003)*, ACM Press, New York.

[10] TeraGrid, www.teragrid.org

[11] WestGrid, www.westgrid.ca

# Reflecting on Several Metaphors for Media Spaces

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I and my students have being doing research in media space systems for well over a decade. As part of this work, we designed and used three media spaces that collect both video snapshots and groupware artefacts. While each has superficially similar capabilities, they are designed around quite different metaphors.

**Teamrooms**, commercialized as Teamwave Workplace, is based on the notion of multiple rooms [3,8];
**Notification Collage** is a shared live bulletin board viewable on a large public display and from people's workstations [4];
**Community Bar** is an expandable sidebar that holds multiple places [5,7].

This paper briefly reflects on each system – and each metaphor – as a communal place.

## 1. TEAMROOMS

Teamrooms was designed around a rooms metaphor, where our goal was to provide multiple virtual rooms that exploit features inherent in physical rooms used for team purposes (e.g., team rooms, war rooms, etc.). Its interface, features, and use are fully described in [3,8], while Figure 1 shows a screen snapshot. Some of its key ideas included:

- *a bounded space* that affords *partitioning* into a collection of rooms;
- *containment* within through individual rooms, where they collect people and groupware objects;
- *permeability* of rooms allowing people and things to enter and leave them;
- *persistence* of objects within the room over time;
- *socially mediated ownership* that controls who should enter and use that room and how privacy is managed;
- *customization* of that room by how its occupants create and manipulate objects within it;
- *spatial location* where objects and people within a room are spatially positioned in a way that maintains common reference and orientation, and where proximity influences action and reciprocity;
- *habitation* where people can be aware of others across and within rooms, and where they can inhabit particular rooms;

We thought that groups would construct social places within these rooms, as the system no longer had many of the 'seams' found in conventional groupware. Rooms could serve as a place for both individual and group work; the distinction between the two was simply a matter of who occupied the room and the purposes the room was used for. Rooms also encouraged modeless interaction: real time interaction was just a consequence of people inhabiting the same room at the same time, while asynchronous interaction

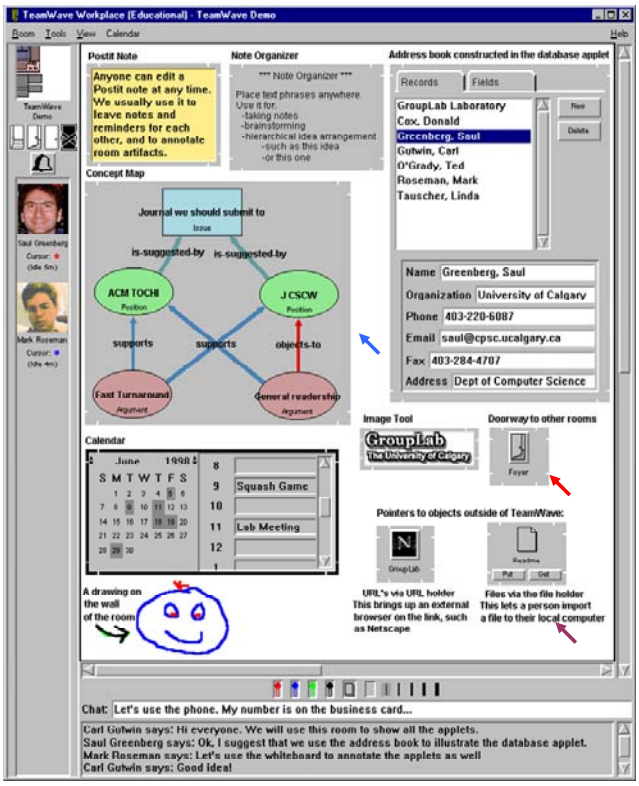


**Figure 1.** Teamrooms

was a consequence of how people left artifacts (i.e., groupware objects showing content) within the room for others to see. Rooms would also let the social place develop over time; because things persisted (including writing that people could put on its back wall), people could craft the social meaning of the room by how they included objects within it, and how they decorated it. The collection of rooms would also form a community; while access control dictated who was allowed into a particular collection of rooms, any community member, once in, could create a room, could enter other rooms, and could see who was around. That is, access within a community was mediated through social vs. technical protocol.

In spite of the rich intellectual premises behind its design, Teamrooms did not live up to its promise as a social environment. While people did create their own rooms, we saw little actual interaction over time. Eventually, the commercial version of this product – Teamwave Workplace – was pitched as a place to hold planned classroom meetings rather than as a media space supporting social interaction and on-going work.

We believe that Teamroom's shortcomings was not with the room metaphor, but with the ways rooms were realized within it. The first major problem was that Teamrooms did not effectively support awareness leading to casual interaction. A person could see who was around and thus available for interaction only after they actually logged into the system. Because logging in was relatively heavyweight, people would rarely do it just to see if someone was there. As well, people would not leave the system up and running just for awareness purposes, as it consumed considerable real estate. This defeated the 'always on' premise behind most media space designs. Thus there was little opportunity for casual interactions simply because no one was in a room long enough for others to notice. The second problem was that Teamrooms did not really support actual work. It only had 'toy' applications within it. While people could do simple tasks, they could not really share their real work done with commercial applications such as Microsoft Word, Excel, and so on. As well, voice was not supported, meaning that people would have to use an awkward chat system to mediate their real time interactions over these applications.

## 2. NOTIFICATION COLLAGE

The Notification Collage (NC) is a groupware system designed around the metaphor of a public bulletin board containing a collage of interactive information fragments [4] (Figure 2). These fragments are called media items, which in turn are interactive groupware applications that let people display and manipulate content. Distributed and co-located colleagues comprising a small community post media items onto a real-time collaborative surface that all members can see. Akin to collages of information found on public bulletin boards, NC randomly places incoming elements onto this surface. People can post assorted media: live video from desktop cameras; editable sticky notes; activity indicators; slide shows displaying a series of digital photos, snapshots of a person's digital desktop, and web page thumbnails. While all see the same items, people can rearrange them as desired on their individual displays. In particular, items placed on the right of a separator bar are never covered by new items.

We chose this metaphor for several reasons. First, unlike Teamrooms with its many rooms as social places, we wanted to give a group a single public place that holds meaning to them. As a media-rich bulletin board / chat room, we hoped that their focus on this single place would encourage sufficient postings and interactions to make it worth keeping on their display. That is, like a media space, we wanted to encourage its always-on, always-present property. Second, because it is a single bulletin board, we could post it in a large public display as well as on people's individual workstations, e.g., in a room populated by co-workers who are part of the NC community. Thus people could see its content as they walked by, or engage with others over it. Third, the overlap of items inherent in a large collage acknowledges that there may be a large number of information fragments, too many to tile neatly on the display. Finally, collages are customarily used to present unstructured information comprising diverse media, conceding that awareness information comes in many forms.

User experiences show that NC did evolve as a communal place, and that it served as a rich resource for awareness and collaboration. First, it gave people a keen sense of presence,

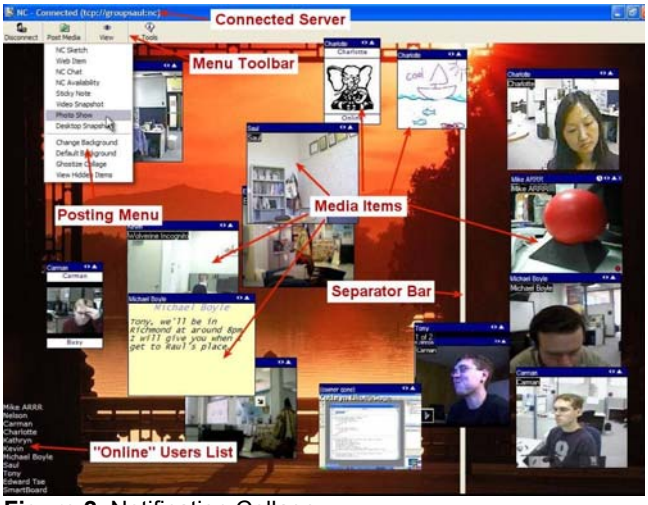


**Figure 2.** Notification Collage

especially because most community members chose to indicate their presence to others by posting live video. People's instinct was to create a visible presence for themselves: they wanted to see others, and others to see them. Second, media items triggered interaction. People acted on its information by engaging in text and video conversations. Unlike instant messaging and conventional media spaces, conversations sometimes began from people seeing interesting artifacts within the space and wanting to talk about them (e.g., photos or desktop snapshots).Third, the public nature of all actions encouraged interaction. All people could overhear conversations and see all postings; because even directed conversations and postings were visible to the group, anyone could monitor and join in. Furthermore, those cohabiting a public physical space could tell a collocated person about a note addressed to them. Fourth, media items concerning communication and information sharing (vs. the work-oriented groupware of Teamrooms) encouraged social engagement. People posted items they believed would interest others, such as desktop snapshots, announcements and vacation photos. Fifth, the public display acted as a way for telecommuters to reach people (including room visitors) visible from its attached camera, and for those people to respond.

While successful as a place supporting a single small community, the Notification Collage had several limitations that restricted how it could be used by less well defined groups. As a single public place, it was all or nothing. People were either 'in' or 'out' of this community. This meant that people on the periphery of this group were sometimes reluctant to join in. The group was very conscious of the appearance of 'strangers' (usually a friend of only one group member), where conversations would cease until that person was somehow introduced by an 'in' group. Similarly, Community Bar did not really support ad hoc groups. People were either a member of the community, or they were not.

## 3. COMMUNITY BAR

The Community Bar (CB) [5,7] extends our earlier work in the Notification Collage. Its design is theory driven, where it is built around the Locales social science framework [2] and the Focus and Nimbus model of awareness [6]. Its 'sidebar metaphor', illustrated in Figure 3, leverages the query in depth properties of the Microsoft Sideshow awareness display [1],

The Locales Framework suggests that people inhabit multiple social worlds, where each 'world' contains not only people, but offers a site and a means for their interactions. CB supports multiple locales through rapid creation of 'Places'. For example, the particular individual's CB client in Figure 3 displays four Places (i.e., four sites), each comprising different sets of media items representing the people within a place (e.g., through video) and various means (e.g., chat boxes, web items). Long standing and ad hoc groups can create, maintain, and destroy places as needed. People within a place can present themselves to others, engage in conversation, and interact with group artefacts as desired. Each person can act in distinct ways in each of the Places they inhabit. Within a Place, all information and interactions are public to all other people currently in that Place. Place members are able to share awareness information, to send broadcast queries (e.g. "Is there anyone who knows about X?"), and to overhear conversations and join those of interest to them. Unlike Notification Collage, CB supports multiple places rather than a single place. Unlike Teamrooms, people can be in multiple places at the same time, and interact within any Place at leisure.

The Sidebar metaphor is important for lightweight transitions from peripheral awareness to foreground interaction. It recognizes the tension between a person's desire for a *minimal* amount of unobtrusive yet dynamic awareness information of their intimate collaborators, against the need to act upon that information, e.g., to explore that information in depth, or to engage in rich communication as desired. Community Bar relieves this tension by offering people a progressive view of information. Rich yet not overwhelming awareness information is located at the periphery of the screen in a space conservative sidebar (shown in Figure 3). Moving the mouse pointer over items causes a "tooltip grande" to appear (example shown in Figure 3) that displays more information and provides interaction opportunities. Clicking on the tooltip grande title raises a "full view" permanent window (not shown) providing full information and interaction opportunities. Collectively, this progression of views allows the user to quickly stay aware of peripheral information, and to easily move into foreground interaction with information and people.

Finally, Community Bar represents the centre and periphery relationship via the focus/nimbus model [6]. People express their involvement within a Place by using sliders to adjust both their nimbus (what others can see of them) and focus (how much they see of others). In this way, views and membership become somewhat more fluid. Unlike Teamrooms, where people are either in or out of a room, people can now adjust their focus/nimbus to control how much they are 'inside' a place.

We performed a field study of CB in use. Many things worked as predicted by the Locales theory, in particular, how people were able to maintain awareness and how they could move into interaction with others. However, the multiple Place functionality was not used heavily by this user community. We initially thought this was because the group was fairly cohesive, where they enjoyed working within one large Place (i.e., as in the Notification Collage). We thought this group did not see a strong need to splinter themselves into long-term sub-groups. Yet on closer inspection, we found that our study participants were easily divided into two groups: a 'core' group who often worked together closely and interacted with each, and a peripheral group comprising everyone else who had less work ties to the first

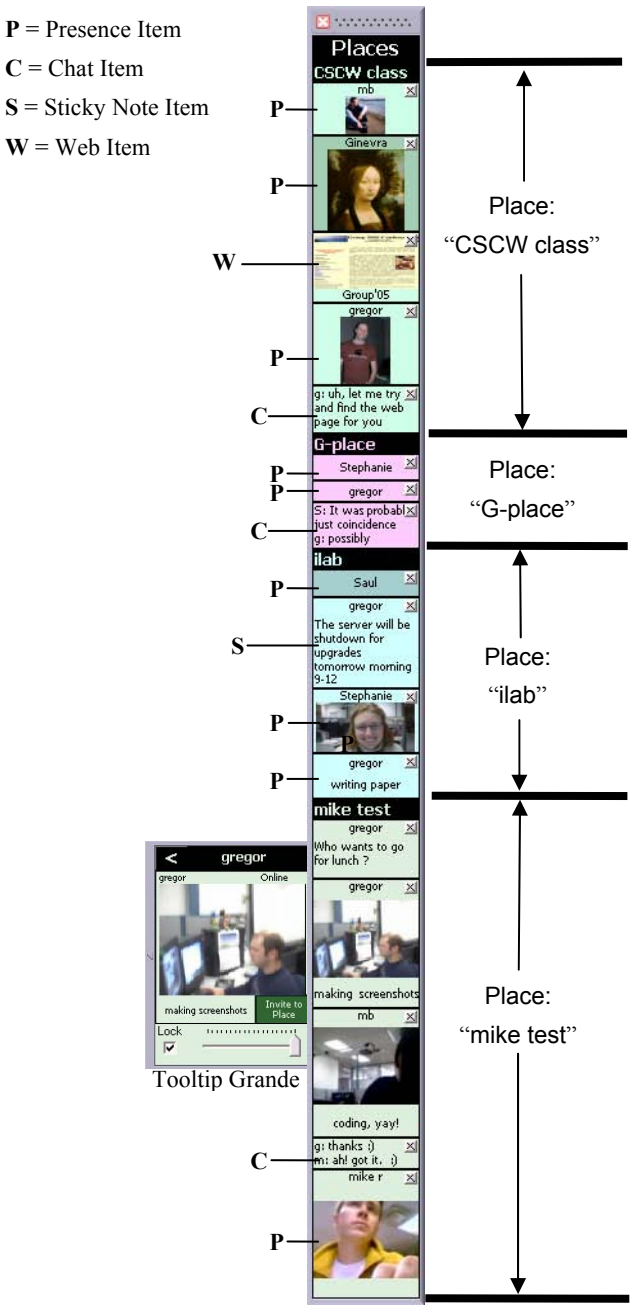


**Figure 3:** Community Bar. Visible are four labeled places, 4 types of items, and the presence tooltip

group. This led to a divide in how CB was considered. Core group members consistently talked about the sense of belonging to the community that CB gave them. In contrast, peripheral members often reported that they felt like outsiders, and that most of the explicit communication on CB did not involve them directly. This was not necessarily a bad thing, as all people, whether core or peripheral, expressed sentiments on how useful CB was for maintaining an idea of what was going on with the rest of the group. We would have thought that this difference in member makeup would have encouraged multiple places. Yet when asked why they did not create new places, participants responded in very similar ways, saying that they were not needed in the

existing community social structure. When asked about the situations under which they would use different places, most participants hypothesised that they would use different places if they were also involved in *distinctly different groups* that did not know each other. That is, a CB Place seemed to define a community rather than a public locale.

A deeper analysis of CB use revealed that there were multiple locales within it, but this happened implicitly within a single Place. We realized that people tended to use sub-collections of media items as implicit locales, where they would 'tune in' to media items of interest and 'tune-out' items that where of lesser interest. They also formed implicit ad hoc groups as a function of their awareness and CB activities. For example, this was evident by the way chat items were used. Typically, only subgroups partook in discussions in chat items, and different chat items were often created (or taken over) for different purposes and people. Similarly, different sub-groups were interested in different things at different times: this likely led to some of the differences in how people interpreted some media item awareness information as useful vs. as clutter and distracting. Yet people seemed comfortable – even those who were 'on the periphery' – of doing all this ad hoc group formation within the context of the larger CB community vs. within the explicit structure of CB Places.

# 4. DISCUSSION

All three systems were built around the notion of a collection of public media items that portray people (usually as live video snapshots), their interactions (usually as text chats), and their things (usually as information containers or mini-groupware applications). They differ considerably in the metaphors they follow, which in turn affects how each system structures and presents these items. What we saw is that many factors – both large and small – profoundly affect how these media spaces are adopted by the community. In spite of its rich room metaphor, Teamrooms was not well adopted, simply because it lacked the lightweight awareness critical to casual interaction and because the walls comprising its room were too hard – they isolated community members rather than brought them together. This left it more suitable as a meeting tool rather than an always on media space. Notification Collage did work as it offered a rich multimedia space for casual interaction. However, it was limited as being an 'all or none' system; people were either in the group defined by the single media space, or out of it. Community Bar achieved the same effect as the Notification Collage while doing a better job at balancing awareness and distraction. Still its key property – that of Places – was not used in the way we expected, i.e., it defined community vs. ad hoc groups. Yet we did see sub-groups evolve within a single Place through how people used its items and how they attended them.

It seems there is a tension between the explicit structures offered by media space design (rooms, places, bulletin boards and so on) *vs.* the very light weight and often implicit ways that people form and reform into groups. In real life, we do this by physically moving closer together, by how we share things, by cohabiting a space, by moving between multiple spaces, and by selectively attending and responding to the world around us. In the computer world, these everyday physics don't apply. Instead, we try to introduce explicit structure through our metaphors that anticipates how groups form and reform, and that controls what people attend. In practice, we see that these structures are often ignored or become hurdles. Rather, systems with little structure do seem to work because people use their own attentive and social resources to define their group; this is often subtle, highly flexible, and tacit. Yet we expect an unstructured approach will have problems, as they likely will not scale beyond reasonably cohesive groups.

# 5. ACKNOWLEDGMENTS

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# 6. SOFTWARE AVAILABILITY

Community Bar is available for download at http://www.cpsc.ucalgary.ca/grouplab/cookbook/.

# 7. REFERENCES

[1] Cadiz, JJ, Venolia, G.D., Jancke, G., and Gupta, A. Designing and deploying an information awareness interface. *Proc ACM CSCW* (2002), 314-323.

[2] Fitzpatrick, G. *The Locales Framework: Understanding and Designing for Wicked Problems*. Kluwer Academic Publishers, (2003).

[3] Greenberg S. and Roseman, M. (2003). Using a Room Metaphor to Ease Transitions in Groupware. In M. Ackerman, V. Pipek, V. Wulf (Eds) Sharing Expertise: Beyond Knowledge Management, 203-256, January, Cambridge, MA, MIT Press.

[4] Greenberg, S. and Rounding, M. (2001) The Notification Collage: Posting Information to Public and Personal Displays. Proc ACM CHI, 515-521, ACM Press.

[5] McEwan, G., and Greenberg, S. (2005)Supporting Social Worlds with the Community Bar. Proc ACM Group 2005, ACM Press.

[6] Rodden, T. Populating the Application: A Model of Awareness for Cooperative Applications. *Proc. ACM CHI,* 1996, 88-96.

[7] Romero, N., McEwan, G. and Greenberg, S. (2006) A Field Study of Community Bar: (Mis)-matches between Theory and Practice. Report 2006-826-19, Deptment Computer Science, University of Calgary, Calgary, Alberta, Canada, T2N 1N4, March 17th.

[8] Roseman, M. and Greenberg, S. (1997). A Tour of TeamRooms. Video Proc ACM CHI, ACM Press. Videotape.

# Designing Sociable Media Spaces

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## ABSTRACT

In this paper we discuss five principles that encourage interaction among people within and between two remote spaces. These are abstraction, transformation, physicality, motion, and time. We describe the motivation for incorporating these principles in three installations that connect remote spaces using audio and/or video. We then explain how the design of these interfaces affected social interaction in these spaces. Finally, we discuss the design process and principles common throughout these three installations that played a critical role in enhancing social interaction.

## INTRODUCTION

The term media space refers to any environment created using video, audio, and networked computers to support interaction between distributed groups of people. When placed in public or semi-public spaces, they are often designed for casual encounters among people within that community. Thus far, communicating via these systems has not met expectations [8, 14]. Some drawbacks to such systems have been lags in interaction time, gaze ambiguity, lack of privacy, spatial incongruity, and fear of appearing too social in a work environment [12, 14].

We believe that current systems are also affected by a lack of mobility in the interaction space and a *window effect*, whereby the rectilinear edges of the transmitted video window frame further emphasize the distance in the interaction. This video window attempts to mimic face-to-face interaction. The changes in scale and the clear separation of space make it apparent that this is a different mode of communication. Mediated communication interfaces need not recreate face-to-face interaction to provide an expressive and satisfying interaction [11, 17, 21]. We stress in this work that using a mediated channel allows for the transmission and visualization of social cues not possible in face-to-face interaction. For example, the interface could display a fantastical environment that violates the laws of physics.

Our approach to creating sociable media spaces is to blend the communication interface into the space of the environment through the use of social catalysts. A social catalyst is a dynamic interface or event created by an interface that that focuses the attention of the inhabitants of the space on a common event and facilitates communication between otherwise disconnected people[16, 17, 26].

This results is a dynamic communication interface. The interface changes form as it is used by the participants in the space. One example of such a change we implement occurs when people's comments appear in text graffiti form on the walls as they speak.

In this paper, we discuss five principles that have helped create catalytic environments. These are abstraction, transformation, physicality, motion, and time.

## RELATED WORK

There have been a number of "media space" projects that connect geographically distinct locales with some combination of audio and video [2,4,6,13,14] as well as studies of the relative affordances of audio, video, and other media [8,12].

One of the main goals behind the creation of the original media space project at Xerox Parc was to find means to support cross-site work and to maintain the necessary social connection between remote research labs [2].

Following media space systems incorporated privacy controls so that one could refuse a connection, block a connection for several seconds, or filter the transmitted video [3, 4, 14]. Telecommunication art pieces such as Hole-in-Space [7] have shown glimpses that people will use audio-video connections for social interaction.

There has also been relevant work focusing in the audio-only or audio-dominant media spaces. Smith and Hudson's work on low disturbance audio found that audio, even when filtered to be incomprehensible (for privacy, in their application) provided a good sense of awareness of the presence and activity of others [23].

One audio-only media space, *Thunderwire*, suggested that users originally had difficulty with the interface and modified their behavior in response [10]. The *Somewire* project is one of the most relevant, since it was designed to foster casual interactions among colleagues [22]. Here, Singer et. al experimented with a number of visual interfaces in conjunction with an audio-only media space. They found that control over such features as localization or other attributes was not needed, but that information that supplemented users' knowledge of the social aspects of the space, such as awareness of the presence of others, was quite useful.

Few audio-video media spaces have ventured into the physical realm. One early example is Buxton's *Hydra* project small distinct physical modules containing cameras, microphones, and speakers were used to model a four-person meeting about a table [4].

This paper describes five principles that can be used to create alternative media spaces and to encourage sociability. They are described below.

**Figure 1.** *Telemurals* in action. The wall displays the two local participants and one remote participant.

## ABSTRACTION

One example of abstraction in an audio-video space can be seen in *Telemurals* [16]. In this media space, participants at both ends are represented as silhouettes on the same screen. The abstraction of people to silhouettes helped us mitigate privacy concerns as well as create a world that is more elastic that those of unmediated environments. The abstracted video maintained the benefits of video communication such as indicating attention level, posture, and agreement-disagreement [12] while mitigating the frustrating such as asynchronous lip movements with the audio channel.

In a new piece called *Ginger*[1], we represent a remote person as an abstract sculpture chair with a visualization of their aural conversation. The sculpture is of human scale and is viewed at human eye-level when sitting in a chair. However, it would not look out of place in a room if someone were not using it as a communication medium. It is designed to be aesthetic as a media space and as a physical object.

The graphics on the sculpture are projected and can be seen from the front and back of the sculpture. The motion of the graphics attracts people from all around to come view and participate in the interaction.

The audio visualization is projected onto the chair. As people speak, circles of red hue fall from the top of the sculpture "chair". The sculpture has a virtual back consisting of lines. When someone speaks through the chair, these lines are interrupted and are pulled toward the circles. As they do so, they bring the chair to life in an animated fashion and highlight the rhythm and flow of the conversation.

The abstraction in *Ginger* allowed for some anonymity in the virtual-physical space similar to that in a graphical chat room. In some ways, the telepresence sculpture acted as a physical avatar.

We are familiar with other forms of volume representation whether they be bar chart visualizations such as in Quicktime™ or waveforms as in many sound recorders and players. Although these representations are readable, they have a technical connotation and their representations are fleeting. The line and dot visualization in *Ginger* separates itself from these traditional technical representations.

1. *Ginger* is an abstract extension of the *Chit Chat Club* [16].

## TRANSFORMATION

There are several transformations that occur in *Telemurals*. Firstly, one's body appears as a silhouette. This made the space more playful and less like a covert surveillance area. Furthermore, the more people spoke and moved, the more detail would emerge in their silhouettes in the form of a cartoon rendering. Therefore, just by entering the space, they would transform it. As they spoke, their words appeared on the wall in the form of graffiti.

The biggest factors in increased interaction within and between the two spaces were the transformation from abstract to detailed persons and the transformation on the wall of the speech visualization. It should be noted that by adding the speech recognition, motion interaction slightly decreased.

With *Ginger*, the transformation was that of audio to graphics. Again, by speaking, the remote user could make a remote sculpture animate and come alive.

## PHYSICALITY

Both of these media spaces were of human-scale. This human-scale interface of *Telemurals* made it possible for the display to occupy a large wall of a room and blend in with the passersby. Participants would sometimes dance together remotely and perform kicks onto their remote companions. This helped users negotiate space and proximity within the space and between their remote companions.

*Ginger* evoked presence due to the sculpture size and the placement about a table. In many ways *Ginger* is reminiscent of a larger and abstract Hydra. The sculpture also functioned as a body for the remote user and a focus point while conversing.

The physicality of *Ginger* makes for interaction far different from what happens while staring at a computer screen.

**Figure 2.** The *Ginger* sculpture and a young companion.

In contrast to the Hydra system mentioned earlier, the human-scale in *Ginger* provides for gestural behaviors at eye-level and not to several chess-piece-like screens. The similarity in scale blends the physical and virtual worlds together to emphasize togetherness versus remoteness.

## MOTION AND TIME

With *Telemurals*, motion and continuity of graphics in the space played a role in verifying that a connection existed. Fluid motion of the movements reminded the user that they were affecting the space. Increased motion in the space increased the level of disclosure in the space. The timing of the fading speech visualization left traces of previous activity in the space and encouraged speaking to leave a graffiti mark on the space.

A variation of *Telemurals* accumulated all the graffiti words at the bottom of the screen over time so that one could peruse topics of discussion from previous participants. This form of preservation allowed newcomers to have a sense of history of the space and to see that the space had been used in the past.

In *Ginger*, the motion of the lines provided awareness that there was an active connection between two spaces even when no one was speaking. As soon as a connection was made, the lines began to wave slightly. Furthermore, the accumulation of circles at the bottom gave the local and remote participants a sense of the duration and tone of the conversation.

## SUMMARY

We discussed five design principles in this paper:

- Transformation of Space through Interaction
- Abstraction for Visualizing Conversation and Presence
- Physical Manifestation of Virtual Presence
- Time
- Motion and Continuity

These concepts are by no means mutually exclusive. It is the combination of these five concepts and the manner in which they are visualized that made these hybrid spaces catalytic for interaction. A result of incorporating these concepts is that they often inspire play and recreation in the interaction.

With the five principles we address in this paper: transformation, abstraction, physicality, time, and motion, we create social catalysts that allow one to navigate this hybrid space and focus on aspects of interaction that we have designed instead of all the surrounding signals. We provide a focus for attention, a focus for presence, and a recreation space in a social link that would otherwise be undecipherable. The transformation highlights changes in the interaction —the abstraction eliminates extra information — the physicality provides for an object to look at and manipulate — motion draws our attention and guides us about the space — time provides a sense of history.

*Telemurals* and *Ginger* created new styles of gestural movement and speech interaction by providing a common language through transformation, abstraction, physicality, and motion. In creating these hybrid spaces, we no longer interact as we do in an online-only space or in a physical-only space. It is a new style of space that brings people together in unfamiliar and serendipitous ways.

## REFERENCES


1. Agamanolis.S., Westner, A., and Bove, V.M. Reflection of Presence: Toward more natural and responsive telecollaboration. *Proc. SPIE Multimedia Networks*.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. Donath, J., Karahalios, K., and Viegas, F. Visiphone. *Proceedings of ICAD2000*.

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. Galloway, K. and Rabinowitz, S. Hole in Space. Available at http://www.ecafe.com/getty/HIS/

8. Grudin, J. Why CSCW applications fail: Problems in the design and evaluation of organizational interfaces. *Proceedings of CSCW 1988.*

9. Harrison, S. and Dourish, P. Re-place-ing Space. *Proceedings of CSCW 1996.*

10. Hindus, D., Ackerman, M., Mainwaring, S., and Starr, B. Thunderwire: A Field Study of an Audio-Only Media Space. *Proceedings of CSCW 1996.*

11. Hollan, J.and Stornetta, S. Beyond Being There. *Proceedings of CHI 1992*.

12. Isaacs E. and Tang J. What Video Can and Can't do for Collaboration: A Case Study. *Multimedia '93*.

13. Ishii, H., Kobayashi, M., and Grudin, J. Integration of inter-personal space and shared workspace: ClearBoard design and experiments. *Proceedings of CSCW 1992.*

14. Jancke, G., Venolia, G., Grudin, J., Cadia, J., and Gupta, A. Linking Public Spaces: Technical and Social Issues. *Proceedings of CHI 2001*.

15. Karahalios, Karrie and Dobson, Kelly. Chit Chat Club: Bridging Virtual and Physical Space for Social Interaction. *ACM Conference on Human Factors in Computing Systems Extended Abstracts*. 2005.

16. Karahalios, Karrie. *Social Catalysts: enhancing communication in mediated environments*. PhD Thesis. Massachusetts Institute of Technology. 2004.

17. Karahalios, Karrie and Donath, Judith. Telemurals: Linking Remote Spaces with Social Catalysts. *Proceedings of CHI 2004*.

18. Krueger, M. *Artificial Reality II*. Addison-Wesley. May 1991.

19. Kubovy, Michael. *The Psychology of Perspective and Renaissance Art*. Cambridge: Cambridge University Press. 1986.

20. McCloud, S. *Understanding Comics*. New York: Kitchen Sink Press. 1993.

21. Pederson, E.R. and Sokoler, T. AROMA: abstract representation of presence supporting mutual awareness. *Proceedings of CHI 199*7.

22. Singer, A., Hindus, D., Stifelman, L., and White, S. Tangible Progress: Less is more in Somewire audio space. *Proceedings of CHI'99*.

23. Smith, I. and Hudson, S. Low disturbance audio for awareness and privacy in media space applications. *Proceedings of Multimedia '95*.

24. Tang, J. and Minneman, S. VideoWhiteboard: video shadows to support remote collaboration. *Proceedings of CHI 1991*.

25. Whittaker, Steve. Rethinking Video as a technology for interpersonal communication: Theory and design implications. *International Journal of Human-Computer Studies*, 42, 501-529. 1995.

26. Whyte, W.H. *City: Rediscovering the Center*. New York: Doubleday. 1988.

# Seeing the *Hole In Space*


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*A shorter version of the following will be published in MacDonald and Erickson's forthcoming book,* HCI Remixed.


This is a story about how one little-known work of art changed the way I think about video-mediated communication. In turn, it has shaped the fundamental insights that have formed much of my CSCW work and gone on to spawn research by many others. It was called the ***Hole In Space***. The extant, scanty documentation can be found at http://www.ecafe.com/getty/HIS/. I'm going to talk about what it was, how it affected me, and finally give some thought to its specific and general implications for current and future research and researchers. There are lessons for researchers in many parts of the story – even in how I came to know about it. But I am getting ahead of myself.

## The Media Space

Coming to Xerox PARC in 1985, I was one of the instigators of the Media Space project. The Media Space was the first research project on electronically-created shared work spaces. Open, always-on video, shared computing environments, and reconfigurable audio environments created connected office spaces at a distance. Although it would later spread, at the time we first encountered Hole in Space (1986), the Media Space existed entirely in the System Concepts Laboratory at PARC, which was split physically between Palo Alto, California, and Portland Oregon.

The fact that three of the creators, Bob Stults, Ranjit Makkuni and I, were all architects had implications at three levels. The first is that we were all concerned with the creation of place from space; the second is that we saw people as legitimate creators of their own places; the third is that we were accustomed to working in large shared drafting rooms and want to use that as the model for collaborative work spaces. We saw it variously as supporting a distributed group, as supporting collaboration, and as a design environment. Furthermore, we saw these characteristics as connected; collaboration – "the social practices of design" as we referred to it – was enabled by the spatial characteristics of a drafting room. (Stults, 1996; Bly et. al., 1993; Harrison et. al., 1997) But the drafting room model was not the only way that the Media Space and its various progeny were used: we were pleased that some people would use it to create continuous office sharing, while others would use it to roam the virtualized hallways and common areas, and yet still others would just use it to look out a window in another office. In all of these uses, we saw media space as about space and place.

## How I Came to Learn About *Hole In Space*

A friend of mine, also an architect, called one day to say that I should talk to a couple of tenants living in an apartment owned by his mother in Santa Monica (near Los Angeles). This did not sound very promising, but he was a friend. He explained that the tenants – Kit Galloway and Sherrie Rabinowitz – were artists, working in what they called "aesthetic research in telecommunications." What could that mean?

I was concerned that my friend's recommendation happened in part because his mother was concerned that they were not getting commissions for their art work and thus might become dead-beat tenants. PARC looked pretty flush in the mid-1980's; in fact, shortly after my first phone call to them, they called back with plans to fly up to Palo Alto to meet with us about how we could work together. This was both gratifying and worrisome.

Although now such technologies are commonplace features of computers, in 1986 video-mediated connection was not considered part of computing or networking research, certainly outside of office systems research, and therefore was almost too radical for most people to comprehend. Computing work spaces supported "tasks", not space that could be social, task-oriented, ambient, or any number of other truly spatial characteristics. A couple of people had "gotten it"; a researcher from NTT in Japan (Hiroshi Ishii) came to visit and was excited by the shared drawing components and the seamlessness created by thinking in terms of space and not application. Bill Buxton from University of Toronto also came through and would argue a few years later that Cambridge EuroPARC should have a media space as part of its initial infrastructure. However, most people had seen it as absolutely blue sky and we were frankly not sure that we knew how to work with anyone outside of our Lab, to say nothing of working with artists.

But Sherrie and Kit came up, showed us a documentary video of the Hole in Space and left behind a copy.

## The Work of Art

The *Hole In Space* website, alas, does not have that video -- black and white, possibly shot on a Sony PortaPak recorder. However, both forms of existing documentation show a remarkable project; over the course of three evenings in November, 1980, a hole was opened in space between the sidewalks at Lincoln Center in New York and those in Century City in Los Angeles. This was accomplished by projecting full-size images of the passersby at both sites in black and white in store-front windows, using rear-projection display of the video, and manually echo-cancelled full-duplex audio. There were no user instructions, no local feedback monitor, no explanatory didactics, just the image of a place three time zones away.

Crowds gathered quickly once the art work was turned on. People would stop, realize they were hearing what was probably the sound from the remote location and ask the person they were seeing – a total stranger – where they were. People at each end realized that it must be somewhere far away because of the difference in sky color and the way people were dressed. The people had nothing in common except they happened to be in the same real-virtual location at the same time. Yet they took the time to find out where they now "were". They asked if they were being seen. They asked why they were "there".

Existential inquiry gave way to spontaneous games like charades. People behaved in ways they would not with strangers on the same physical sidewalk: they lingered instead of moving on; they were engaged with one another. Because of the video mediation, these sidewalks and these people were creating an event.

As creators of the media space, we resonated with what we saw in this project. It expanded our understanding of the great potential we were playing with. In the corporate context of our work, we focused on the quotidian aspects of the media space and justified the aesthetic ones in terms of pragmatic ends – keeping our split laboratory together. What we realized from the Hole in Space was that we might be able to truly alter our sense of community. In fact, "community" was very powerful *juju* in our Laboratory. SCL had a long tradition of close togetherness, of actively maintaining the social fabric of the group. This had become a de facto part of the research with half of the research staff located in Portland Oregon. The Media Space already had elements of lab community, but Hole in Space showed that media space might be a way to engage and constitute community differently. It was truly art in that it made us see our familiar world with new eyes.

Yow! What a possibility.

I know Sherrie and Kit were disappointed that we did not have a project in mind nor did we see them as consultants. It was a very odd position to be in – while justifying very expensive computers was quite easy for researchers at PARC at the time, justifying the purchase of any sort of video or audio equipment, to say nothing of hiring video artists as consultants, required

enormous amounts of argumentation and took months. But here were artists who had worked with live coast-to-coast broadcast-quality video feeds that had cost hundreds of thousands of dollars to set up. They must have wondered why we just didn't write them a big check on the spot. But either because it took us too long to understand their contribution or because of facts of PARC culture that I've since forgotten, this was not on the table.

## The Contributions

In the moment, Sherrie and Kit showed us the possibility of radical re-seeing. But over the years since then, I have come to see other radical messages inherent in their work. We had been focusing on space and place in mediated connection. Beyond new forms of community, they showed us that events were also an essential element of mediated communications. However, because they were performance artists, creating events was such deep background that they never talked about the "eventness" of what they were doing, only the nature of the particular events. By the time I co-authored "Re-Place-ing Space" (Harrison and Dourish, 1996), this had become obvious to me. I noted that mediated connection is composed and explainable in terms of people, events and places, but place-ness and space-ness overshadowed event-ness then[1].

## The Medium is the Message

Artists work with media. It is obvious that Kit and Sherrie used telecommunications systems as the medium of their art, and that's why they called it "aesthetic research in telecommunication". I came to realize over the years that telecommunication was only one part of their medium. If you look at other projects on the website, you will notice that most of the art work is about social connection that attempts to break alienation through mediated connection. Thus, the other medium was human relations. Human relations as an art medium?

Since they were working with human relations, they were open to showing and seeing the effect of telecommunications absent the rhetorical and actual aspects of spatiality. "Hole in Space" was a cute title and it did describe the "physics" of the situation in quasi-science fiction terms, but it was the social realm in which they operated most effectively.

They took a very direct stance to their subjects and their media. That is, they did not base their work on irony[2]. This made them not very hip. Yet there was irony present at a different level; it was the irony of the separation that creates connection. It was, at least, a reflection about relationship engendered by strangeness.

## Pioneering Efforts, Commodified Results

There is another kind of irony in their work as well. Sherrie and Kit became quite attached to the idea of cafes as community centers. The last project listed on the website is Electronic Café International[3]. It took the model of the Electronic Café and tried to extend it beyond Los Angeles to the entire world[4]. It abstracted the social qualities of creative people

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[1] The role of events as part of the construction of places turns out to be rather complicated and essential. In fact, I have had to devote an entire journal article to unscrambling a few of the more salient types. (Harrison and Tatar, N/D)

[2] In the mid-1990's, Rich Gold joined PARC's research staff after being, among other things, a performance artist in Los Angeles. He was surprised that we took Kit and Sherrie seriously since it seemed particularly difficult that any artist whose work was about mediating imagery could do so without using irony.

[3] In the 1990's Kit developed a debilitating and degenerative disease that seems to have arrested their art work. I do not know what became of them in recent years, but I do note that the website is hosted by the Getty Center.

[4] Yet one more irony is that they are known in the art world for their electronic cafes and not the body of their work, including Hole in Space. (Wilson, 2002)

encountering one another as part of communities attached to particular locations. What they did not foresee was the Internet. The Internet did not need the grounding of particular locations. Encounters could happen almost without any context or excuse in cyberspace. Worse, they did not see how arty café culture would become co-opted and commodified by chain coffee houses selling hip Euro-style ambiance and connected by wireless service providers out to make a buck. Ideas, inspiration, human connection, community were not the central reasons to hang anymore.

But we must acknowledge the insight they had and should be very careful when someone says that we should look at the research being conducted by the tenants of the mother of some random acquaintance.

## The Work of Art in the Age of Mediated Presence

Missing from the website's flat narrative and few pictures is a memorable interview in the video. A woman in New York whose son lives in Los Angeles arranges to meet at the Hole in Space on its last evening of operation. It is very crowded at both locations when they meet. Everyone is shouting trying to be heard. They spend a few minutes in this chaos. The interview takes place a few steps away from the chaos. She says, "I can go home now. I'm happy. We haven't such a good time together in a very long time." At some level this was schmaltzy treacle but at another, this was about the formation of meaning. She wasn't really with her family, of course. But the real time video and audio put her in proximity to her son while giving it both temporal and physical bounding. The event, "Hole in Space", which occurred at the location, "Hole in Space", created content out of strangers who became known to each other almost entirely as others in the "Hole in Space". What a marvelous thing!

One purpose of art is to help us stand at a distance from the everyday and experience it differently. "Hole in Space" remains an interesting reminder of how technology use at a certain moment in time can free us, cause us to see differently, create a paradigm shift. Maybe now, when video-mediated communication is so inexpensive and available, is the time to seriously think about its radical social affordances and what it says about us from the perspective of art, from a perspective of re-seeing[5]. And, in a world in which technology creation and use is increasingly hemmed in by evaluation, explicit, objective criteria, and the semblance of pragmatic argumentation at least, it should, it ought to teach us not dismiss art as a way of understanding potential[6]. In the long run, the things we do for art are more interesting and enduring than those we do for profit.

## References

Bly, S., Harrison, S., and Irwin, S. 1993. Media Spaces: Bringing people together in a video, audio, and computing environment. *Communications of the Association of Computing Machinery*, NY; vol. 36, no. 1, January 1993. pp 28-45.

Harrison, S., Bly, S., Anderson, S., Minneman, S., 1997. The Media Space *Video-Mediated Communication*, (Finn, K., Sellen, A., & Wilbur, S. eds.) Mahwah, NJ Lawrence Erlbaum Associates pp 273-300.

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[5] I took this lesson seriously, becoming the PARC Artist in Residence Program's second director and am now part of the core group creating an art and engineering program at Virginia Tech.

[6] In the controversial, *Art and Physics*, Leonard Shlain has written on how artistic insights pre-figures scientific ones. (Shlain, 1993)

Harrison, S. and Dourish, P., 1996. Re-Placing Space: The Roles of Place and Space in Collaborative Systems. *Proceedings of ACM CSCW 96.* November 18-21, 1996. Reading, MA: Addison-Wesley pp 67-76.

Harrison, S.and Tatar, D. "Places: People, Events, Loci. The relation of semantic frames in mediated experience" Publication forthcoming in *Journal of Computer-Supported Cooperative Work*.

Shlain, L. 1993. *Art & Physics*. New York: Harper Perennial.

Stults, R. 1986. *Media Space.* Xerox Corporation, Palo Alto.

Wilson, S. 2002. *Information Arts. Intersections of Art. Science and Technology*. Cambridge: MIT Press.

# From analog to digital, from the office to the living room: why I happily worked in a media space but don't live in one

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## INTRODUCTION

CSCW researchers have long investigated the reasons for the failure of traditional videoconferencing (e.g. [4]) and proposed alternative uses of video for mediated communication. Media Spaces [2], in particular, showed the value of persistent connections to support activities ranging from casual awareness and informal talks to focused collaboration. This research somehow culminated in 1997 with the book *Video-mediated communication* edited by Finn, Sellen and Wilbur [5]. Strangely, however, the interest for innovative uses of video and Media Spaces dropped off just as digital media and fast large area networks were becoming ubiquitous. As partly prophesied by Karam [10], the information superhighways killed most of the existing projects, based on analog media, like the US interstate system killed Route 66:

> People were not so likely to seek their fortune on the edge of a doomed road, and of those who were already there, fewer and fewer saw any value in upgrading or expanding or - sometimes - doing basic maintenance. After 1956, Route 66 remained important, but its importance was slowly moving away from the concrete toward the glorification of what the highway had been." (S.C. Kelly in *Route 66 - The highway and its people*, cited in [10])

Over the last ten years, I have myself designed, implemented and used several video communication systems inspired by early Media Spaces. I am personally convinced that Media Spaces remain an interesting research topic and that they deserve more than just a souvenir ceremony. In this paper, I will briefly describe what I learned from these systems, how I built upon them and what I think remains to be done.

## FROM ANALOG TO DIGITAL

I first got interested in video-mediated communication in 1995. Michel Beaudouin-Lafon was then looking for someone to design the user interface of what would be the first french Media Space at Paris-Sud University. Michel had visited the Telepresence Project in Toronto and Rank Xerox EuroPARC. He had also implemented *xcave*, a control interface for *Kasmer*, the system used at PARC. I had no particular experience in audiovisual communication but happily started reading papers, playing with the analog 8x8 crossbar switch and pulling wires through the building.

*Lascaux* [11] was the first application I created to control our Media Space. It allowed to glance at other people or to connect with them for an undefined period of time. It provided a simple available/do-not-disturb switch for privacy protection. It also implemented a basic session model which supported multi-user conferences using a push-to-talk approach and the association of shared applications (e.g. a whiteboard) to the current session. Lascaux, however, was far from successful. It was hard to maintain and distribute. As we were all in the same building, people saw little interest in the multi-user conferences and the shared tools. Many of them often "forgot" to run the software. The only service that was really used was a Web gateway that captured snapshots from the nodes of our analog network and presented them on our group's Web page in a way similar to NYNEX Portholes [8].

A closer look at the early Media Space literature made me realize I had underestimated several essential aspects of these environments. Successful Media Spaces were designed to support existing practices and tools rather than impose new ones. They were designed to be flexible, making it possible for users to repurpose them with little effort. They provided sophisticated notification and control mechanisms.

As the Web gateway was the only popular component of our Media Space, I decided to make the analog services also available through a Web-based interface. I implemented a custom HTTP server to control the crossbar switch. This server supported the old glance, connect and snapshot services as well as a new one that allowed users to leave messages on other people's computer screen. It also implemented more refined control mechanisms inspired by CAVECAT's door states [10]. The resulting system, named *Mediascape* [12], made it possible to easily create interfaces to our Media Space by using simple HTML code such as:

```
<a href="http://mediascape/connect.michel">
   <img src="http://mediascape/grab.michel">
</a>
```

Duplicating these lines and replacing `michel` with other users' name was enough to create an HTML awareness view that could also be used to establish analog connections. The same code could also be used to integrate live snapshots into email messages (Figure 1, left) and existing or new HTML documents (Figure 1, right). An interesting use of this feature was to include a live snapshot of one's office in one's email signature or in a Web page showing contact informa-

* projet in|situ| (`http://insitu.lri.fr`), Pôle Commun de Recherche en Informatique du plateau de Saclay (CNRS, Ecole Polytechnique, INRIA, Université Paris-Sud)

tion so that people who wanted to reply to an email or talk with someone could see if that person was available for discussion.


**Figure 1: Live snapshots displayed in an email message and a traditional HTML document. Images are captured and transmitted every time the message or document is rendered by the application.**

The snapshot service of Mediascape made it possible to send live pictures from our offices to distant colleagues, friends or relatives. In order to share the Media Space experience with them, I designed and implemented *videoServer* [12], a personal HTTP server that could make live images or video streams captured from a local digital camera accessible through simple URLs similar to the ones presented above. As webcams were becoming more common, we started adding videoServer images to the awareness views of our analog Media Space. At some point, the room hosting the analog equipment had to be cleared for maintenance. This equipment was never put back in order after that. But although we stopped using the Mediascape system, videoServer still runs on some machines around the world.

VideoServer has no support for audio communication. But it allows people to see live images from a distant camera by simply pointing a standard, unmodified Web browser to the appropriate URL. As a group communication tool, it quickly became an invaluable add-on to the telephone, as a way of checking the availability of someone before making a call and seeing that person while talking to her. Obviously, digital video makes it possible to communicate with people much farther away. But it also allows more dynamic forms of communication. A few lines of JavaScript, for example, can simply turn a snapshot into a medium frame-rate video when the mouse moves over it and pop up a new window displaying a high frame-rate and resizable stream when one clicks on it (Figure 2). These three levels of details proved very useful to resolve ambiguities related to the small size of awareness views and accompany the transition between the moment when a user checks for the availability of another person, picks up the phone and start calling that person.

As most Media Spaces, and unlike webcam software, videoServer provides users with customizable notification and access control mechanisms. For every request it receives, it executes a control script with arguments indicating the name of the remote machine, possibly the remote user's login name, the resource that led to the server (the HTTP referrer) and a description of the requested service. The script uses this contextual information to generate auditory or on-screen notifications and sends back to the server a description of the service to be executed. This description can be inferred from


**Figure 2: From a low resolution snapshot in a Portholes-like awareness view to a high frame rate independent video that the user can freely move and resize.**

a set of pre-defined rules or negotiated with the user through some interactive dialog. An important feature is that the script is not limited to a binary accept/refuse choice but can freely redefine the service to be executed. It might request that a spatial filter be applied on the images, which the remote person will probably notice. It might redirect the client to another server. But it might also substitute a pre-recorded sequence to the live stream, supporting the creation of ambiguities and stories [1].

I lived in a Media Space constantly accessible from the Internet for about five years and this was great. But to be more precise, I should probably say "I worked in a Media Space", since I only had access to it in my office. To be even more precise, I might even say that I worked in a Media Space, which was nice, and that I took advantage of this situation to keep in touch with my girlfriend and other close friends during office hours, which made it great. This might sound anecdotal but I somehow suspect that every successful Media Space built on similar close relationships, although they're rarely mentioned in scientific papers.

## FROM THE OFFICE TO THE LIVING ROOM

Domestic environments pose a number of interesting challenges for Media Space designers. While most Media Space studies probably dealt with relatively predictable office configurations and uses, homes are highly dynamic places that host a wide range of activities, many of which the inhabitants might not want to expose. In the context of the interLiving project [7], I participated in an effort to adapt some of the Media Space concepts to support communication among distributed, multi-generational families. Together with other colleagues, I designed and implemented *videoProbe* [3], a system that allows a group of people to share their daily lives by exchanging pictures.

The system physically consists in a screen, two speakers and a camera connected to a networked computer. A specific software analyzes the images captured by the camera in real-time and automatically transmits a picture to similar systems in other households when it detects a persistent scene change (only pictures are exchanged, not video streams). The screen normally operates in mirror mode, showing the camera images, but can be switched (using a remote control) to a browsing mode that shows the pictures taken by all the connected systems.

VideoProbe was designed as a kind of portable Media Space node: it had to be compact, non-intrusive, simple to handle and usable in a variety of spatial configurations (Figure 3). As a result, it can stand alone on any item of furniture or be mounted onto a wall like a picture frame. The interaction with the system was also carefully designed to be as simple and direct as possible without imposing physical proximity. Motion-based scene change detection was chosen to allow users to interact with the device at a distance in order to trigger or prevent the transmission of a picture. Graphical and auditory feedback are also used to indicate transitions between the various states of the system (e.g. asleep, awake, about to take a picture, transmitting).

**Figure 3: VideoProbe**

VideoProbe supports both explicit and implicit forms of communication. The explicit form takes place when the user is consciously using the system to transmit a particular image. The implicit form typically takes place when someone enters the room, stays there for some reason but doesn't pay attention to the device. This implicit form proved very useful for maintaining group awareness as it usually produces pictures showing day-to-day activities that users would not or could not take themselves.

But choosing the right place to install the videoProbe in a home (or any other communication device) is quite difficult. Lightweight wireless devices that people could move around might partially solve this problem. Yet, my experience with wireless phones indicates that these devices seem to always be in the wrong place when they're needed, no matter how many you have got... Another problem, in the case of videoProbe, is that windows, doors and corridors make it difficult to limit the field of view to a unique room.

This problem got me interested in the use of space in video-mediated communication and lead to the design of *MirrorSpace* [13]. As the name suggests, this system relies on a mirror metaphor (Figure 4). Live video streams from the places connected through the system are superimposed on a single display at each site. In order to support intimate forms of communication, the camera has been placed right in the middle of the screen. This setup allows users to come very close to the camera while still being able to see the remote people and interact with them. MirrorSpace also includes a proximity sensor. A blur filter applied on the images visually expresses a distance computed from the local and remote sensor values.

Blurring distant objects and people allows one to perceive their movement or passing with minimum involvement. It also offers a simple way of initiating or avoiding a change to a more engaged form of communication by simply moving closer or further away. A recent study showed that blur filtration fails at providing an obfuscation level that could balance privacy and awareness for home situations [9]. Yet, I strongly believe that this type of filtering is still valuable. Not because of what it tries to remove, but because of what it adds: the filter shows the remote person that we don't want them to observe. The fact that it does not necessarily enforce this leaves room for negotiation and social regulation, two concepts traditionally associated with Media Spaces.

**Figure 4: MirrorSpace**

## WHAT REMAINS TO BE DONE

A lot! As I said in the introduction, I believe that the concepts that originated from early Media Space studies still offer many opportunities for research.

As I hope to have illustrated, I think that digital technologies can provide ways of enriching or impoverishing audio and video communications to create a wider range of services corresponding to more degrees of engagement. I believe that a key aspect of future Media Space research will be to find ways to ease transitions both ways between low levels of engagement (i.e. awareness services) and higher ones (e.g. synchronous chat, telephony, videoconferencing). I am in fact already investigating these aspects [6].

I would love to see more work done on the adaptation of Media Space concepts to domestic environments. One aspect that seems particularly interesting to me is the use of Media Space technologies for in-house communication. Asynchronous communication, for example. Domestic environments also pose the problem of shared always-on communication resources, a problem that already existed (but wasn't really solved) in office settings.

Finally, Media Spaces in mobile contexts also seems an interesting topic. One of the reasons why I don't run videoServer on my laptop anymore is that I skip from one network to another with long periods of unreachability. Again, simple, unobtrusive asynchronous communication services (other than text-based) would be greatly appreciated...

## References


[1] P. M. Aoki and A. Woodruff. Making space for stories: ambiguity in the design of personal communication systems. In *CHI '05: Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 181–190, New York, NY, USA, 2005. ACM Press.

[2] S. Bly, S. Harrison, and S. Irwin. Mediaspaces: Bringing people together in a video, audio and computing environment. *Commun. ACM*, 36(1):28–47, Jan. 1993.

[3] S. Conversy, W. Mackay, M. Beaudouin-Lafon, and N. Roussel. VideoProbe: Sharing Pictures of Everyday

Life. Rapport de Recherche 1409, LRI, Université Paris-Sud, France, Apr. 2005. 8 pages.

[4] C. Egido. Videoconferencing as a Technology to Support Group Work: A Review of its Failure. In *Proceedings of ACM CSCW'88 Conference on Computer-Supported Cooperative Work*, pages 13–24. ACM Press, Sept. 1988.

[5] K. Finn, A. Sellen, and S. Wilbur, editors. *Video-Mediated Communication*. Lawrence Erlbaum, Apr. 1997. 584 pages.

[6] S. Gueddana and N. Roussel. Pêle-mêle, a video communication system supporting a variable degree of engagement. In *Proceedings of ACM CSCW'06 Conference on Computer-Supported Cooperative Work*. ACM Press, Nov. 2006. 4 pages, to be published.

[7] H. Hutchinson, W. Mackay, B. Westerlund, B. Bederson, A. Druin, C. Plaisant, M. Beaudouin-Lafon, S. Conversy, H. Evans, H. Hansen, N. Roussel, B. Eiderbäck, S. Lindquist, and Y. Sundblad. Technology probes: Inspiring design for and with families. In *Proceedings of ACM CHI 2003 Conference on Human Factors in Computing Systems*, volume 5(1) of *CHI Letters*, pages 17–24. ACM Press, Apr. 2003.

[8] A. Lee, A. Girgensohn, and K. Schlueter. NYNEX Portholes: Initial User Reactions and Redesign Implications. In *Proceedings of GROUP'97, Phoenix*, pages 385–394. ACM Press, 1997.

[9] C. Neustaedter, S. Greenberg, and M. Boyle. Blur filtration fails to preserve privacy for home-based video conferencing. *ACM Transactions on Computer-Human Interaction*, 13(1):1–36, 2006.

[10] R. Riesenbach, W. Buxton, G. Karam, and G. Moore. Ontario Telepresence Project. Final report, Information technology research centre, Telecommunications research institute of Ontario, Mar. 1995.

[11] N. Roussel. Au-delà du mediaspace : Un modèle pour la collaboration médiatisée. In *Actes des 9ème journées francophones sur l'Interaction Homme Machine (IHM'97)*, pages 159–166. Cépaduès, Septembre 1997.

[12] N. Roussel. Mediascape: a Web-based Mediaspace. *IEEE Multimedia*, 6(2):64–74, April-June 1999.

[13] N. Roussel, H. Evans, and H. Hansen. Proximity as an interface for video communication. *IEEE Multimedia*, 11(3):12–16, July-September 2004.

## Biographical Information

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# Media Spaces, places and palpable technologies

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## ABSTRACT

In this paper, we briefly describe how emergency response in major incidents typically is carried out, in terms of division of work, collaboration and use of technologies. We then describe two prototypes we are developing, meant to support those who act in emergency response. Use of these prototypes form what can be termed as media spaces – but rise questions to the traditional understanding of the media space concept – since the emergency response media spaces are not 'set up' in predefined physical settings, do allow use of a range of (not necessarily predefined) media, and the people in the media space cannot be defined as a limited group of users. We also rise questions to the formality of communication, where we see the communication going on in emergency response, as a mix of formal and informal communication.

## 1. INTRODUCTION

This position paper describes input to how the concept of Media Space can be considered in the future where ubiquitous and palpable computing [10, 11] is a natural part of everyday life. The idea is to expand the traditional media space concept, as e.g. described in the papers on http://people.cs.vt.edu/~srh/MediaSpace.html and [1]: To watch a media space not as something rather predefined and well known, both regarding technologies, users and settings, but watch – and discuss – the media space concept in terms of:

- settings that can *also* be outdoor and are *not* (necessarily) predefined
- where the different applied media can be *whatever* the participants want to use
- where the participants – those who join the media space – are *not* a predefined group; in fact people can be unknown to each other, both regarding name, appearance and role.

The input to this supplement to the original Media Space concept comes from ongoing work in the PalCom project [10] and more specific work with development of prototypes to be used in major incidents (MI) situations – to support the professionals involved in emergency response work, both at the incident site and remotely in the involved police/ambulance/firebrigade call centers and/or involved hospital(s) [3, 4, 5, 6].

Below (section 2.1) follows a brief description, first of the emergency response in general, together with a short specification of today's use of IT. Then follows a short introduction to the prototypes and the purpose of their use, to illustrate the ongoing research in PalCom on future technologies, to support professionals in emergency response situations (section 2.2). For more details, please read [3, 4, 5, 6]. After this description we will elaborate on how we view and understand this future use of new technologies in MI, in the light of media spaces (section 3).

## 2. MAJOR INCIDENTS AND FUTURE TECHNOLOGIES

### 2.1 Emergency Response – 'State-of-the-art'

Some of the main characteristics for emergencies are their unforeseen occurrence and the need for immediate response from several and different professionals. The response to an emergency is in almost all cases initiated by someone's call to an alarm centre. When activated, the emergency response resources on stand-by are allocated to the incident site and assisting sites (e.g. hospitals) through use of the country and/or region specific code of practice. Each emergency situation is unique in the way that the specific incident situation is assessed regarding needs for resources, initially by the receiver of the call in the alarm centre, and later on by the response manager(s) at site.

The larger an incident is (regarding physical spread, severity and/or number of casualties), the more resources (personnel and equipment) are needed and the more complex and difficult it becomes to overview the overall situation and with that to organize the emergency response. Many different types of emergency response professionals are involved (especially police, fire fighters, medical staff and ambulance staff), and they follow the beforehand planned and – fortunately – in most cases known Incident Command System (ICS), e.g. [8]. In the ICS the roles of the different professionals, their structure for collaboration and their mutual routes of communication are specified, together with directions for physical configuration of the rescue area. The actions taken – and the communication – happen within a certain structured hierarchy, both within each profession and across the different professions. Working and communicating within a certain hierarchy should have the effect that each professional are able to recognize what to do, who to refer to and collaborate with. Each person can concentrate on exactly his/her task in close cooperation with other professionals involved.

Briefly explained the overall division of work between professional skills is as follows:

1. The firefighters are the primary rescuers – they are responsible for getting people out from the primary emergency area and for securing the incident area.
2. The police are the overall responsible professional group. They establish the cordoning off around the emergency area and are responsible for providing and obtaining routes for transportation of equipment and people. They are also responsible for registration of all involved people – both injured and non-injured. Moreover they have to take care of the public, the media and the relatives.
3. The ambulance people are responsible for obtaining and maintaining enough available ambulances for transportation of injured persons to hospital(s) and also for the transportation itself.
4. The medical professionals are responsible for handling the injured persons – the initial assessment, treatment and transfer to hospital. This is often carried out in close cooperation with the ambulance staff.

Today's use of information technologies (IT), especially at the emergency site, is very sparse and to some degree old fashioned:

- Person-to-person communication happens through use of radios or mobile phones or by physically finding the person you want to speak to. This means that those who really need to have direct, ongoing communication strive to physically stay together. This *is* possible for the managers – those who coordinate and collaborate across professions on the same hierarchical – but high – level, but regarding the collaboration and coordination within one profession, between the bottom and the top of the hierarchy (e.g. the firefighters) it is impossible to keep direct face-to-face contact. So, their mutual communication depends on (most often) old-fashioned and unstable equipment.
- Use of common tools is limited to pen and paper (for drawing of plans), paper maps and/or reference books with information about e.g. stand pipes, electric installations in buildings, chemical depots, etc.
- Regarding use of IT for medical purposes the tools are limited to:
  - Use of state-of-the-art monitoring equipment – which *is* very credible, *but* is a subject to limitations due to wired communication between the sensors on the body and the display, and to the size and weight of the equipment.
  - Use of paper-based registration and communication tools for registration/communication of all types of medical related data (types and severity of injuries, damage mechanism, treatments).
- Communication between the incident site and remote situated collaborative partners depends totally on radios and/or mobile phones.
- Moreover it is for all involved rather difficult to keep track of ID's of all the involved (both victims and professionals) and where people and equipment are.

## 2.2 Technology for Future Use in Emergency Response

In close cooperation with the future users [6] we are working on the development of two prototypes to support those who act in the emergency response situations. The prototypes are called 'The BlueBio biomonitoring system' and 'Overview'.

### *2.2.1 BlueBio*

The BlueBio biomonitoring system prototype is intended to support collection of, and remote, wireless access to, biomedical data, picked up by sensors, placed on the injured person's bodies.

The idea is that the biomonitoring system is placed on all injured persons very early in the response work. In addition to sensors the system also contains a unique ID, and it should be possible also to link a GPS (or other positioning technology), photos, video-streams and speech to the system. All these data, regarding each injured person, has to be available for those who need to get access to them; those who plan and carry out the medical emergency response both at site, on the way to the hospital and at the hospitals. To obtain and maintain these ever changing connections between multiple technical equipment, carried by many different people moving around in different physical settings make demands on stable but changing network connections, depending on where and what to transmit. So, the biomonitoring system also contains a Bluetooth unit, so that the data can be communicated from the monitor to a basestation, and from the basestation data can be communicated to the recipient, also by use of Bluetooth or by use of GPRS/WIFI.

In this way the BlueBio prototype can be viewed as a system of different and changing technologies, not only located on one injured person, but being a part of a much larger connected – but ever changing – system.

In the picture below (figure 1) it is sketched how a media space of the biomonitor prototypes can look like. We have here monitors on patients and data from the monitors displayed on different displays, carried around by/available to different persons with different roles in different settings/places.

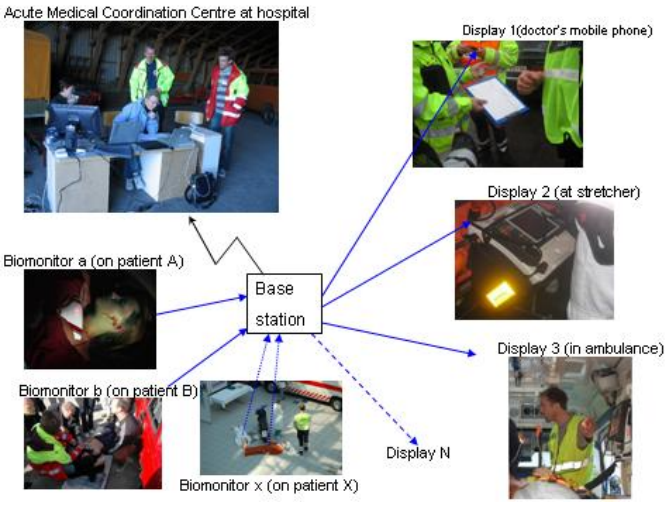


**Figure 1**

### *2.2.2 Overview*

The Overview prototype is intended to support the coordination and collaboration between all professionals, involved in the emergency response. The prototype uses the 43D Topos software product as a starting point [9]. The Overview prototype makes use of a number of large shared displays and several smaller ones, and is meant as a common planning tool for all professions involved, both at site and remotely situated. Thus, those, who use the prototype in an emergency response situation, share views and may interact independently of where they are. Moreover the prototype holds different "layers" of information and interaction possibilities; one "layer" for sketching ideas during a discussion, one "layer" for visual profiling of approved plans and one "layer" for actual status of different resources/persons.

Creation of input to the system will most often be carried out by the different managers, situated at site or remotely, but will in many cases be aimed at the professionals carrying out the direct response work "in the field". So, the plans and/or facts, created and/or made visible at the large screen(s) may be transmitted and made "visible" (or "audible") also at (small) "displays" / audio equipment, carried by the "in the field" workers (e.g. firefighters inside a crashed train, police officers at barriers, ambulance drivers in ambulances…)

In this way the Overview prototype can also be viewed as a system of different and changing technologies, where technologies appear and disappear during the emergency response process.

In the picture below (figure 2) a police officer and a fire fighter manager use a large interactive display to sketch common ideas for an emergency response strategy, on the background of information about the incident and where resources and people in the field actually are (injured persons, rescuing personnel, fire engines, ambulances….). They can communicate with the rescuing personnel via graphics, text messages or speech, and the rescuing personnel in the field can follow the decided strategy on their small display.

**Figure 2**

## 3. MAJOR INCIDENTS IN MEDIA SPACES

As described above, the two prototypes, we are developing, are meant to be used in different, not predefined settings, by many different users and involving a range of different technologies, both with respect to software and hardware. Even if the places and media spaces related with major incidents is far from similar to the traditional media space concept, we can speak of the prototypes as creating media spaces – since several media are in use – though definitely not in the traditional media space sense.

On this background further investigation on Media Spaces could be:

- How to relate the physical places and 'objects' (buildings, roads, people, equipment etc.) and the media spaces?
- How to handle different communication channels and discrepancies between them, e.g. discrepancies between media space communication of plans and direct verbal communication?
- How to perceive space and place when neither are clearly delimited and are constantly changing?
- How to know when users are in a media space and when they are not, if users of a media space is not a clearly delimited group?
- How to ensure that media are known and can be used by the users, in a world where many different media are in use, and users and devices come and go?

As an inspiration to a discussion and further investigation of the above mentioned questions, the notions of *habitats* as described in [7], could be used. May discusses habitats in three dimensions: A physical, informational and conceptual dimension.

The *physical habitats* denote the localities – places – where we stay. During an emergency response situation people are located in many different places and move more or less continuously around, so, *places* in emergency response are difficult to define and delimit.

The *informational habitats* can be described as "created with and exist in information" [7]. In emergency response information is on one hand very focused (it concerns the incident and the response to it). On the other hand it is (potentially) very rich and holds almost unlimited possibilities, since no two incidents are the same.

The *conceptual habitats* are in [7] defined as habitats in terms of concepts and ideas. Here culture comes into play. In emergency response certain cultures rules – cultures that contains rules for behavior, e.g. communication, cooperation, hierarchies and division of work. And when several emergency response agencies are involved different "rules of conduct" often create severe difficulties.

An in depth analysis of emergency response, taking the questions and notions outlined above into account could give new input to the media spaces concept.

Another issue to discuss is related to the formality of communication, as discussed in [2]. The current communication, going on in major incidents, seems to be a mix of the characteristics of formal and informal communication.

Most of the important communications are *unscheduled*, the victims (*participants*) are random and the rescue workers (*participants*) are not known in advance, but 'selected' on the basis of being "available'. The agenda is not *preset*, but developed 'on the spot' based on well-known procedures. Communication is *interactive* and has a *rich content* – especially the non-it based communication. The *language and speech register* is a mix of formal and informal.

It might be that communication in major incidents is primarily informal. On the other hand, it could be considered if characteristics of informal/formal communication change, when we look into more broad and mixed settings?

## 4. REFERENCES


[1] Bardram, JE, Hansen, TR, Soegaard, M. AwareMedia – A Shared Interactive Display Supporting Social, Temporal, and Spatial Awareness in Surgery. *To be presented at CSCW2006*

[2] Fish, R.S, Kraut, R.E, Chalfonte, B.L. The VideoWindow System in Informal Communications. *Proceedings of the 1990 ACM conference on Computer-Supported cooperative work,* October 7-10, Los Angeles, California, USA, 1990. p 1-11.

[3] Kramp, G, Kristensen, M, Pedersen JF. Physical and digital design of the BlueBio biomonitoring system prototype, to be used in emergency medical response. *1st international Conference on Pervasive Computing for Healthcare*, Innsbruck, Austria, Nov-Dec 2006. Accepted.

[4] Kristensen M, Kyng M, Nielsen ET. IT support for healthcare professionals acting in major incidents. *SHI2005, Proceedings, 3rd scandinavian conference on health informatics*; August 25-26; Aalborg: Aalborg University; 2005, p 37-41.

[5] Kristensen M, Kyng M, Palen L. Participatory design in emergency medical service: designing for future practice. *Proceedings of the SIGCHI conference on Human Factors in computing systems CHI '06.* Montreal, April 2006, p 161-170.

[6] Kyng M, Nielsen, ET, Kristensen M. Challenges in Designing Interactive Systems for Emergency Response. *Proceedings of the 6th ACM conference on Designing Interactive systems DIS '06,* Penn State University, June 2006, p. 301-310

[7] May, D.C-M, Kristensen, B.B. Habitats for the Digitally Pervasive World in Andersen, P.B, Qvortrup, L (eds). *Virtual Applications: Applications with Virtual Inhabited 3D Worlds.* Springer. 2003.

[8] The Danish National Level Incident Command System. Description available at: http://www.brs.dk/uk/danish_preparedness_act.htm

[9] The 43D homepage: http://www.43d.com/index.php

[10] The PalCom project homepage: http://www.ist-palcom.org

[11] Weiser, M. The computer for the 21st century. *ScientificAmerican*, 13(2):94–10, Sept. 1991.

# Maybe Media Spaces are NOT all about Video

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## Media Spaces and Video

As a user of an early Media Space at Xerox PARC [Bly et al., 1993], I remember being intrigued by how the video connections enabled sharing rich cues for negotiating contact. I have come to realize that the Media Space video links enabled conversation partners to *mutually* negotiate starting and ending conversations in ways that other communication technologies are not able to support. The reciprocal video views enabled each person to see the reactions to an approaching attempt to start a conversation, and subtle cues could be used to either encourage or dissuade such an approach.

The way that video helped people find good times to start and end conversations (which I will refer to as *contact negotiation*) had a big impact on the remote communication tools that I have since designed. By contrast, other communication technologies provide little support for sharing cues to negotiate making contact. For example, initiating a telephone call is done with almost no information about the status and interruptibility of the recipient. While using phone answering machines to screen calls and caller identification have given recipients some mechanisms for managing incoming calls, the burden of managing contact is not *mutually* negotiated but shifted more toward the recipient. With the diffusion of mobile telephony, it is apparent how the call recipient must bear most of the responsibility for managing the disruptiveness of handling incoming calls.

The very richness that enabled video to share the subtle cues for contact negotiation, however, also raised privacy concerns. Even in the Media Space deployment within PARC, privacy reactions surfaced around freely sharing video connections among private offices and shared work locations. Furthermore, practical concerns of deploying video have hampered widespread adoption of video technologies to this day. Integrated hardware for capturing and displaying video and a technical infrastructure for distributing the network bandwidth intensive media are still emerging twenty years after Media Spaces first appeared.

But I now wonder whether the most important thing I learned from the Media Space was not about video but about the social negotiation that video enabled. Since my Media Space experience, I have been involved in designing several computer-mediated communication (CMC) prototypes. The earlier ones were video-based, but the most recent one relied on text and icons to convey awareness cues to help people initiate contact, much like current instant messaging (IM) systems. In reflecting on this progression of designs [Tang, forthcoming], I observed that video is only one way (and

perhaps not the most convenient way) of enabling remote colleagues to gracefully negotiate contact. In this paper, I briefly summarize what I learned from that progression and suggest future directions for helping mediate communication among remote people that essentially have their roots in the Media Space from twenty years ago.

## Reflecting on a Progression of Communication Prototypes

I briefly describe the design of three CMC prototypes to support the communication among teams who are distributed among different locations:

- DCP — an early Desktop Conferencing Prototype,
- Montage — a prototype interface for initiating desktop video conferencing, and
- Awarenex — an IM and awareness prototype.

An understanding of how people traditionally accomplish contact negotiation was used to design these prototypes to enable remote collaborators to negotiate making contact. Our design approach followed the tradition of social translucence [Erickson & Kellogg 2000] by providing the participants the cues that allow them to socially negotiate appropriate action among themselves.

The Desktop Conferencing Prototype (DCP) took advantage of the emerging capability of real-time audio and video connections among computer desktops [Tang & Isaacs 1993]. To better support the process of starting a desktop video conference, we integrated a chat-like shared message area into the interface that allowed prospective participants to exchange text messages to confirm if they were available and perhaps indicate the topic of the conversation. Once participants indicated availability for a conversation, a desktop video conference was started (which due to the technology at the time required about a half a minute).

This text chat interface for starting desktop conferences foreshadowed the current practice of using an IM to negotiate contact before moving to the phone or other more efficient means of communication [Nardi et al., 2000]. However, the over 10-second delay in starting the text chat interface and over half-minute delay in starting video connections made starting a DCP conversation feel very heavyweight.

The Montage interface [Tang & Rua 1994] explored using video glances to support contact negotiation, rather than the text messages used in the DCP. This approach built on the ways contact initiation is typically accomplished in face-to-face (and Media Space) settings where people typically visually assess whether a person is available for a conversation. Establishing mutual eye contact is often the first cue of being available and starting a conversation. In Montage, we gave users a small video "glance" between them to help assess whether they were available.

While video was good at supporting the pre-interaction negotiation, it also raised privacy concerns of opening video connections among computer desktops. To mitigate these concerns, the video glances were reciprocal, and gradually faded in (accompanied with an audio sound) to provide a sense of approach. In our study of the use of Montage [Tang et

al., 1994], people liked the informal, lightweight feel of Montage glances, and used them to negotiate both starting and deferring conversations to a more appropriate time.

The Awarenex prototype [Tang et al. 2001], represented a different approach to supporting distributed communication. Rather than including a video channel, Awarenex relied on textual and iconic representations of awareness and communication (IM, telephone) information. This approach was in part due to the lack of penetration of a networked video infrastructure, contrasted with the popularity of IM systems. While Awarenex built on many design elements popularized by commercial IM systems, our design approach shared more cues to help manage contact negotiation.

Beyond indicating if a user was logged on and actively typing on the keyboard, Awarenex also showed if the user was currently on the phone, in an IM chat, or had an appointment scheduled in their on-line calendar during the current time. These cues of whether a colleague was socially engaged with others helped users decide whether it was a good time to attempt contacting a colleague. Sharing these cues supported mutual contact negotiation, as the person initiating the contact now had some information to suggest whether it would be a good time to contact a user or not. By using textual and iconic cues to share this information, the privacy and deployment issues around video are avoided. Awarenex is a step toward more negotiated contact initiation without video.

## Designing Technology to Support Mutual Contact Negotiation

While video is great at conveying awareness cues that are physical, Awarenex begins to demonstrate ways of sharing awareness cues that the computer knows about through prior interactions with the user (e.g., in a scheduled appointment). As much of our work is accomplished using a computer, sharing the computational context of our work may become increasingly important in supporting the contact negotiation process. We designed the Piazza prototype [Isaacs et al., 1994] to explore opportunities of sharing cues of people working virtually "nearby" (using the same application to access the same data at the same time) as a way of providing context for initiating communication with those people.

We are essentially now carrying "personal communicators" in the form of cell phones. These cell phones are almost always on and equipped with a battery of sensors, such as camera (video-capable), microphone, and GPS. Current trends indicate that these personal communicators will get smaller, integrate more features, and will become more convenient to go with us anywhere, thus becoming more pervasive. This development presents an ongoing challenge to develop technologies to support mutual contact negotiation, whether through video (as was largely done in Media Spaces) or other types of sensor information now available through our personal communicators.

Personal communicators evoke the science fiction programs, such as *Star Trek*, that popularized them. Yet, perhaps the biggest myth in *Star Trek* is not the technical advances of warp-drive engines that travel faster than the speed of light or transporters that teleport objects across distances. Rather, the social myth that people were *always* available when summoned on their personal communicator without any apparent cues to

negotiate contact may be the most unrealistic. (Exceptions occurred only when a communication problem was important to the plot line.) Our current-day experience with cell phones demonstrates that finding appropriate times to make contact with remote people often requires some social negotiation beyond what current technology supports.

The opportunity we now have, then, is to build technology that *gracefully* supports contact negotiation. Twenty years ago, the Media Space work illuminated how video can be a valuable resource in supporting contact negotiation. Building on those experiences and current advances in technology, we can build systems that better support contact negotiation. However, video may not be the only way to support contact negotiation. The popularity of IM, our experiences with Awarenex, and the potential of location and other sensor information suggest new opportunities to support contact negotiation without the invasiveness of video. While video literally conveys rich cues to help people negotiate contact negotiation, a combination of other sensors may enable people to make social inferences for contact negotiation without the invasiveness and deployment concerns of video. By integrating studies to understand human communication practices with new developments in technology, we have the opportunity to go beyond Media Spaces to gracefully enable making contact among remote participants.

## References


Bly, S., A.,, Steve R. Harrison and S. Irwin, "Media Spaces: Bringing People Together in a Video, Audio, and Computing Environment." *Communications of the ACM*, 36(1), 1993, pp. 28-47.

Erickson, Tom and Wendy Kellogg, "Social Translucence: An Approach to Designing Systems that Mesh with Social Processes," *ACM Transactions on Computer-Human Interaction*, 7(1), 2000, pp. 59-83.

Isaacs, Ellen, John C. Tang, and Trevor Morris, "Piazza: A desktop environment supporting impromptu and planned interactions", *Proc. of the Conference on Computer-Supported Cooperative Work (CSCW) 1996*, (Boston, November 1996), ACM, pp. 315-324.

Nardi, Bonnie, Steve Whittaker, Erin Bradner, "Interaction and Outeraction: A Study of Instant Messaging in the Workplace", *Proc. of the Conference on Computer-Supported Cooperative Work (CSCW) 2000*, (Philadelphia, December 2000), ACM, pp. 79-88.

Tang, John C., "Approaching and leave-taking: Negotiating contact in computer-mediated communication", *ACM Transactions on Computer-Human Interaction*, forthcoming.

Tang, John C. and Ellen A. Isaacs, "Why Do Users Like Video? Studies of Multimedia-Supported Collaboration", *Computer Supported Cooperative Work: An International Journal*, 1(3), 1993, pp. 163-196.

Tang, John C., Ellen A. Isaacs, and Monica Rua, "Supporting Distributed Groups with a Montage of Lightweight Interactions", *Proc. of the Conference on Computer-Supported Cooperative Work (CSCW) `94*, (Chapel Hill, NC, October 1994), ACM, pp. 23-34.

Tang, John C. and Monica Rua, "Montage: Providing Teleproximity for Distributed Groups", *Proc. of the Conference on Computer Human Interaction (CHI) `94*, (Boston, April 1994), ACM, pp. 37-43.

Tang, John C., Nicole Yankelovich, James "Bo" Begole, Max Van Kleek, Francis Li, and Janak Bhalodia, ConNexus to Awarenex: Extending awareness to mobile users, *Proc. of the Conference on Computer Human Interaction (CHI) 2001*, (Seattle, April 2001), ACM, pp. 221-228.

# Exploring Mixed Presence Scenarios: some initial reflections

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**Abstract**

The extent to which one feels connected with another (sense of social presence) has been studied in a video conferencing domain where participants were either in the same room or all in different rooms [2]. In the real-world, people often work with both co-located participants (physical presence) and remote participants (telepresence). In this paper we investigate the sense of social presence in mixed presence groups. The Networked Mind measure of Social Presence has shown differences in attributed social presence based on media condition [5;2]. We examine the experiences of a mixed presence group, in which F2F and mediated encounters occur simultanously, investigating how empirical findings might be extended.

## 1. Introduction

Video conferencing facilitates access to remote places and people through technological mediation. Technology that enables remote and collocated engagement is known as groupware [1]. Numerous approaches attempt to approximate the ideal F2F quality. For example, Hauber et al. developed an interface with 3-D like interactivity [2]. In another approach to support a realistic telepresence encounter, Yamaashi et al. provides the remote person with two views from the connected site, a foveal (near) and peripheral (far) view [3]. These are just two examples of systems encouraging a natural sampling of visual information of a remote space.

Telepresent encounters have a social component as well as a technological one. Constructs like social presence allow researchers to evaluate the connectedness and interpersonal fluidity of the mediated interaction. A theoretically grounded social presence measure used in telepresence research assesses the extent to which a person feels connected with a remote person (for example, through an interface). The presence field has developed several measures to gauge physical and social presence [4].. While telepresence is the sense of "being there", social presence is the sense of "being together with another". Social presence theory asks the question: "how much did one person feel socially and psychologically connected to another person when engaged in a mediated interaction?" According to Biocca [5] the assessment of satisfaction with video conferencing systems is based largely on the quality of social presence they afford. Various measures of social presence have been proposed in the literature. While Short defines social presence as a constant property of the media, Biocca [5] looks at social presence as the moment by moment awareness of the co-presence of another accompanied by a sense of engagement. Biocca identifies three theoretical dimensions of social presence: Co-presence, Psychological involvement and Behavioral engagement. Each of these dimensions has empirically determined factors. A recent version of Networked Mind measure consists of six factors [9]:

- co-presence
- attention allocation
- perceived message understanding
- perceived affective understanding
- perceived affective interdependence
- perceived behavioral interdependence.

The Networked Mind measure of social presence is determined by multiple questions for each factor scale and has been used to compare face to face and purely mediated conditions [5] and to compare 3D video conferencing with 2D video conferencing [2].

We examine the experiences of a mixed presence group, in which F2F and mediated encounters occur simultaneously, investigating how these findings may be extended.

## 2. Description of Study

Two participants sat side by side, interacting via videoconference with a single participant in another room. The connection between the two locations used a high quality audio and video link utilising Digital Video (DV) over IP [3]. The remote participant was provided with two views: a zoomed out, wide angle view and a tight, close up view. Groups of three completed the scenario "Desert Survival Game"; used in previous studies of social presence [1;2;4]. The Desert Survival Game involves two activities: individual rank-ordering items to survival (e.g. compass and sunglasses), and a group activity negotiating about items' importance to group survival in the desert. Once completed, the Networked Mind tool was administered to all participants [5,9]. Co-located participants rated both the physically present and telepresent participant. The remote participant rated the co-located pair. In addition to administering the Networked Mind measure we asked general

questions about their work awareness and experience. Questions included: which item they discussed most which item they agreed on first, the strategies they have used for negotiation etc.

We compared social presence ratings of co-located and remotely located participants, hypothesizing that co-located participants report greater ratings of social presence than those remotely located. We also compared work awareness rating of co- present participants and remote participant. The remote participant's visual behaviour was captured using gaze tracking technology[10].

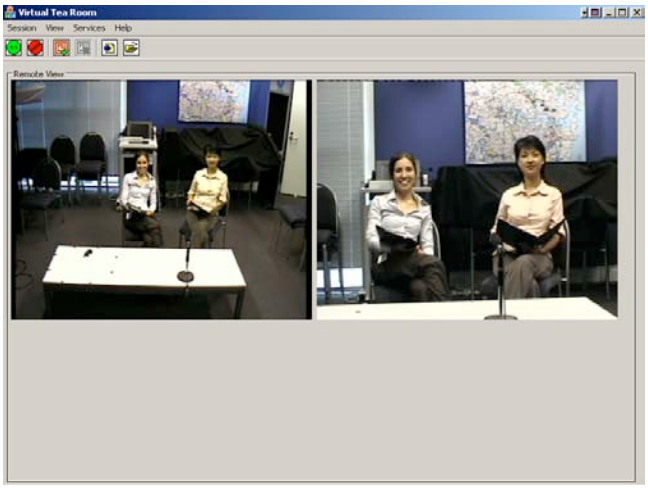


**Figure 1: Remote Interface**

## 3. Results of Study

This pilot consisted of 24 participants (10 females and 14 males), between the age of 20 and 44 (mean = 26 years, S.D. = 6.69). Cronbach alpha for the six social presence subscales ranged from 0.83 to 0.94, satisfying reliability requirements [11]. Three groups of questionnaire responses were statistically analysed in one-way ANOVAs, revealing no significant differences between conditions with respect to social presence ratings (See Table 1). In interview responses, participants' reported appropriate physical descriptions of others and task artefacts like first item of consensus and an item of debate. Their impressions of groupware technology and activity context indicate the most salient aspects of the collaboration.

| | **Co-located Pair** | | **Remote Person** |
|---|---|---|---|
| **Social Presence Factor** | **F2F** | **Remotely located** | **Remotely located** |
| **Co-presence** | 6.17 (.71) | 5.71 (.92) | 6.04 (.56) |
| **Attentional Allocation** | 4.90 (1.10) | 4.82 (1.25) | 5.29 (.90) |
| **Perceived Message Understanding** | 5.90 (.85) | 5.56 (1.06) | 5.56 (.62) |
| **Perceived Affective Understanding** | 4.74 (.90) | 4.22 (1.46) | 4.83 (.93) |
| **Perceived Affective Interdependence** | 4.33 (1.03) | 4.18 (1.04) | 4.13 (1.40) |
| **Perceived Behavioural Interdependence** | 4.24 (1.07) | 3.89 (1.23) | 4.60 (.69) |

**Table 1: Mean Scores by Media Condition & Social Presence Factors**
**Reported: mean ratings (standard deviation)**

## 4. Discussion

Our main objective of this study was to investigate the measures and underlying theories that may be relevant to study of mixed presence scenarios. We subjected the Networked Mind measure to a "reality test" of telepresence [11]. Administering a questionnaire in a mixed presence group contributes to the validity criteria of this particular social presence tool [12]. Results indicate impressions of social presence for someone physically present compared to someone telepresent are statistically indistinguishable in this setting. This implies that the Networked Mind measure may not be applicable to this configuration and hence suggests a limitation of the social presence theory in not being to able to account for situations mixing co- presence and telepresence. While the Networked Mind measure focussed on the sense of being connected with another, the work awareness questions were asking participants questions leading them to reflect on their negotiation experience from both a process and content point of view..In general the participants adequately answered these questions suggesting that their location (co present or remote) did not affect their response. In our view a multi-method approach blending conventional questionnaires with behavioural observations. is required to more completely captures both people's collaboration experience and sense of social presence.

The small sample size and design of the media space present possible experimental confounds. The co- located pair was in a large room and the remote participant was in a small room. The view of remote participant was projected on a plasma screen, displaying a "larger than life" image. Null differences could also imply a lack of variance in presence levels between the simultaneous mediated and F2F encounters.

Future work will draw on the lessons learned from this pilot study, the design space issue as well as measurement and underlying theoretic foundation. While social presence and work awareness are social and cognitive constructs that we have find very useful in exploring mixed presence scenarios, they failed to capture participant's overall experience.. Investigating real and complex remote collaborations may

require different measurement tools, specific measures such as social presence and work awareness but also overall satisfaction or quality of experience measures. More importantly we need to identify the relationship between these focussed measures and the overall quality of experience measure. Are social presence and work awareness prerequisite to participant quality of experience ?. A theory of remote collaboration is needed in order to explore such important issues. It is our believe that studies accounting for the complexity of real-world videoconference settings benefit the research community from a theoretical and measurement perspective as well as designers of telepresence technology.

## References


[1] Ellis, C. A., Gibbs, S. J., and Rein, G. L. (1991). Groupware: some issues and experiences. *Communications of the ACM 34(1)*, 39-58.

[2] Hauber, J., Regenbrecht, H., Hills, A., Cockburn, A., and Billinghurst, M. Social presence in two- and three- dimensional videoconferencing. In *Proceedings of ISPR 2005,* 2005.

[3] Yamaashi, K, Cooperstock, J. R, Narine, T, and Buxton, W. Beating the limitations of camera-monitor mediated telepresence with extra eyes. In *Proceedings of CHI '96*, 50-57. 1996.

[4] Presence-research.org URL: http://www.presence-research.org/

[5] Biocca, F., Harms, C., and Gregg, J. The networked minds measure of social presence: Pilot test of the factor structure and concurrent validity. In *Proceedings of ISPR 200*1, 2001.

[6] Ogawa, A., Kobayashi, K., Sugiura, K., Nakamura, O., and Murai, J. Design and implementation of DV based video over RTP. In *IEEE Packet Video Workshop, 2000.*

[7] RogerKnapp URL: http://www.rogerknapp.com/download/games.htm

[8] Veinott, E. S., Olson, J., Olson, G. M., and Fu, X. Video helps remote work: Speaker who need to negotiate common ground benefit from seeing each other. In *Proceedings of CHI '99,* 302-309. 1999.

[9] Harms, C. M., Levine, T., and Biocca, F. The effects of media type and personal relationship on perceptions of social presence. Thesis/Dissertation. Michigan State University, East Lansing, 2004.

[10] Stitzlein, C. A, Li, J., and Alem, L. A study of visual behaviour in video mediated negotiation using gaze tracking. Submitted Ozchi'06, Sydney, November 2006.

[11] Cohen, J. (1992). A Power Primer. Psychological Bulletin 12(1), 155-159.

[12] Usoh, M., Catena, E., Arman, S., and Slater, M. (2000). Using presence questionnaires in reality. Presence 9(5), 497-503.

# Creating Assemblies in Media Space

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## Introduction

There has been a long-standing interest in CSCW in developing systems to support real time, synchronous collaboration amongst individuals based in different locations. Media spaces, lie at the heart of these developments. For a number of years they seemed to provide the solution to the 'disaggregated' organisation; meeting the demand for people to engage in focused collaborative work despite their physical distance. Despite technical innovations, the creation of imaginative prototypes and accompanying social science research, media spaces remain relatively underdeveloped and under-exploited. Few would argue that we have developed systems that can support reliably little more than relatively basic forms of interpersonal communication.

One of the challenges for this research has been to develop systems that provide support for activities and interaction on and over everyday objects and artefacts. In our work over the past few years we have been engaged in a series of attempts to improve access to, to refer objects in, and to manipulate objects in a remote setting. This has involved the development of prototypes using a range of technologies and ways of combining these, including different kinds of pointers and pointing, physical and mechanical embodiments of individuals, projections of details of conduct and most recently automatic analysis of behavior. Successive analysis of these prototypes have revealed the difficulties of supporting interactions and activities in media space and some of the critical requirements necessary for them to support collaborative work. More importantly, perhaps developing media spaces has revealed more about what we do not know about how everyday collaborative work and interaction is accomplished.

At the workshop we would like to discuss a programme of work that has been undertaken in collaborations between engineers, computer scientists and social scientists from the Japan and the United Kingdom over the last few years. By revealing the transformations in the technologies we have developed, through successive iterations and the introduction of alternative and different devices we would like to show how our conceptions of collaborative work and the solutions media spaces need to have solved have been refined. In this position paper we will mention some of the studies that have been undertaken within this programme of research.

## Background

Studies if the initial implementations of media spaces, such as those at EuroPARC, raised some critical challenges facing those seeking to provide real-time synchronous support for collaboration. Rather than provide symmetric resources for the participants they seem to introduce interactional asymmetries that the participants have to manage. Despite hopes that they would support real-time interaction through the provision of a real-time image of the head and shoulders of a co-particioant even these simple resources seemed to undermine the ways in which individuals undertake collaborative activities. Rather than offering a media space where participants have common access to objects they create fragmented environment in which participants have to work to make the activities of their colleagues coherent (e.g. Gaver et al. 1993, 1995, Heath and Luff 1992). This is hardly surprising, since early developments remained preoccupied with a face-to-face model of interaction, and when attempts to expand the space to encompass the local material environment, various problems and difficulties began to emerge. As we have suggested elsewhere, developing a 'coherent environment' in which participants are able to work together using material artefacts, in particular documents, has proved an intractable problem, with various technical solutions serving to engender difficulties of accessibility, perspective and mutual reference. These difficulties are not resolved when one replaces the connected physical spaces with a CVE; indeed, participants have to undertake all sorts of remedial action, primarily through talk to reconcile incongruities and establish a reciprocity of perspective in undertaking even the more simple activities like pointing and reference (Gaver, et al., 1993; Heath, et al., 2001; Heath and Luff, 1992; Hindmarsh, et al., 1998).

Coupling these initial studies of media space with studies of work in everyday environments (’workplace studies) we outlined a number of ’requirements’ for real-time systems to support collaborative work. These included

- providing participants with the ability to determine the location, orientation and frame of reference of others ;
- providing resources for participants to determine their standpoint with regard to other participants and the space(s) in which they and others are located;
- providing resources through which participants can discriminate the actions of others which involve shifts in orientation and reference to the space and a range of objects, artefacts and features;
- considering ways in which participants can refer to, invoke, grasp, manipulate, address, and in various ways animate properties of the space, and coordinate such actions with the real-time conduct of others;
- considering how participants can be provided with, and themselves preserve a stable constellation of relevant objects, artefacts and scenes within the space(s), so that they can produce and interpret

activities with respect to a presupposed coherent and stable environment (cf. Heath, et al., 1995).

Trying to meet these requirements has proven extremely difficult and it is apparent that the technologies we have developed do not support the kind of activities and interactions that even the humble paper document supports in co-present interaction. However, in trying to meet them we have discovered just how complex are the ways in which people coordinate their activities in interaction. Even a simple point or a reference to an item on a document involves a complex configuration and orgainsation of conduct for this to be achieved. In different ways the technologies we have developed have explored different resources for undertaking 'embodied' interaction and collaboration. A number of our initial experiments focused primarily on how to point to a remote physical object through a 'media space' (e.g. GestureLaser and GestureCar). Other systems like Agora have begun to explore what it would involve to develop systems to support a range of more complex embodied, interactional activities.

## GestureLaser + GestureLaser Car

In our initial experiments we focused on simple activities between participants, which could be called instructional interactions where one participant needs to describe, refer to and generally talk about a remote physical object. GestureLaser was a remote-control laser spot actuator placed in the environment of another which the instructor could use to identify locations (Fig. 1). The instructor did this by controlling the location of the laser spot with a mouse. The instructor could monitor the position of the laser spot as well as objects and operators on an image from a camera unit. It was thus possible for the instructor to treat the laser spot as if it were a mouse cursor. In this way, the instructor could develop various more complex ways of referring to objects such as by rotating and directing the movement of the laser spot.

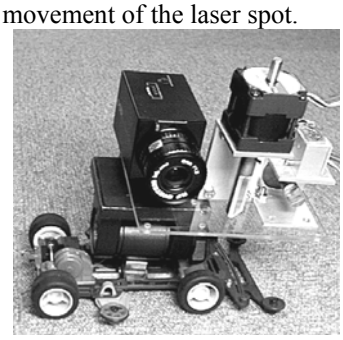

Figure 1. GestureLaser and GestureLaser Car

We were particularly concerned that.

- The instructed must not only have access to another's talk but features of his or her bodily conduct,.
- Participants should be able to mutually observe each other's activities.
- The instructor could position the device, without much effort, so that he or she can easily see the other and the environment around them.
- The sequential and interactive organization of the conduct should be possible without serious time delay.

When we undertook studies of this system it became apparent that one of the major problems of the GestureLaser was its low mobility, and it did not provide very good support how participants configure themselves in a setting, around an object for example, to undertake collaborative activities.

In order to mitigate this problem and to enable more dynamic body positions and rearrangements, we designed a mobile robot on which the functions of the GestureLaser were mounted. We then developed a series of mobile robots named GestureMan-1, GestureMan-2, and GestureMan-3.

## GestureMan-1 and GestureMan-2

GestureMan-1 and GestureMan-2 (Fig. 2) were small robots, about 1.2-m tall, that moved around a remote domain. They had three cameras and a laser pointer. Images from the cameras and commands to the robot were transmitted through a high-bandwidth wireless channel, providing a remote instructor with high quality, real-time video. The instructor could control the movement of the robot - it moved around on wheels. The top (or head) unit held the cameras.

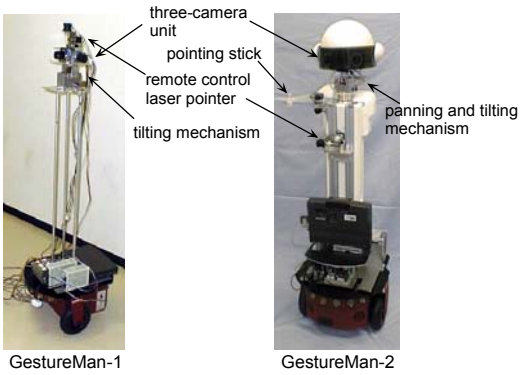


Figure 2. GestureMan-1 and GestureMan-2.

In the instructor's environment, there were three monitors displaying images from the cameras and the instructor used a joystick to control the movement of the robot.

Our experiments with GestureMan-1 and 2 highlighted the problem of the different spaces in which instructor and operator accomplished their activities. The ecology for the instructor included, the monitors, the operating devices and the other aspects of the user interface for controlling the robot. The ecology for the operator included the robot, and the local surroundings. If a robot was to be an effective communication device, the system designer needed to consider both these ecologies and how actions accomplished in each are related to one another.

For example, in GestureMan-1 and -2 a joystick was used to control the head and body motion of the robot. However, we observed that instructors frequently reoriented themselves within the local environment. For instance, since the three monitors were spread out in front of the instructor, they naturally changed their head orientation to look around the operator's environment displayed on the monitors.

Detailed studies of the gaze and bodily conduct in interaction reveal that the head movement of a participant

frequently projects what to see and what to do next. In turn, seeing this movement provides co-participants with the resources to coordinate their own conduct, so for example, they too can move/look towards, a common focal point. In this way they subtly coordinate heir actions to facilitate what to do next on which object and in what way.

Unfortunately, these shifts in orientation were not reflected in the GestureMan's head rotation. In fact, these resources are critical for the production and understanding of sequential communicative activities.

## GestureMan-3

GestureMan-3 was designed to support this kind of 'projectability' in interaction. We used the three-monitor system located in front of the instructor and put a small 3D motion tracker on his or her head. Since the three monitors were spread out in front of the instructor, when the instructor looked around, his or her head naturally moved to the right and left. This head movement could be traced by the 3D motion tracker (Fig. 3). The robot's head was mounted on a pan-tilt (horizontal and vertical motion) mechanism and could be controlled and moved in accordance with the instructor's head movements.

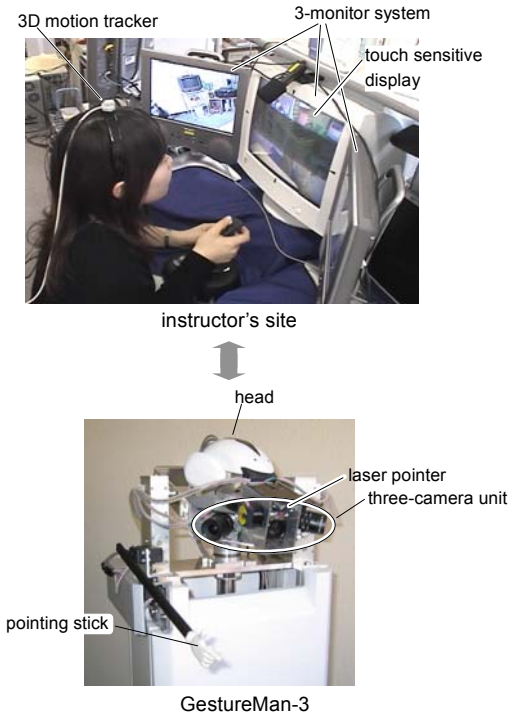


Figure 3. GestureMan-3 system

Three-camera unit was mounted on a camera frame and to design the robot's head to pan and tilt independently from the camera frame (Fig. 3). It should be noted that the robot's head only served as an indicator of the instructor's head orientation. In other words, it moved so that the participant could distinguish the direction of the instructor's orientation. The direction of the camera did not change unless the instructor changed the robot's body orientation using the joystick.

Experimental results with the GestureMan-3 showed that, by appropriately reflecting a remote instructor's head orientation, its head movements were effective in supporting the projection of activities through media space and in some ways supported one simple activity associated with remote objects, pointing.

## Agora

With the Agora system we investigated providing support for richer forms of activities with objects. This system was more akin to the original media spaces, being built around the idea of activities on and around a desktop, but where participants could discuss and manipulate real objects like paper documents. We were particularly concerned with providing variable forms of access to another's environment and their conduct within it. As well as providing audio access, Agora offered a series of interrelated views that enabled remote participants both to see and hear each other, access and share paper and digital documents, and point to and gesture over documents both in their own domain and their co-participants' (Fig. 4).

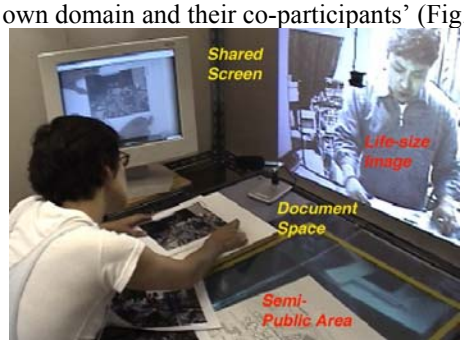


Figure 4. View of the Agora showing the different spaces

More specifically the system consisted of:

- a 120 cm screen situated along one side of the desk that projected a life-size image of the remote participant as they sit (or stand) at their desk. This provided a view of the other as well as a small portion of their desk;
- a large 'working area' (66cm x 49cm) on the desk in front of the participant. Here documents and hand gestures on and over the desktop were captured by a video camera above the desk, transmitted to a remote site, and projected onto the remote desktop from beneath. Because of this, documents on the local desktop could cover the image of documents on the remote one.
- a smaller document space (the same size as an A3 piece of paper) where documents could be placed and worked upon. Above this a document camera captured an image of the documents and participants' hand gestures. These images were mixed to be presented on the shared screens in both locations.

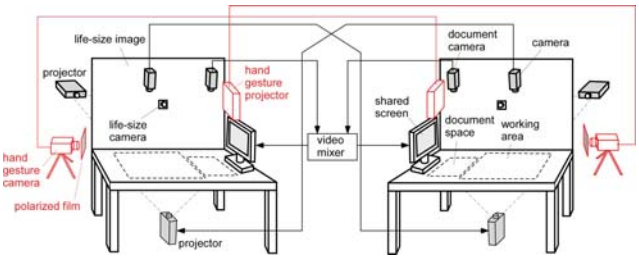


Fig 5. The additional cameras and projectors in Agora required to display gestures to 'digital' documents.

Agora enabled participants not only to see details of documents and objects in the remote space but also gestures to and around them. This could not be provided by projection (working area) alone and to see details of documents a higher resolution screen (shared screen) was

required. As this then offered another location to refer to, cameras positioned across the desk (hand gesture cameras) were also required to pick up hand gestures to the screen (see Fig. 5).

With this rather complex arrangement both participants could point at real documents (in their own space) and at the same documents displayed in the shared document monitor.

Figure 6. Projection of remote person's hand gesture

One of the interesting features of Agora, in particular in contrast to our earlier attempts to support collaboration with and around objects, were the ways in which the participants were able to interweave a range of resources and spaces within the developing course of a particular activity. For example relatively subtle shifts in orientation, the delicate onset of particular actions, and shifting glances between particular objects and domains, were not only available to the co-participant, but were oriented to in sequentially relevant ways. In other words, participants were able to retrieve the sense and significance of particular actions from the standpoint of the co-participants and thereby produce a sequentially appropriate action. This sense and sensibility was achieved through the ways in which co-participants interweaved the visibility of co-participants' actions on different displays and in different locales, so that for example, a shift in orientation on the large projected display and the beginnings of an arm movement towards the co-participant's screen, could be seen to prefigure, project, some activity on a document – either on one's own shared screen or on a document on the desk.

There were drawbacks to the system and its arrangement. This media space consisted of a complex configuration of cameras, projectors, filters, monitors and screens and although the system was only intended as experimental it is indeed somewhat cumbersome. However the system appeared particularly suitable for relatively intense forms of document focused collaboration, where it was critical that participants require subtle and fine-grained access to each others' actions. In this respect Agora was configured to support a different order of activity than addressed in earlier work on media spaces and CVEs. In this case, we found a system which, as a consequence of its design and the quality of equipment, is able to support highly intensive forms of materially mediated collaboration

## Summary

One final observation should be mentioned. In our early experiments with prototype version of Agora we noticed that participants rarely oriented to each others' hands unless some explicit, spoken, reference was made to them by a co-participant. These earlier experiments were undertaken using conventional projectors and cameras. In our later experiments, we were able to use high resolution projectors and digital rather than analogue cameras. These provided a clarity and level of detail unavailable with the earlier equipment. The quality of the images in these more recent experiments, provided participants with access to each others' conduct which was hitherto unavailable, and their ability to coordinate their actions with each other and remain sensitive to the fine details of each others' behaviour, derived in part from the resolution and contrast of the image.

The quality of the images available in the experiments and possibilities for collaboration they afford also have some bearing on the empirical analysis of material-focused collaboration. We are increasingly finding, that digital video recordings of conduct and collaboration, whether in experimental or naturalistic settings, provides access to the organisation of action and interaction which until recently was unavailable. So for example, even our data which was collected as part of these experiments, reveals characteristics of social action and collaboration with and around documents that has not been addressed, as far as we aware, in the social and cognitive sciences and is disregarded in much work in CSCW. Indeed, compared to our initial investigations with media spaces at EuroPARC, we now have materials for analysis that provide details of visual conduct which reveal incredible subtleties and complexities in the ways everyday social actions are organised and coordinated. This of course is not the first time that a technology, even in the behavioural sciences, might have a significant impact on the ability of researchers to see new phenomena. It is interesting to note in the case of CSCW, that studies with media spaces could not only suggest what support is necessary to undertake remote activities, but also our understanding of, everyday collaborative work. Ironically perhaps, experiments with media spaces whilst appearing to support certain forms of collaboration amongst remote participants begin to reveal features of conduct and interaction with and around artefacts and assemblies of artefacts, which will place even greater demands on our attempts to support communication and collaboration.

## References


Gaver, W. W., Sellen, A., Heath, C. C. and Luff, P. (1993). 'One is not enough: Multiple Views in a Media Space', in Proc. of INTERCHI '93, Amsterdam, Apr 24 - 29, 335-41.

Heath, C., Luff, P., Kuzuoka, H., Yamazaki, K. and Oyama, S. (2001). 'Creating Coherent Environments for Collaboration', in Proc. of ECSCW 2001, Bonn, 119-38.

Heath, C. C. and Luff, P. (1992). Media Space and Communicative Asymmetries: Preliminary Observations of Video Mediated Interaction, Human-Computer Interaction. 7: 315-46.

Heath, C. C., Luff, P. and Sellen, A. (1995). 'Reconsidering the Virtual Workplace: Flexible Support for Collaborative Activity', in Proceedings of ECSCW'95, Stockholm, 83-100.

Heath, C. C. and Luff, P. K. (2000). Technology in Action. Cambridge University Press.

Hindmarsh, J., Fraser, M., Heath, C. C., Benford, S. and Greenhalgh, C. (1998). 'Fragmented Interaction: Establishing mutual orientation in virtual environments', in Proc of CSCW'98, Seattle, 217-26.