Managing visibility in ubiquitous multimedia communication environments

Leon Watts & Emmanuel Dubois

Centre for HCI Design,
Department of Computation, U M I S T
PO Box 88, Manchester, M60 1QD, United Kingdom

Telephone: (44) 0161 200 3383
Fax: (44) 0161 200 3324
Email address: leon.watts@co.umist.ac.uk

Equipe IIHM,
CLIPS-IMAG, BP 53,
38041 Grenoble Cedex 9, France

Users of Ubiquitous Multimedia Communications Environments (UMCE), such as media spaces, have to manage a trade-off between gaining some awareness of colleagues' ongoing activities and the risk posed to their own personal privacy by being on permanent display. UMCEs involve pervasive, continuous and heterogeneous connections between people and spaces. In order to learn more about the mechanisms underlying this trade-off, we studied a UMCE in the form of a minimal media space over a period of three months. We interpreted our results with reference to social identity theory, which casts self-identity as a set of affiliations and externally visible association with them. UMCE users themselves would define, configure and occupy places, or locales, within their spaces as a way of achieving a reliable and low-cognitive-effort management of their self-presentation. It may be that effective interpersonal and inter-group connections of this kind require attention to intra-space heterogeneity as well as heterogeneity in inter-space and technological terms. In this way, it would be possible to avoid the attentional demands of adjusting visibility through manipulations of sensor position or continually fiddling with filters. Instead, one may capitalise on a familiar regime of managing self-presentation by creating and then moving into and out of intra-space locales, each associated with a particular set of identities and audiences.

Keywords: media space, ubiquitous computing, multimedia communication environments, social identity theory, place, privacy.

1 Introduction

For nearly a decade, extensive research and development of media spaces has been underway at a number of academic and industrial laboratories (Fish et al., 1990; Heath & Luff, 1992; Lee et al., 1997; Mantei et al., 1991; Tang & Rua, 1994). Media spaces are typically intended to support low-level and low-effort interpersonal awareness among workgroup members. They exist as a surrogate for a physical milieu where building architecture or physical distribution hinder spontaneous and informal interaction. Indeed, this was a major design goal for Fish and Kraut's pioneering work (Fish et al., 1990). The design intention has been to add to the infrastructure of a work place, conveying on an ongoing basis information about who is where and doing what. The distinctive and necessary feature of the media space, in this role, is its continuous operation.

Most media spaces have been video-based although the concept does not in principle require a literal visibility. Interval Research Corporation has been working on an audio-only media space for some years (Singer et al., 1999). A number of media spaces have also honoured the principle of facilitating interaction by including or integrating companion conferencing facilities. Early media spaces, such as Bellcore's VideoWindow and CRUISER,

were based on an analogue of person-to-person face-to-face communication, using point-to-point audio and video connections over a network of media space nodes. To reflect the 'everywhere and always on' nature of the media space, and a continuity with wearable and ubiquitous technologies (Falk & Bj rk, 2000), they are better understood as a class of technologies called Ubiquitous Multimedia Communication Environments (UMCE) (Adams & Sasse, 1999a; Bellotti, 1997).

Dourish et al., reporting several years of personal experience with an office share media space, suggest that the true potential of a media space is given by the generation of a hybrid space out of the local, physical space and image of the distant space (Dourish et al., 1996). They contrast this with multimedia support for isolated interactions. There is some evidence to suggest that seeing the physical aspects of joint activity (manipulating, pointing etc.) or person-in-place, simply offers a different kind of value than that obtained from seeing a person's face (Watts & Monk, 1996). In other words, the value of transmitted images has more to do with their objective information content than in the subtleties of non-verbal communication cues. At the same time, the propensity for the physical locations themselves to affect mediated interactions has become ever more apparent (Dourish et al., 1996; Watts & Monk, 1998). This trend is evident in UMCE development. Emphasis has shifted away from having several targeted views within a persons work space (Gaver et al., 1993) towards a general awareness of one's group via images of activity at various locations (Daly-Jones et al., 1998; Lee et al., 1997; R¿nby-Pederson & Sokoler, 1997).

Figure 1. A typical CoMedi window in use, showing images from nine active nodes.

Despite the fact that much of UMCE research and development has been carried out in commercial laboratories, few of these systems have appeared in the every-day office. The tension between privacy and accessibility seems to be the critical factor. Image filters have been used to safeguard privacy (Hudson & Smith, 1996; Zhao & Stasko, 1998) but seem to be skirting the issue, simply reducing awareness to improve privacy and thereby risking removal

of the benefit. The evolution of NYNEX Portholes is a notable exception, in trying to couple filtering regimes with classes of onlooker (Girgensohn et al., 1999). Indeed "audience awareness", or knowing who are in receipt of personal information, has been argued as one of the cornerstones of privacy maintenance (Adams & Sasse, 1999b). This paper draws upon empirical data to explore the changing ideas behind the UMCE concept, with special reference to the architectural notion of 'place', an account of privacy risk developed by Adams and Sasse, and social identity theory.

The architect Christian Norberg-Schulz defines place as a design concept for architecture, composite of a locality within a physical area and the activities that customarily characterise it. Place defines an atmosphere within which human actions are appropriate or inappropriate, so that the architect s task is to create a culturally and functionally effective facility for people to live in and to use (Norberg-Schulz, 1980). Harrison and Dourish (1996) have argued that the design of collaborative systems need to take account of this space-place distinction by including the role, function, nature and convention of a space when introducing technologies. Adams and Sasse (1999a; 1999b) have developed a multidimensional framework for privacy with reference to UMCE adoption. They note that privacy is an inextricably subjective construct which, nevertheless, shows common structural characteristics between individuals. For example, the sensitivity of a given piece of information is conditioned by its expected recipient, and the acceptability of transmitting information is governed by obtaining prior permission for its transmission. There is hence no absolute privacy status for any particular piece of information: it is always about permission and control over any information on the part of the person to whom it pertains. Social identity theory concerns how people understand themselves in relation to their peers and also how they affiliate and then demonstrate their affiliations to their peers. Lea and Spears have been applied social identity theory to studies of computer-mediated communication and found some marked effects for such media on intra- and inter-group processes. This paper will argue for a connection between place, social identity and UMCE design.

At this laboratory a JAVA-based UMCE, CoMedi, has been under development for some time (Coutaz et al., 1999; Coutaz et al., 1998). In March 1999, a light-weight version of CoMedi was installed in a total of fifteen locations in three physically separated buildings (and across three floors in one of these buildings). Our intention was to examine and extend understanding of the UMCE concept by recording both preconceived ideas of its merits and demerits and then seeing how these attitudes were confronted by real and extended experience. A particular emphasis in our study was placed on the relationship between information in public and private space, and between spaces for work and social space, a distinction that is not always clearly understood (Falk & Bj rk, 2000). We thus report first a set of assumptions within the community about the vital aspects of media spaces, positive and negative, that were expressed just prior to the CoMedi installation. We report an analysis of the use of CoMedi based on day-to-day observations and examination of a diary records, informal discussions with community members and a questionnaire that was intended to bring out some of the themes we felt we had identified during the observational period.

2 The CoMedi media space

CoMedi exists in two forms. One is a fully-functioned concept demonstrator, including computer vision as a tool for image filtering and other technically advanced functions. In its other form, CoMedi is a light-weight Java implementation, allowing robust and fully compatible installations on Silicon Graphics, PC and Macintosh computers. Indeed, all three platforms supported CoMedi nodes during the period of our study.

In the following account, a CoMedi node means a workstation running CoMedi software associated with a single camera, not a particular office. Some offices had two CoMedi nodes. The interface and interaction model is deliberately simple and common to all platforms. Starting a CoMedi node causes the local image to be displayed on the local monitor first and in the same form as it is multicast to other nodes. Following automatic network checking for other nodes, images are added to the CoMedi GUI window, automatically resizing each image pane as a function of the total number of current images. Figure 1 shows a typical CoMedi window, comprising nine panes, each containing an image sent approximately every 5 seconds by a distant CoMedi node. Users may select a particular image and enlarge it with the zoom slider, shown on the right-hand edge of the Figure 1, in which case other images are contracted to compensate.

CoMedi thus provides each connected user with a view of all other locations containing functioning and accessible CoMedi nodes. CoMedi supports a weak visibility-reciprocity principle. Those who can see others via the media space are normally also visible, since connection is automatic on launching the media space unless permission is explicitly refused. All active nodes, whether or not contributing an image to the local node, are included in an audience list that may be displayed from a CoMedi menu. Besides restricting other nodes from displaying their image (filtering who can see by changing access permission), local users can also select one of two software filters to degrade the view of his/her office (filtering what can be seen). Filters once applied affect images for all audiences by:

- providing "venetian blind" style of mask (see Figure 2, bottom left-hand image pane),
- transmitting only a representation of office activity (see Figure 2, bottom right-hand image pane).

Figure 2. Image filters on CoMedi image panes showing (clockwise from top left), local filter, no filter, motion filter and venetian blind filter.

Additionally, CoMedi includes explicit "accessibility" signal in the form of a coloured circle. These are visible in Figure in the top right-hand corner of each pane. Users can choose 'available' (green), 'busy' (yellow) and or 'do not disturb' (red).

3 Community and experience

We carried out a number of complementary data collection exercises in over a three-month period, each building on data gathered to date. In this paper, we focus on observations made by ourselves and diary comments left by the community of users.

3.1 The user community

CoMedi was established within a large French research institute: of the order of 100 people would have experienced it on a fairly regular basis during the study period. It was installed on 15 workstations in research laboratories located in three different buildings. Of these, 14 were situated in offices to be hosted on volunteers' workstations and one in a communal rest and coffee area simply known as the "Cafette". Members of five separate research groups within the institute responded in the written data resources (initial survey, diaries and final questionnaire) although it is likely that some of the comments made in a communal diary were left by people outside the Institute. Relations between members of the community are characterised by cordiality and informality, with much shared social time. In contrast, working practices did not extend to very much shared formal activity between the groups. The group that developed CoMedi formed the largest single response group (contributing about half of all data gathered) and this was split over two floors in one of the buildings. Within this group, working practices involve extensive and continuous interaction on a range of projects.

3.2 Observations of CoMedi in use

The physical deployment of media space technologies is known to be important, whether as a matter of competition for limited amount of 'desktop real-estate', or as a difficulty in arranging camera and position to give an honest view of occupancy/audience (Dourish et al., 1996). We found our users very willing to exploit the physical configuration of camera and monitor to adjust the visibility of themselves and, more critically for the thrust of this paper, their space. In the first place, camera angles were adjusted frequently and seemingly without hesitation. The cameras at all CoMedi nodes were light-weight, compact and had fixed and generous depths and fields of view (with the exception of the Cafette camera, discussed below). This meant that users had a lot of freedom to choose how much of their space (i.e. which of their places) they displayed, at the cost of however much self-visibility they were prepared to tolerate. It is clear that this flexibility meant every user could put a cast-iron guarantee on privacy, simply by keeping their camera pointed away from themselves or other colleagues. In office settings, this was an extremely rare occurrence. Members of the community seemed to settle on a degree of visibility that varied from full-image head-and-shoulders to just profile or 3/4 view occupying a fraction of their CoMedi image (contrast the lower right pane with the upper centre pane in Figure 1).

Secondly, some parts of users' spaces were more sensitive places than others. In Figure 1, three users (top and centre left, centre right) have used strips of clear sticky tape to obscure only part of their spaces, leaving the remainder free for others to see. This became so conventional that we considered it to be part of the official repertoire of image filters (see Figure 2, top left pane). It selectively restricted available information by partitioning the space strictly in terms of the camera's image. Hereafter, this practice shall be referred to as **locale filtering**.

People who adopted locale filters applied them both to their own habitual seating positions, so that they themselves were obscured (although still visible in a degraded form) or to their working areas (notably, obscuring the content of computer screens). People who adopted locale filters tended not to move their cameras: to do so would have changed the filtered place within their space. It seemed that people in offices resolved the privacy-availability trade-off by choosing between the visibility of a restricted subset of their space in a generalised or selective way., where the direction of the camera achieved the former and the locale filters were the mechanism for the latter. Depending on the configuration they arrived at, users could maintain enough presence within CoMedi for other users to determine that they were individually located within the Institute and to some extent how appropriate some contact would be, given current evidence of activity. This evidence of activity could be any or all of interacting with objects, such as components or papers, computers or people.

The central pane in Figure 1 shows an image from the Cafette. The camera was fitted with a lens given a particularly narrow field of view, only showing a small part of the room at a time. This limited the likelihood of any given Cafette user appearing on camera at any moment since more of the Cafette space was out of shot than in shot . Frequently they were people who did not encounter CoMedi in office contexts and also were less familiar with the content and function of the CoMedi display. Furthermore, the Russian roulette of the five-second image update meant that the current image of the Cafette was of limited use for determining what would be shown next. Worse still, if they were captured for the next frame, their image would persist for the next five seconds or so. Several users complained that they lacked confidence in being out of frame, as they desired, and so directed the camera out of the window. The benefit of so doing was seeing an image that was unequivocally not of the Cafette interior (the limbs and leaves of a tree) and so reduced concern about wandering into the camera's field of view without realising it. Users enforced a field of view that did not include any path between, for example, the coffee machine and easy chairs. From the point of view of any other connected office, this had an immediate and catastrophic effect on audience awareness: one could never be sure who was present in the Cafette and consequently who might be 'looking in'. And yet there was no evidence of retaliatory behaviour by office-based users on these occasions.

On several occasions, the directibility of the camera was also capitalised upon to set a welcoming tone for the Cafette. The camera was occasionally pointed at brioche or pizza for all in the building to enjoy, as a general announcement to come and be sociable. The link here between the Cafette as a space and the Cafette as cultural central point for the user community is clear. The community exploited the connection between image from a known space and an atmosphere consistent with the social meaning of that place. There was never an instance of an office user pointing their camera at a pizza, for example, although on one occasion an office user pointed their camera at their white board with an announcement of a particular success.

Every CoMedi pane carried an identification label integrated with the image. By default, this was set to the workstation's network name. However, the label could be reset very simply via a CoMedi menu to a text string. To accommodate longer strings, the display font contracted according to the number of characters used (note differences between top left and top right panes in Figure 1). Users variously displayed their own names, office locations, phone extensions, email addresses or short messages. This underlines the role of CoMedi as a UMCE despite being designed as a minimal awareness tool. It was explicitly used to send interpersonal and intergroup messages, both through the text label and symbolic acts or in combination. The centre pane of Figure 1 was altered to LA BRIOCHE following the use of

the Cafette camera to advertise the presence of this French delicacy on a coffee table there. It is interesting to note that whereas office nodes frequently took individuals' names, this was never true of the Cafette. In so far as personal labelling signifies personal ownership, it highlights an individual-collective dimension to the differences between office and Cafette nodes in parallel with the private-public distinction.

Occasionally, cameras were re-directed to local whiteboards (including in the Cafette) to show messages. These were commonly humorous but included occasionally vitriolic complaints from Cafette users about the CoMedi installation there. Group-level effects were thus in clear evidence in both positive, cohesive and negative, devisive guises. Interestingly, these were relatively rarely matched by comments in the Cafette log. The communal display of upset in this way, within the very medium itself, suggests that the disembodied CoMedi manifestation was identified as an agency in its own right, as opposed to the CoMedi evaluators who would read the book.

3.3 Data from CoMedi users

Log books were kept with each CoMedi installation, including the Cafette, and comments solicited. Notes were also made from informal conversations about CoMedi experiences. Three months following the installation, a formal evaluation was undertaken, including circulation of questionnaires and interpretation of the responses with reference to the other materials.

3.3.1 Informants

Informants were recruited anonymously by email. In addition, copies of the questionnaires were left in the Cafette itself and a URL with a version of the questionnaire was publicised. 26 completed questionnaires were returned, 4 of which were discarded because they were spoiled or the respondents used the Cafette for less than 5 visits per week. The remainder were from people who rated their usage of the Cafette as greater than 20 visits per week, including 14 office + Cafette users and 8 Cafette-only users.

3.3.2 Diaries and Discussions

Seeing an unoccupied space strongly implies that it is empty, but the validity of this inference strictly depends on the camera's field of view. The consequence is that empty images are always untrustworthy. During the observation phase, it seemed that this was be more disturbing for the Office than Cafette only group.

Diaries and informal discussions showed that Office users were initially worried by le sentiment d'etre pi (the feeling of being spied upon) but learnt that the image definition was so low that relatively little could be learnt by remote viewers, at least compared to their original concerns. Visibility and legibility of computer screen content was mentioned several times, for example.

For Adams and Sasse, Information Usage is a strong determinant of the perception of privacy risk. We explicitly stated that we would not be filming from the video feeds to the media space. Even so, residual worries were there for some members of the community. One wrote:

"*at the start, my impression was negative... in fact, taking stock, we weren't really being filmed live as the images that everyone else could see were updated after a certain delay*".

So in two accidental ways, the technical limitations of CoMedi worked to the advantage of Office users by placing a bottleneck on the quality and frequency of information transmission.

Location was a strong and recurrent theme in the diaries and in conversation: knowing just where someone else was so that they could be sought out without wasting a journey. As a

consequence of the degree of mobility within the community, it was often hard to find someone and so CoMedi really did seem to fill a niche - at least for the Office subgroup with members of their own research group also connected. For other Office users, this value was not relevant and several commented on the fact.

The working practices of the community involve a great deal of face-to-face contact inspite of telephones in every room, and a culture where everyone is constantly within email reach. Despite these other communications technologies, several people regretted the lack of a text ping to precede a visit. The implication is the CoMedi fell short of its aim to support accessibility awareness. This is surprising, given the existence of an explicit circular indicator with the CoMedi image panes. However, this indicator was almost never used. It seemed that people just liked CoMedi to be there, available at a glance and that using menus to change status settings a greater cost than the gain of maintaining a proper reflection of their accessibility through this mechanism. The contrast with the menu usage for changing text strings is striking. Accessibility is something that changes as a function of activities orthogonal to a UMCE: an additional effort would be required to harmonise a UMCE indicator in this way that inevitably interfere with the accessibility-moderating activity. Where the UMCE is operating as a low-level awareness device, it cannot require more than low-level or incidental activity to change its state.

3.3.3 Questionnaire

The questionnaire for the second study comprised 33 items on analogue differential scales, made up of issues that had been identified by the community in an intial round of opinion-gathering supplemented by Adams & Sasse s privacy model. These scales offer more subtlety of response than a conventional 7 point Likert scale without adding an appreciable analytic burden and have proven sensitive devices in other studies of mediating technologies (Daly-Jones et al., 1998; Watts et al., 1996). An example of such a scale is given in Figure 3.

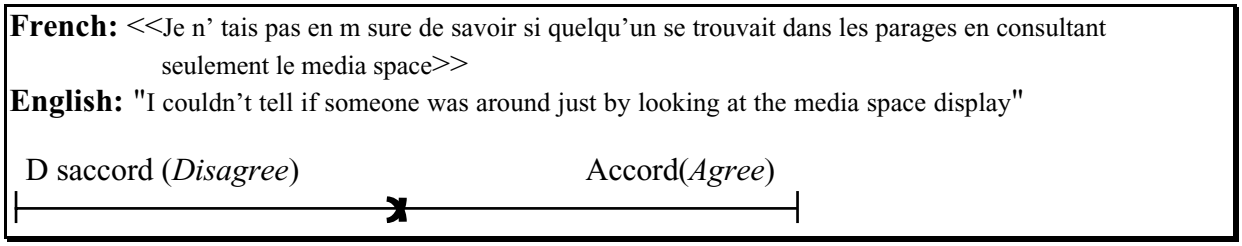

Figure 3: The inverse presence item as an example of the analogue-scale format questionnaire, with English translation, showing a response half way between Disagree and Agree (=0.5 as proportion).

Data presented in this section compare responses in terms of experience group: whether just in the Cafette (Cafette) or in both offices and in the Cafette (Office). In each case a rating figure is given as the mean rating point on the analogue scale, ranging from 0 (very negative rating) to 1 (very positive rating). Thus, mid-scale ratings indicate uncertainty about the issue for the respondents.

Group	Atmosphere	Location *	Presence	Rapprochement	Accessibility *
Cafette	.47 (.41)	.27 (.31)	.20 (.31)	.27 (.19)	.28 (.23)
Office	.48 (.33)	.67 (29)	.36 (.32)	.45 (.28)	.57 (.27)

Table 1. Ratings of potential advantages (mean ratings as a proportion of the analogue scale, standard deviations of the mean). [1]

Table 1 summarises questionnaire data for the mooted benefits of CoMedi. Cafette and Office users were non-committal about the value of CoMedi for the atmosphere at a connected node. Neither group were convinced that CoMedi was much use for telling in a general sense whether a particular person was in the building. Rapprochement, the extent to which intra and intergroup cohesion might improve, seems to contrast the two groups but the difference did not reach significance ($t(17)=1.31$; $p=.207$)[2]. The groups contrast strongly on the ability to tell exactly where a person was (location: $t(20)=3.08$;$p=.006$) and how appropriate it would be to initiate contact with a person (accessibility: $t(20)=2.84$; $p=.013$) with office users expressing more confidence on both counts.

Group	Privacy	Misleading reciprocity *	Inter-ference *	Self-presentation control	Audience identity	
					Worry	Aware
Cafette	.56 (.38)	.37 (.27)	.58 (.34)	.24 (.35)	.50 (.43)	.18 (.28)
Office	.27 (.22)	.73 (.27)	.24 (.26)	.23 (.31)	.33 (.30)	.24 (.28)

Table 2. Ratings of potential disadvantages (means, standard deviations of the mean) Asterisks denote statistical signficance.

Table 2 summarises responses to questions about potentially problematic aspects of living with CoMedi. The similarity of privacy rating between groups was somewhat surprising, just failing to reach significance ($t(20)=2.01$; $p=.073$). Two items on the questionnaire were intended to expose this factor. We noticed that one asked about the acceptability of sending information on the respondents activities and the other directly about privacy violation. There was good agreement on these two items for the Cafette group (Pearson's $r=.90$) but not for the Office group (Pearson's $r=.20$). This difference may reflect the personal nature of judgements about privacy violation, as discussed by Adams and Sasse. For this reason, only the explicit privacy invasion item contributed to Table 2. Individual differences in the Office group seem to underline the control issues for self-presentation discussed above. Interference, how much CoMedi changed patterns of behaviour, differentiated the groups strongly, with Cafette group equivocating about changes to their patterns of activity whereas Office users responded clearly that their behaviour had been affected ($t(20)=2.60$; $p=.017$).

Uncertainty about "audience awareness" covers two issues. We wanted to know how clearly users felt they knew who could see them and whether, if they did not know, this was worrying. As Table 2 indicates, neither group felt that they really knew who was watching

[1] An asterisk * indicates significant difference between the groups at the .05 level.

[2] Not all respondents chose to rate this item.

but, at the same time, they did not find this uncertainty particularly worrying. The difference between Cafette and Office user ratings did not reach significance. Both of these findings should be interpreted in the context of the observations reported in the previous section. Users routinely positioned cameras so that they were barely visible, or with highly restricted fields of view. This both meant that the images were relatively unrevealing to an observer and uncompromising for the observed. Finally, following up on this point, respondents were asked about their perception of control over self-visibility. Both groups rated themselves as having very limited self-presentation control. Since their level of mechanical control extended to absolute invisibility, this is rather surprising. An interpretation is that the sophistication of control they wanted was far from the level of control they had. Misleading reciprocity describes the confusion between being present to a CoMedi display but invisible for its camera, or person-node discontinuity. The Cafette group, as occasional users, were considerably less concerned about this than the Office group ($t(20)=2.72$; $p=.028$).

4 Discussion

Several issues for UMCE design persisted throughout our period of study, whilst others dropped away with familiarity or the evolution of work-arounds. The flexibility of the physical equipment making up our media space mitigated against great interference in day-to-day activity, although it clearly did happen, whilst early-expressed concerns about being distracted by the presence of a CoMedi seemed to evaporate. The cost of physical manoeuvring may be measured in time and effort: both are mainly in terms of an additional attentional demand. Furthermore, in the Cafette, the transience of occupation and frequency of sensor reconfiguration (i.e. camera movement) meant that the position of the media space camera had to be checked on every visit. For Office users, it was less likely to shift from where it was last placed. Privacy concerns are always complex: they were resolved at least to a level of tolerance for some whilst for others they were never adequately addressed.

4.1 The hybridity of places

Reporting on their own experiences, Dourish et al. (1996) wrote:

"the spaces we have been dealing with are hybrids of the physical and the electronic ... (creating) new spaces, which become distinctive places as sets of appropriate orientations arise within our communities. Our ability to appropriate, transform and reuse space is rooted in the flexible switching which media spaces afford."

Our study is found that flexible switching lead to an unpredictability that is at odds with this account. It is worth re-emphasising the complexity of the Cafette in this respect. We found that the ability to appropriate and reuse was a function of group membership within the community as whole. The ability to appropriate is strictly conditioned by ownership and kind of place; its very sociality. The placeness of the Cafette was heavily ingrained and resistant to change, by virtue of its identity resting in on an idea of sociable comportment among a large number of individuals.

Perception of place is in terms of appropriateness of behaviours and readiness for their expression: clear link exists between what a place stands for and the normed comportment of social groups. It follows that the appropriateness of an individual's self-presentation in the context of a given place is a matter of their evolving perceptions of the norms of place. This is important as placeness owes not only to a physical location but also to its contents, including people and artefacts, and these contents (especially people!) changed in the Cafette on a fairly unpredictable basis and often invisibly to CoMedi users. The mobility of our users within physical space, a motivating factor for the installation of our UMCE, suggests that the placeness of a location is subject to continual adjustment with its occupancy. Indeed, the volatility of certain locations in this regard might itself be thought of as one of the defining

characteristics of our CoMedi study. So the rigidity of place is indivisible from the inertia of expectation on the part of its users. We see this inertia as a function of the number of people who share an understanding of place and also the extent to which expectations are entrenched on the part of particular individuals or groups. Activities across a UMCE begin from pre-existing ideas about its placeness but are then blended with the personalities and 'atmosphere's of switched-in places, as a composite of the behavioural propensities of persons, groups and affordances of the contributing locales.

Self-presentation is a key concept in social identity theory (Tajfel & Turner, 1986). People belong to many groupings, each of which is associated with norms of conduct. In order to maintain in-group identity, one must act within the limits of conduct recognised as appropriate for the group. Importantly, social identity theory posits the existence, and need to actively maintain, multiple identities. For a number of years, Lea and Spears have leveraged social identity theory to study the influence of anonymity on group normative behaviour, so-called deindividuation effects , in text-based communication media (Postmes et al., 1998; Spears et al., in press). They have demonstrated that filtering out interpersonal cues can give rise to more opportunity for the influence of group-level cues for identity and consequently affect group-level processes. In particular, they argue that mediating technologies can exert a very strong influence on the extent to which an individual feels able to express behaviour in line with a particular identity.

It should be understood that expression of identity-relevant behaviour is as much about volunteering information as it is about its withholding. As a minimal UMCE, there are some challenging contradictions between the coupling of CoMedi s linguistic poverty with its intermittent, obscured and low-resolution visual cues and the visually impoverished nature of text-based communication. Although the non-verbal role of appearance is usually associated with posture, gesture and dress (Argyle, 1988), personal effects (family photos, ornaments, sports gear etc.) were included in CoMedi images. These effects were located within distinct zones of physical space, locales understood as appropriate for social self-presentation. An approach to designing self-presentation fluent UMCEs based on social identity theory is perfectly congruent with the Adams and Sasse framework. Whereas Adams and Sasse posit structural similarities between individuals agreement to participation in a UMCE, social identity theory would predict that the structures are in terms of the compatibility of self-presentation norms among concurrently connected social groups. In effect, this means that Adams and Sasse s framework is a very useful but incomplete design tool.

There are some serious problems for the prospect of multiple concurrent connections for this reason. One might imagine a number of views on a space, each optimized to an audience group in terms of self-presentation, based on configuration of technological filters and user-defined locales. Inevitably, there is a practical limit on the number of variables and, still more importantly from a social identity perspective, the transparency of such configurations. Moving aspects of configuration into real space eases matters but does not then give carte blanche for an infinite set of UMCE connections.

In non-technological contexts, the processes for recognizing place are invariably over-learnt and very low effort. For the UMCE designer, the challenge is to create a facility that would allow individuals to build hybrid places at which they are multiply present, based on the physical and cultural reality of the places they objectively inhabit. Only then can individuals properly manage each of their places in terms of their own self-presentation.

4.2 Coping with sensitivity of hybrid places

CoMedi's filters are general, in that once selected they apply to the images displayed on all CoMedi workstations. Self-presentation, including both showing and hiding aspects of self,

may be governed with acceptable limits for some colleagues but be entirely inappropriate for others. Furthermore, the highly transient nature of Cafette occupancy made it difficult for individuals to decide on the criteria for self-presentation. The perception of office space was not subject to the same level of ambiguity. It is here that we return to the idea of place. Place can stand for group-level affiliation and so support the identities associated with them. Although occupancy of the offices in our study was uncertain, the fact that they were offices set usable limits on expectations of the expression of behaviours. Our users seemed to manage their self-presentation by deciding on areas of risk in terms of their behaviour and translating these into constrained locales within their spaces. The locales were then filtered to a level of clarity consummate with the risk of transgressing group norms. Furthermore, the office space was more stable and so more easily controllable for the office users. The space was understood to represent different degrees of risk and this risk could be seen, on a social identity interpretation, to be in terms of potential norm violation or exposure to unwelcome attention from out-group members.

5 Conclusion

UMCE connections explicitly link spaces and implicitly link people. They do this by generating a set of hybrid interaction zones, made up of constellations of people and places. As a design problem, the disambiguation of connections between people and spaces is a very significant. Not only are they fluid but, in the order to fulfil their infrastructural or background design brief, they must maintain a low attentional demand. Critical points for CoMedi seemed to be that there were limited opportunities to tailor self-presentation for different audiences, that partitioning of a physical space into locales of differential sensitivity helped with this process, and that ownership and control could not be satisfactorily resolved in the communal place.

Lee and Girgensohn, describing the issue as "awareness of audience", consider it to be mainly a matter of poor interface supporting for reciprocity, and have proposed some inventive strategies for teasing apart levels of audience in relation to self-presentation (Girgensohn et al., 1999). There is a clear need for mechanisms to support multiple self-presentations via communications technologies. It was clear at the outset of our study that the Cafette was quite explicitly a "place" rather than a space. It was perhaps less clear that the same could be said of offices, and that placeness could be refined to govern the status of locales within offices. We have argued that placeness is intimately related to personal presence and self-presentation, linking the filtering of activity through ad-hoc manipulation of self-image to social identity theory. It may be that effective interpersonal and inter-group connection by UMCE requires attention to intra-space as well as inter-space and technological heterogeneity, grounded in terms of self-presentation. The architectural notion of place suggests that one might design media spaces in terms of the interpersonal and cultural significance of areas within physical spaces. Places must be defined by UMCE users themselves according to the static (appearance) and dynamic (activity-based) forms of self-presentation they wish to project to members of the on-looking community. In this way, individual visibility to a UMCE network would be managed by physical positioning in a local area, rather than through the onerous and cumbersome business of constantly adjusting visibility through manipulations of a camera s global field of view.

Acknowledgements

This work was supported by the European Union 'TACIT' TMR network (contract ERB FMRX CT97 0133) and France T l com. We would like to thank Jo lle Coutaz, Yann Laurillau for technical support and the PRIMA-INRIA group, Montbonnot, France, Lorna

Goulden for discussion of 'place', and all the members of CLIPS-IMAG, Grenoble who participated in this study.

References

Adams, A., & Sasse, M. A. (1999a). Privacy issues in ubiquitous multimedia environments: wake sleeping dogs, or let them lie? In M. A. Sasse & C. Johnson (Eds.), *Human-Computer Interaction - INTERACT'99*. Amsterdam: IOS Press.

Adams, A., & Sasse, M. A. (1999b). Taming the wolf in sheep's clothing: Privacy in multimedia communications, *Proceedings of ACM Multimedia'99* (pp. 101-107). New York: ACM Press.

Argyle, M. (1988). *Bodily Communication* (2nd ed.). London: Methuen.

Bellotti, V. (1997). Design for privacy in multimedia computing and communication environments. In P. E. Agre & M. Rotenberg (Eds.), *Technology and privacy in the new landscape*. Boston, Mass: MIT Press.

Coutaz, J., Berard, F., Carraux, E., Astier, W., & Crowley, J. L. (1999). CoMedi: using computer vision to support awareness and privacy in mediaspaces. In M. G. Williams & M. W. Altom & K. Ehrlich & W. Newman (Eds.), *Proceedings of the CHI99 Conference on Human Factors in Computing Systems*. New York: ACM Press.

Coutaz, J., Berrard, F., Carraux, E., & Crowley, J. (1998). Early experience with the mediaspace CoMedi, *Proceedings of EHCI'98, the IFIP Working Conference on Engineering for Human-Computer Interaction, Heraklion, Crete* (pp. 57-72). Amsterdam: North Holland (see also http://iihm.imag.fr/publs/1998/EHCI98_CoMedi.ps.gz).

Daly-Jones, O., Monk, A. F., & Watts, L. A. (1998). Some advantages of video conferencing over high-quality audio conferencing: fluency and awareness of attentional focus. *International Journal of Human-Computer Studies, 49*(1), 21 - 59.

Dourish, P., Adler, A., Bellotti, V., & Henderson, A. (1996). Your place or mine? Learning from long-term user of audio-video communication. *Computer Supported Cooperative Work, 5*(1), 33-62.

Falk, J., & Bj rk, S. (2000). Privacy and information integrity in wearable computing and ubiquitous computing, *Proceedings of the CHI2000 Conference on Human Factors in Computing Systems* (pp. 177-178). New York: ACM Press.

Fish, R. S., Kraut, R. E., & Chalfonte, B. L. (1990). The VideoWindow System in Informal Communications, *Proceedings of ACM CSCW'90 Conference on Computer-Supported Cooperative Work* (pp. 1-11). New York: ACM Press.

Gaver, W., Sellen, A., Heath, C., & Luff, P. (1993). One is Not Enough: Multiple Views in a Media Space, *Proceedings of ACM INTERCHI'93 Conference on Human Factors in Computing Systems* (pp. 335-341).

Girgensohn, A., Lee, A., & Turner, T. (1999). Being in public and reciprocity: Design for Portholes and user preference. In M. A. Sasse & C. Johnson (Eds.), *Human-Computer Interaction - INTERACT'99* (pp. 458-465): IOS Press.

Harrison, S., & Dourish, P. (1996). Re-place-ing space: the roles of place and space in collaborative systems, *Proceedings of the CSCW'96 Conference on Computer Supported Cooperative Work* (pp. 67-76). New York: ACM Press.

Heath, C., & Luff, P. (1992). *Disembodied conduct: interactional asymmetries in video mediated communication* (Technical report EPC-92-119): Rank Xerox.

Hudson, S. E., & Smith, I. (1996). Techniques for addressing fundamental privacy and disruption tradeoffs in awareness support systems, *Proceedings of the CSCW'96 Conference on Computer Supported Cooperative Work* (pp. 248-257). New York: ACM Press.

Lee, A., Girgensohn, A., & Schlueter, K. (1997). NYNEX Portholes: Initial user reactions and redesign implications, *GROUP 97, International Conference on Supporting Group Work* (pp. 385-394). New York: ACM Press.

Mantei, M. M., Baecker, R. M., Sellen, A. J., Buxton, W. A. S., Milligan, T., & Wellman, B. (1991). Experiences in the Use of a Media Space, *Proceedings of ACM CHI'91 Conference on Human Factors in Computing Systems* (pp. 203-208). New York: ACM Press.

Norberg-Schulz, C. (1980). *Genius loci: towards a phenomenology of architecture*. New York: Rizzoli.

Postmes, T., Spears, R., & Lea, M. (1998). Breaching or building social boundaries? SIDE-effects of computer-mediated communication. *Communication Research, 25*, 689-715.

R¿nby-Pederson, E., & Sokoler, T. (1997). AROMA: abstract representation of presence supporting mutual awareness. In S. Pemberton (Ed.), *Proceedings of ACM CHI'97 Conference on Human Factors in Computing Systems* (pp. 51 - 58). Atlanta, Georgia. USA.: ACM Press.

Singer, A., Hindus, D., Stifelman, L., & White, S. (1999). Tangible progress: less is more in Somewire audio spaces. In M. G. Williams & M. W. Altom & K. Ehrlich & W. Newman (Eds.), *Proceedings of the CHI99 Conference on Human Factors in Computing Systems* (pp. 104-111). New York: ACM Press.

Spears, R., Lea, M., & Postmes, T. (in press). Social psychological theories of computer-mediated communication: social pain or social gain? In H. Giles & W. P. Robinson (Eds.), *The handbook of language and social psychology* (2nd ed.). Chichester: Wiley.

Tajfel, H., & Turner, J. C. (1986). The social identity theory of intergroup behaviour. In S. Worchel & W. G. Austin (Eds.), *Psychology of intergroup relations*. Chicago: Nelson-Hall.

Tang, J. C., & Rua, M. (1994). Montage: Providing Teleproximity for Distributed Groups, *Proceedings of ACM CHI'94 Conference on Human Factors in Computing Systems* (Vol. 2, pp. 201).

Watts, L. A., & Monk, A. F. (1996). Remote assistance: a view of the work AND a view of the face? In M. J. Tauber (Ed.), *Companion proceedings of the CHI'96 conference on Human factors in computing systems: Common Ground* (Vol. Conference Companion, pp. 101 - 102). Vancouver, British Columbia, Canada: ACM Press.

Watts, L. A., & Monk, A. F. (1998). Reasoning about tasks, activity and technology to support collaboration. *Ergonomics, 41*(11), 1583-1606.

Watts, L. A., Monk, A. F., & Daly-Jones, O. (1996). Inter-personal awareness and synchronization: assessing the value of communication technologies. *International Journal of Human-Computer Studies, 44*(6), 849 - 875.

Zhao, Q. A., & Stasko, J. T. (1998). Evaluating image filtering based techniques in media space applications, *Proceedings of the CSCW'98 Conference on Computer Supported Cooperative Work* (pp. 11 - 18). New York: ACM Press.

Managing visibility in ubiquitous multimedia communication environments

Leon Watts & Emmanuel Dubois

Centre for HCI Design,
Department of Computation, U M I S T
PO Box 88, Manchester, M60 1QD, United Kingdom

Telephone: (44) 0161 200 3383
Fax: (44) 0161 200 3324
Email address: leon.watts@co.umist.ac.uk

Equipe IIHM,
CLIPS-IMAG, BP 53,
38041 Grenoble Cedex 9, France

Users of Ubiquitous Multimedia Communications Environments (UMCE), such as media spaces, have to manage a trade-off between gaining some awareness of colleagues' ongoing activities and the risk posed to their own personal privacy by being on permanent display. UMCEs involve pervasive, continuous and heterogeneous connections between people and spaces. In order to learn more about the mechanisms underlying this trade-off, we studied a UMCE in the form of a minimal media space over a period of three months. We interpreted our results with reference to social identity theory, which casts self-identity as a set of affiliations and externally visible association with them. UMCE users themselves would define, configure and occupy places, or locales, within their spaces as a way of achieving a reliable and low-cognitive-effort management of their self-presentation. It may be that effective interpersonal and inter-group connections of this kind require attention to intra-space heterogeneity as well as heterogeneity in inter-space and technological terms. In this way, it would be possible to avoid the attentional demands of adjusting visibility through manipulations of sensor position or continually fiddling with filters. Instead, one may capitalise on a familiar regime of managing self-presentation by creating and then moving into and out of intra-space locales, each associated with a particular set of identities and audiences.

Keywords: media space, ubiquitous computing, multimedia communication environments, social identity theory, place, privacy.

1 Introduction

For nearly a decade, extensive research and development of media spaces has been underway at a number of academic and industrial laboratories (Fish et al., 1990; Heath & Luff, 1992; Lee et al., 1997; Mantei et al., 1991; Tang & Rua, 1994). Media spaces are typically intended to support low-level and low-effort interpersonal awareness among workgroup members. They exist as a surrogate for a physical milieu where building architecture or physical distribution hinder spontaneous and informal interaction. Indeed, this was a major design goal for Fish and Kraut's pioneering work (Fish et al., 1990). The design intention has been to add to the infrastructure of a work place, conveying on an ongoing basis information about who is where and doing what. The distinctive and necessary feature of the media space, in this role, is its continuous operation.

Most media spaces have been video-based although the concept does not in principle require a literal visibility. Interval Research Corporation has been working on an audio-only media space for some years (Singer et al., 1999). A number of media spaces have also honoured the principle of facilitating interaction by including or integrating companion conferencing facilities. Early media spaces, such as Bellcore's VideoWindow and CRUISER,

were based on an analogue of person-to-person face-to-face communication, using point-to-point audio and video connections over a network of media space nodes. To reflect the 'everywhere and always on' nature of the media space, and a continuity with wearable and ubiquitous technologies (Falk & Bj rk, 2000), they are better understood as a class of technologies called Ubiquitous Multimedia Communication Environments (UMCE) (Adams & Sasse, 1999a; Bellotti, 1997).

Dourish et al., reporting several years of personal experience with an office share media space, suggest that the true potential of a media space is given by the generation of a hybrid space out of the local, physical space and image of the distant space (Dourish et al., 1996). They contrast this with multimedia support for isolated interactions. There is some evidence to suggest that seeing the physical aspects of joint activity (manipulating, pointing etc.) or person-in-place, simply offers a different kind of value than that obtained from seeing a person's face (Watts & Monk, 1996). In other words, the value of transmitted images has more to do with their objective information content than in the subtleties of non-verbal communication cues. At the same time, the propensity for the physical locations themselves to affect mediated interactions has become ever more apparent (Dourish et al., 1996; Watts & Monk, 1998). This trend is evident in UMCE development. Emphasis has shifted away from having several targeted views within a persons work space (Gaver et al., 1993) towards a general awareness of one's group via images of activity at various locations (Daly-Jones et al., 1998; Lee et al., 1997; R¿nby-Pederson & Sokoler, 1997).

Figure 1. A typical CoMedi window in use, showing images from nine active nodes.

Despite the fact that much of UMCE research and development has been carried out in commercial laboratories, few of these systems have appeared in the every-day office. The tension between privacy and accessibility seems to be the critical factor. Image filters have been used to safeguard privacy (Hudson & Smith, 1996; Zhao & Stasko, 1998) but seem to be skirting the issue, simply reducing awareness to improve privacy and thereby risking removal

of the benefit. The evolution of NYNEX Portholes is a notable exception, in trying to couple filtering regimes with classes of onlooker (Girgensohn et al., 1999). Indeed "audience awareness", or knowing who are in receipt of personal information, has been argued as one of the cornerstones of privacy maintenance (Adams & Sasse, 1999b). This paper draws upon empirical data to explore the changing ideas behind the UMCE concept, with special reference to the architectural notion of 'place', an account of privacy risk developed by Adams and Sasse, and social identity theory.

The architect Christian Norberg-Schulz defines place as a design concept for architecture, composite of a locality within a physical area and the activities that customarily characterise it. Place defines an atmosphere within which human actions are appropriate or inappropriate, so that the architect s task is to create a culturally and functionally effective facility for people to live in and to use (Norberg-Schulz, 1980). Harrison and Dourish (1996) have argued that the design of collaborative systems need to take account of this space-place distinction by including the role, function, nature and convention of a space when introducing technologies. Adams and Sasse (1999a; 1999b) have developed a multidimensional framework for privacy with reference to UMCE adoption. They note that privacy is an inextricably subjective construct which, nevertheless, shows common structural characteristics between individuals. For example, the sensitivity of a given piece of information is conditioned by its expected recipient, and the acceptability of transmitting information is governed by obtaining prior permission for its transmission. There is hence no absolute privacy status for any particular piece of information: it is always about permission and control over any information on the part of the person to whom it pertains. Social identity theory concerns how people understand themselves in relation to their peers and also how they affiliate and then demonstrate their affiliations to their peers. Lea and Spears have been applied social identity theory to studies of computer-mediated communication and found some marked effects for such media on intra- and inter-group processes. This paper will argue for a connection between place, social identity and UMCE design.

At this laboratory a JAVA-based UMCE, CoMedi, has been under development for some time (Coutaz et al., 1999; Coutaz et al., 1998). In March 1999, a light-weight version of CoMedi was installed in a total of fifteen locations in three physically separated buildings (and across three floors in one of these buildings). Our intention was to examine and extend understanding of the UMCE concept by recording both preconceived ideas of its merits and demerits and then seeing how these attitudes were confronted by real and extended experience. A particular emphasis in our study was placed on the relationship between information in public and private space, and between spaces for work and social space, a distinction that is not always clearly understood (Falk & Bj rk, 2000). We thus report first a set of assumptions within the community about the vital aspects of media spaces, positive and negative, that were expressed just prior to the CoMedi installation. We report an analysis of the use of CoMedi based on day-to-day observations and examination of a diary records, informal discussions with community members and a questionnaire that was intended to bring out some of the themes we felt we had identified during the observational period.

2 The CoMedi media space

CoMedi exists in two forms. One is a fully-functioned concept demonstrator, including computer vision as a tool for image filtering and other technically advanced functions. In its other form, CoMedi is a light-weight Java implementation, allowing robust and fully compatible installations on Silicon Graphics, PC and Macintosh computers. Indeed, all three platforms supported CoMedi nodes during the period of our study.

In the following account, a CoMedi node means a workstation running CoMedi software associated with a single camera, not a particular office. Some offices had two CoMedi nodes. The interface and interaction model is deliberately simple and common to all platforms. Starting a CoMedi node causes the local image to be displayed on the local monitor first and in the same form as it is multicast to other nodes. Following automatic network checking for other nodes, images are added to the CoMedi GUI window, automatically resizing each image pane as a function of the total number of current images. Figure 1 shows a typical CoMedi window, comprising nine panes, each containing an image sent approximately every 5 seconds by a distant CoMedi node. Users may select a particular image and enlarge it with the zoom slider, shown on the right-hand edge of the Figure 1, in which case other images are contracted to compensate.

CoMedi thus provides each connected user with a view of all other locations containing functioning and accessible CoMedi nodes. CoMedi supports a weak visibility-reciprocity principle. Those who can see others via the media space are normally also visible, since connection is automatic on launching the media space unless permission is explicitly refused. All active nodes, whether or not contributing an image to the local node, are included in an audience list that may be displayed from a CoMedi menu. Besides restricting other nodes from displaying their image (filtering who can see by changing access permission), local users can also select one of two software filters to degrade the view of his/her office (filtering what can be seen). Filters once applied affect images for all audiences by:

- providing "venetian blind" style of mask (see Figure 2, bottom left-hand image pane),
- transmitting only a representation of office activity (see Figure 2, bottom right-hand image pane).

Figure 2. Image filters on CoMedi image panes showing (clockwise from top left), local filter, no filter, motion filter and venetian blind filter.

Additionally, CoMedi includes explicit "accessibility" signal in the form of a coloured circle. These are visible in Figure in the top right-hand corner of each pane. Users can choose 'available' (green), 'busy' (yellow) and or 'do not disturb' (red).

3 Community and experience

We carried out a number of complementary data collection exercises in over a three-month period, each building on data gathered to date. In this paper, we focus on observations made by ourselves and diary comments left by the community of users.

3.1 The user community

CoMedi was established within a large French research institute: of the order of 100 people would have experienced it on a fairly regular basis during the study period. It was installed on 15 workstations in research laboratories located in three different buildings. Of these, 14 were situated in offices to be hosted on volunteers' workstations and one in a communal rest and coffee area simply known as the "Cafette". Members of five separate research groups within the institute responded in the written data resources (initial survey, diaries and final questionnaire) although it is likely that some of the comments made in a communal diary were left by people outside the Institute. Relations between members of the community are characterised by cordiality and informality, with much shared social time. In contrast, working practices did not extend to very much shared formal activity between the groups. The group that developed CoMedi formed the largest single response group (contributing about half of all data gathered) and this was split over two floors in one of the buildings. Within this group, working practices involve extensive and continuous interaction on a range of projects.

3.2 Observations of CoMedi in use

The physical deployment of media space technologies is known to be important, whether as a matter of competition for limited amount of 'desktop real-estate', or as a difficulty in arranging camera and position to give an honest view of occupancy/audience (Dourish et al., 1996). We found our users very willing to exploit the physical configuration of camera and monitor to adjust the visibility of themselves and, more critically for the thrust of this paper, their space. In the first place, camera angles were adjusted frequently and seemingly without hesitation. The cameras at all CoMedi nodes were light-weight, compact and had fixed and generous depths and fields of view (with the exception of the Cafette camera, discussed below). This meant that users had a lot of freedom to choose how much of their space (i.e. which of their places) they displayed, at the cost of however much self-visibility they were prepared to tolerate. It is clear that this flexibility meant every user could put a cast-iron guarantee on privacy, simply by keeping their camera pointed away from themselves or other colleagues. In office settings, this was an extremely rare occurrence. Members of the community seemed to settle on a degree of visibility that varied from full-image head-and-shoulders to just profile or 3/4 view occupying a fraction of their CoMedi image (contrast the lower right pane with the upper centre pane in Figure 1).

Secondly, some parts of users' spaces were more sensitive places than others. In Figure 1, three users (top and centre left, centre right) have used strips of clear sticky tape to obscure only part of their spaces, leaving the remainder free for others to see. This became so conventional that we considered it to be part of the official repertoire of image filters (see Figure 2, top left pane). It selectively restricted available information by partitioning the space strictly in terms of the camera's image. Hereafter, this practice shall be referred to as **locale filtering**.

People who adopted locale filters applied them both to their own habitual seating positions, so that they themselves were obscured (although still visible in a degraded form) or to their working areas (notably, obscuring the content of computer screens). People who adopted locale filters tended not to move their cameras: to do so would have changed the filtered place within their space. It seemed that people in offices resolved the privacy-availability trade-off by choosing between the visibility of a restricted subset of their space in a generalised or selective way., where the direction of the camera achieved the former and the locale filters were the mechanism for the latter. Depending on the configuration they arrived at, users could maintain enough presence within CoMedi for other users to determine that they were individually located within the Institute and to some extent how appropriate some contact would be, given current evidence of activity. This evidence of activity could be any or all of interacting with objects, such as components or papers, computers or people.

The central pane in Figure 1 shows an image from the Cafette. The camera was fitted with a lens given a particularly narrow field of view, only showing a small part of the room at a time. This limited the likelihood of any given Cafette user appearing on camera at any moment since more of the Cafette space was out of shot than in shot . Frequently they were people who did not encounter CoMedi in office contexts and also were less familiar with the content and function of the CoMedi display. Furthermore, the Russian roulette of the five-second image update meant that the current image of the Cafette was of limited use for determining what would be shown next. Worse still, if they were captured for the next frame, their image would persist for the next five seconds or so. Several users complained that they lacked confidence in being out of frame, as they desired, and so directed the camera out of the window. The benefit of so doing was seeing an image that was unequivocally not of the Cafette interior (the limbs and leaves of a tree) and so reduced concern about wandering into the camera's field of view without realising it. Users enforced a field of view that did not include any path between, for example, the coffee machine and easy chairs. From the point of view of any other connected office, this had an immediate and catastrophic effect on audience awareness: one could never be sure who was present in the Cafette and consequently who might be 'looking in'. And yet there was no evidence of retaliatory behaviour by office-based users on these occasions.

On several occasions, the directibility of the camera was also capitalised upon to set a welcoming tone for the Cafette. The camera was occasionally pointed at brioche or pizza for all in the building to enjoy, as a general announcement to come and be sociable. The link here between the Cafette as a space and the Cafette as cultural central point for the user community is clear. The community exploited the connection between image from a known space and an atmosphere consistent with the social meaning of that place. There was never an instance of an office user pointing their camera at a pizza, for example, although on one occasion an office user pointed their camera at their white board with an announcement of a particular success.

Every CoMedi pane carried an identification label integrated with the image. By default, this was set to the workstation's network name. However, the label could be reset very simply via a CoMedi menu to a text string. To accommodate longer strings, the display font contracted according to the number of characters used (note differences between top left and top right panes in Figure 1). Users variously displayed their own names, office locations, phone extensions, email addresses or short messages. This underlines the role of CoMedi as a UMCE despite being designed as a minimal awareness tool. It was explicitly used to send interpersonal and intergroup messages, both through the text label and symbolic acts or in combination. The centre pane of Figure 1 was altered to LA BRIOCHE following the use of

the Cafette camera to advertise the presence of this French delicacy on a coffee table there. It is interesting to note that whereas office nodes frequently took individuals' names, this was never true of the Cafette. In so far as personal labelling signifies personal ownership, it highlights an individual-collective dimension to the differences between office and Cafette nodes in parallel with the private-public distinction.

Occasionally, cameras were re-directed to local whiteboards (including in the Cafette) to show messages. These were commonly humorous but included occasionally vitriolic complaints from Cafette users about the CoMedi installation there. Group-level effects were thus in clear evidence in both positive, cohesive and negative, devisive guises. Interestingly, these were relatively rarely matched by comments in the Cafette log. The communal display of upset in this way, within the very medium itself, suggests that the disembodied CoMedi manifestation was identified as an agency in its own right, as opposed to the CoMedi evaluators who would read the book.

3.3 Data from CoMedi users

Log books were kept with each CoMedi installation, including the Cafette, and comments solicited. Notes were also made from informal conversations about CoMedi experiences. Three months following the installation, a formal evaluation was undertaken, including circulation of questionnaires and interpretation of the responses with reference to the other materials.

3.3.1 Informants

Informants were recruited anonymously by email. In addition, copies of the questionnaires were left in the Cafette itself and a URL with a version of the questionnaire was publicised. 26 completed questionnaires were returned, 4 of which were discarded because they were spoiled or the respondents used the Cafette for less than 5 visits per week. The remainder were from people who rated their usage of the Cafette as greater than 20 visits per week, including 14 office + Cafette users and 8 Cafette-only users.

3.3.2 Diaries and Discussions

Seeing an unoccupied space strongly implies that it is empty, but the validity of this inference strictly depends on the camera's field of view. The consequence is that empty images are always untrustworthy. During the observation phase, it seemed that this was be more disturbing for the Office than Cafette only group.

Diaries and informal discussions showed that Office users were initially worried by le sentiment d'etre pi (the feeling of being spied upon) but learnt that the image definition was so low that relatively little could be learnt by remote viewers, at least compared to their original concerns. Visibility and legibility of computer screen content was mentioned several times, for example.

For Adams and Sasse, Information Usage is a strong determinant of the perception of privacy risk. We explicitly stated that we would not be filming from the video feeds to the media space. Even so, residual worries were there for some members of the community. One wrote:

"*at the start, my impression was negative... in fact, taking stock, we weren't really being filmed live as the images that everyone else could see were updated after a certain delay*".

So in two accidental ways, the technical limitations of CoMedi worked to the advantage of Office users by placing a bottleneck on the quality and frequency of information transmission.

Location was a strong and recurrent theme in the diaries and in conversation: knowing just where someone else was so that they could be sought out without wasting a journey. As a

consequence of the degree of mobility within the community, it was often hard to find someone and so CoMedi really did seem to fill a niche - at least for the Office subgroup with members of their own research group also connected. For other Office users, this value was not relevant and several commented on the fact.

The working practices of the community involve a great deal of face-to-face contact inspite of telephones in every room, and a culture where everyone is constantly within email reach. Despite these other communications technologies, several people regretted the lack of a text ping to precede a visit. The implication is the CoMedi fell short of its aim to support accessibility awareness. This is surprising, given the existence of an explicit circular indicator with the CoMedi image panes. However, this indicator was almost never used. It seemed that people just liked CoMedi to be there, available at a glance and that using menus to change status settings a greater cost than the gain of maintaining a proper reflection of their accessibility through this mechanism. The contrast with the menu usage for changing text strings is striking. Accessibility is something that changes as a function of activities orthogonal to a UMCE: an additional effort would be required to harmonise a UMCE indicator in this way that inevitably interfere with the accessibility-moderating activity. Where the UMCE is operating as a low-level awareness device, it cannot require more than low-level or incidental activity to change its state.

3.3.3 Questionnaire

The questionnaire for the second study comprised 33 items on analogue differential scales, made up of issues that had been identified by the community in an intial round of opinion-gathering supplemented by Adams & Sasse s privacy model. These scales offer more subtlety of response than a conventional 7 point Likert scale without adding an appreciable analytic burden and have proven sensitive devices in other studies of mediating technologies (Daly-Jones et al., 1998; Watts et al., 1996). An example of such a scale is given in Figure 3.

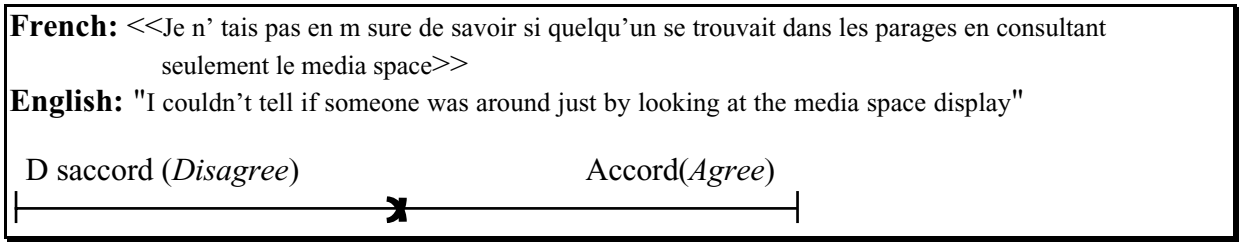

Figure 3: The inverse presence item as an example of the analogue-scale format questionnaire, with English translation, showing a response half way between Disagree and Agree (=0.5 as proportion).

Data presented in this section compare responses in terms of experience group: whether just in the Cafette (Cafette) or in both offices and in the Cafette (Office). In each case a rating figure is given as the mean rating point on the analogue scale, ranging from 0 (very negative rating) to 1 (very positive rating). Thus, mid-scale ratings indicate uncertainty about the issue for the respondents.

Group	Atmosphere	Location *	Presence	Rapprochement	Accessibility *
Cafette	.47 (.41)	.27 (.31)	.20 (.31)	.27 (.19)	.28 (.23)
Office	.48 (.33)	.67 (29)	.36 (.32)	.45 (.28)	.57 (.27)

Table 1. Ratings of potential advantages (mean ratings as a proportion of the analogue scale, standard deviations of the mean). [1]

Table 1 summarises questionnaire data for the mooted benefits of CoMedi. Cafette and Office users were non-committal about the value of CoMedi for the atmosphere at a connected node. Neither group were convinced that CoMedi was much use for telling in a general sense whether a particular person was in the building. Rapprochement, the extent to which intra and intergroup cohesion might improve, seems to contrast the two groups but the difference did not reach significance ($t(17)=1.31$; $p=.207$)[2]. The groups contrast strongly on the ability to tell exactly where a person was (location: $t(20)=3.08$;$p=.006$) and how appropriate it would be to initiate contact with a person (accessibility: $t(20)=2.84$; $p=.013$) with office users expressing more confidence on both counts.

Group	Privacy	Misleading reciprocity *	Inter-ference *	Self-presentation control	Audience identity	
					Worry	Aware
Cafette	.56 (.38)	.37 (.27)	.58 (.34)	.24 (.35)	.50 (.43)	.18 (.28)
Office	.27 (.22)	.73 (.27)	.24 (.26)	.23 (.31)	.33 (.30)	.24 (.28)

Table 2. Ratings of potential disadvantages (means, standard deviations of the mean) Asterisks denote statistical signficance.

Table 2 summarises responses to questions about potentially problematic aspects of living with CoMedi. The similarity of privacy rating between groups was somewhat surprising, just failing to reach significance ($t(20)=2.01$; $p=.073$). Two items on the questionnaire were intended to expose this factor. We noticed that one asked about the acceptability of sending information on the respondents activities and the other directly about privacy violation. There was good agreement on these two items for the Cafette group (Pearson's $r=.90$) but not for the Office group (Pearson's $r=.20$). This difference may reflect the personal nature of judgements about privacy violation, as discussed by Adams and Sasse. For this reason, only the explicit privacy invasion item contributed to Table 2. Individual differences in the Office group seem to underline the control issues for self-presentation discussed above. Interference, how much CoMedi changed patterns of behaviour, differentiated the groups strongly, with Cafette group equivocating about changes to their patterns of activity whereas Office users responded clearly that their behaviour had been affected ($t(20)=2.60$; $p=.017$).

Uncertainty about "audience awareness" covers two issues. We wanted to know how clearly users felt they knew who could see them and whether, if they did not know, this was worrying. As Table 2 indicates, neither group felt that they really knew who was watching

[1] An asterisk * indicates significant difference between the groups at the .05 level.

[2] Not all respondents chose to rate this item.

but, at the same time, they did not find this uncertainty particularly worrying. The difference between Cafette and Office user ratings did not reach significance. Both of these findings should be interpreted in the context of the observations reported in the previous section. Users routinely positioned cameras so that they were barely visible, or with highly restricted fields of view. This both meant that the images were relatively unrevealing to an observer and uncompromising for the observed. Finally, following up on this point, respondents were asked about their perception of control over self-visibility. Both groups rated themselves as having very limited self-presentation control. Since their level of mechanical control extended to absolute invisibility, this is rather surprising. An interpretation is that the sophistication of control they wanted was far from the level of control they had. Misleading reciprocity describes the confusion between being present to a CoMedi display but invisible for its camera, or person-node discontinuity. The Cafette group, as occasional users, were considerably less concerned about this than the Office group ($t(20)=2.72$; $p=.028$).

4 Discussion

Several issues for UMCE design persisted throughout our period of study, whilst others dropped away with familiarity or the evolution of work-arounds. The flexibility of the physical equipment making up our media space mitigated against great interference in day-to-day activity, although it clearly did happen, whilst early-expressed concerns about being distracted by the presence of a CoMedi seemed to evaporate. The cost of physical manoeuvring may be measured in time and effort: both are mainly in terms of an additional attentional demand. Furthermore, in the Cafette, the transience of occupation and frequency of sensor reconfiguration (i.e. camera movement) meant that the position of the media space camera had to be checked on every visit. For Office users, it was less likely to shift from where it was last placed. Privacy concerns are always complex: they were resolved at least to a level of tolerance for some whilst for others they were never adequately addressed.

4.1 The hybridity of places

Reporting on their own experiences, Dourish et al. (1996) wrote:

"the spaces we have been dealing with are hybrids of the physical and the electronic ... (creating) new spaces, which become distinctive places as sets of appropriate orientations arise within our communities. Our ability to appropriate, transform and reuse space is rooted in the flexible switching which media spaces afford."

Our study is found that flexible switching lead to an unpredictability that is at odds with this account. It is worth re-emphasising the complexity of the Cafette in this respect. We found that the ability to appropriate and reuse was a function of group membership within the community as whole. The ability to appropriate is strictly conditioned by ownership and kind of place; its very sociality. The placeness of the Cafette was heavily ingrained and resistant to change, by virtue of its identity resting in on an idea of sociable comportment among a large number of individuals.

Perception of place is in terms of appropriateness of behaviours and readiness for their expression: clear link exists between what a place stands for and the normed comportment of social groups. It follows that the appropriateness of an individual's self-presentation in the context of a given place is a matter of their evolving perceptions of the norms of place. This is important as placeness owes not only to a physical location but also to its contents, including people and artefacts, and these contents (especially people!) changed in the Cafette on a fairly unpredictable basis and often invisibly to CoMedi users. The mobility of our users within physical space, a motivating factor for the installation of our UMCE, suggests that the placeness of a location is subject to continual adjustment with its occupancy. Indeed, the volatility of certain locations in this regard might itself be thought of as one of the defining

characteristics of our CoMedi study. So the rigidity of place is indivisible from the inertia of expectation on the part of its users. We see this inertia as a function of the number of people who share an understanding of place and also the extent to which expectations are entrenched on the part of particular individuals or groups. Activities across a UMCE begin from pre-existing ideas about its placeness but are then blended with the personalities and 'atmosphere's of switched-in places, as a composite of the behavioural propensities of persons, groups and affordances of the contributing locales.

Self-presentation is a key concept in social identity theory (Tajfel & Turner, 1986). People belong to many groupings, each of which is associated with norms of conduct. In order to maintain in-group identity, one must act within the limits of conduct recognised as appropriate for the group. Importantly, social identity theory posits the existence, and need to actively maintain, multiple identities. For a number of years, Lea and Spears have leveraged social identity theory to study the influence of anonymity on group normative behaviour, so-called deindividuation effects , in text-based communication media (Postmes et al., 1998; Spears et al., in press). They have demonstrated that filtering out interpersonal cues can give rise to more opportunity for the influence of group-level cues for identity and consequently affect group-level processes. In particular, they argue that mediating technologies can exert a very strong influence on the extent to which an individual feels able to express behaviour in line with a particular identity.

It should be understood that expression of identity-relevant behaviour is as much about volunteering information as it is about its withholding. As a minimal UMCE, there are some challenging contradictions between the coupling of CoMedi s linguistic poverty with its intermittent, obscured and low-resolution visual cues and the visually impoverished nature of text-based communication. Although the non-verbal role of appearance is usually associated with posture, gesture and dress (Argyle, 1988), personal effects (family photos, ornaments, sports gear etc.) were included in CoMedi images. These effects were located within distinct zones of physical space, locales understood as appropriate for social self-presentation. An approach to designing self-presentation fluent UMCEs based on social identity theory is perfectly congruent with the Adams and Sasse framework. Whereas Adams and Sasse posit structural similarities between individuals agreement to participation in a UMCE, social identity theory would predict that the structures are in terms of the compatibility of self-presentation norms among concurrently connected social groups. In effect, this means that Adams and Sasse s framework is a very useful but incomplete design tool.

There are some serious problems for the prospect of multiple concurrent connections for this reason. One might imagine a number of views on a space, each optimized to an audience group in terms of self-presentation, based on configuration of technological filters and user-defined locales. Inevitably, there is a practical limit on the number of variables and, still more importantly from a social identity perspective, the transparency of such configurations. Moving aspects of configuration into real space eases matters but does not then give carte blanche for an infinite set of UMCE connections.

In non-technological contexts, the processes for recognizing place are invariably over-learnt and very low effort. For the UMCE designer, the challenge is to create a facility that would allow individuals to build hybrid places at which they are multiply present, based on the physical and cultural reality of the places they objectively inhabit. Only then can individuals properly manage each of their places in terms of their own self-presentation.

4.2 Coping with sensitivity of hybrid places

CoMedi's filters are general, in that once selected they apply to the images displayed on all CoMedi workstations. Self-presentation, including both showing and hiding aspects of self,

may be governed with acceptable limits for some colleagues but be entirely inappropriate for others. Furthermore, the highly transient nature of Cafette occupancy made it difficult for individuals to decide on the criteria for self-presentation. The perception of office space was not subject to the same level of ambiguity. It is here that we return to the idea of place. Place can stand for group-level affiliation and so support the identities associated with them. Although occupancy of the offices in our study was uncertain, the fact that they were offices set usable limits on expectations of the expression of behaviours. Our users seemed to manage their self-presentation by deciding on areas of risk in terms of their behaviour and translating these into constrained locales within their spaces. The locales were then filtered to a level of clarity consummate with the risk of transgressing group norms. Furthermore, the office space was more stable and so more easily controllable for the office users. The space was understood to represent different degrees of risk and this risk could be seen, on a social identity interpretation, to be in terms of potential norm violation or exposure to unwelcome attention from out-group members.

5 Conclusion

UMCE connections explicitly link spaces and implicitly link people. They do this by generating a set of hybrid interaction zones, made up of constellations of people and places. As a design problem, the disambiguation of connections between people and spaces is a very significant. Not only are they fluid but, in the order to fulfil their infrastructural or background design brief, they must maintain a low attentional demand. Critical points for CoMedi seemed to be that there were limited opportunities to tailor self-presentation for different audiences, that partitioning of a physical space into locales of differential sensitivity helped with this process, and that ownership and control could not be satisfactorily resolved in the communal place.

Lee and Girgensohn, describing the issue as "awareness of audience", consider it to be mainly a matter of poor interface supporting for reciprocity, and have proposed some inventive strategies for teasing apart levels of audience in relation to self-presentation (Girgensohn et al., 1999). There is a clear need for mechanisms to support multiple self-presentations via communications technologies. It was clear at the outset of our study that the Cafette was quite explicitly a "place" rather than a space. It was perhaps less clear that the same could be said of offices, and that placeness could be refined to govern the status of locales within offices. We have argued that placeness is intimately related to personal presence and self-presentation, linking the filtering of activity through ad-hoc manipulation of self-image to social identity theory. It may be that effective interpersonal and inter-group connection by UMCE requires attention to intra-space as well as inter-space and technological heterogeneity, grounded in terms of self-presentation. The architectural notion of place suggests that one might design media spaces in terms of the interpersonal and cultural significance of areas within physical spaces. Places must be defined by UMCE users themselves according to the static (appearance) and dynamic (activity-based) forms of self-presentation they wish to project to members of the on-looking community. In this way, individual visibility to a UMCE network would be managed by physical positioning in a local area, rather than through the onerous and cumbersome business of constantly adjusting visibility through manipulations of a camera s global field of view.

Acknowledgements

This work was supported by the European Union 'TACIT' TMR network (contract ERB FMRX CT97 0133) and France T l com. We would like to thank Jo lle Coutaz, Yann Laurillau for technical support and the PRIMA-INRIA group, Montbonnot, France, Lorna

Goulden for discussion of 'place', and all the members of CLIPS-IMAG, Grenoble who participated in this study.

References

Adams, A., & Sasse, M. A. (1999a). Privacy issues in ubiquitous multimedia environments: wake sleeping dogs, or let them lie? In M. A. Sasse & C. Johnson (Eds.), *Human-Computer Interaction - INTERACT'99*. Amsterdam: IOS Press.

Adams, A., & Sasse, M. A. (1999b). Taming the wolf in sheep's clothing: Privacy in multimedia communications, *Proceedings of ACM Multimedia'99* (pp. 101-107). New York: ACM Press.

Argyle, M. (1988). *Bodily Communication* (2nd ed.). London: Methuen.

Bellotti, V. (1997). Design for privacy in multimedia computing and communication environments. In P. E. Agre & M. Rotenberg (Eds.), *Technology and privacy in the new landscape*. Boston, Mass: MIT Press.

Coutaz, J., Berard, F., Carraux, E., Astier, W., & Crowley, J. L. (1999). CoMedi: using computer vision to support awareness and privacy in mediaspaces. In M. G. Williams & M. W. Altom & K. Ehrlich & W. Newman (Eds.), *Proceedings of the CHI99 Conference on Human Factors in Computing Systems*. New York: ACM Press.

Coutaz, J., Berrard, F., Carraux, E., & Crowley, J. (1998). Early experience with the mediaspace CoMedi, *Proceedings of EHCI'98, the IFIP Working Conference on Engineering for Human-Computer Interaction, Heraklion, Crete* (pp. 57-72). Amsterdam: North Holland (see also http://iihm.imag.fr/publs/1998/EHCI98_CoMedi.ps.gz).

Daly-Jones, O., Monk, A. F., & Watts, L. A. (1998). Some advantages of video conferencing over high-quality audio conferencing: fluency and awareness of attentional focus. *International Journal of Human-Computer Studies, 49*(1), 21 - 59.

Dourish, P., Adler, A., Bellotti, V., & Henderson, A. (1996). Your place or mine? Learning from long-term user of audio-video communication. *Computer Supported Cooperative Work, 5*(1), 33-62.

Falk, J., & Bj rk, S. (2000). Privacy and information integrity in wearable computing and ubiquitous computing, *Proceedings of the CHI2000 Conference on Human Factors in Computing Systems* (pp. 177-178). New York: ACM Press.

Fish, R. S., Kraut, R. E., & Chalfonte, B. L. (1990). The VideoWindow System in Informal Communications, *Proceedings of ACM CSCW'90 Conference on Computer-Supported Cooperative Work* (pp. 1-11). New York: ACM Press.

Gaver, W., Sellen, A., Heath, C., & Luff, P. (1993). One is Not Enough: Multiple Views in a Media Space, *Proceedings of ACM INTERCHI'93 Conference on Human Factors in Computing Systems* (pp. 335-341).

Girgensohn, A., Lee, A., & Turner, T. (1999). Being in public and reciprocity: Design for Portholes and user preference. In M. A. Sasse & C. Johnson (Eds.), *Human-Computer Interaction - INTERACT'99* (pp. 458-465): IOS Press.

Harrison, S., & Dourish, P. (1996). Re-place-ing space: the roles of place and space in collaborative systems, *Proceedings of the CSCW'96 Conference on Computer Supported Cooperative Work* (pp. 67-76). New York: ACM Press.

Heath, C., & Luff, P. (1992). *Disembodied conduct: interactional asymmetries in video mediated communication* (Technical report EPC-92-119): Rank Xerox.

Hudson, S. E., & Smith, I. (1996). Techniques for addressing fundamental privacy and disruption tradeoffs in awareness support systems, *Proceedings of the CSCW'96 Conference on Computer Supported Cooperative Work* (pp. 248-257). New York: ACM Press.

Lee, A., Girgensohn, A., & Schlueter, K. (1997). NYNEX Portholes: Initial user reactions and redesign implications, *GROUP 97, International Conference on Supporting Group Work* (pp. 385-394). New York: ACM Press.

Mantei, M. M., Baecker, R. M., Sellen, A. J., Buxton, W. A. S., Milligan, T., & Wellman, B. (1991). Experiences in the Use of a Media Space, *Proceedings of ACM CHI'91 Conference on Human Factors in Computing Systems* (pp. 203-208). New York: ACM Press.

Norberg-Schulz, C. (1980). *Genius loci: towards a phenomenology of architecture*. New York: Rizzoli.

Postmes, T., Spears, R., & Lea, M. (1998). Breaching or building social boundaries? SIDE-effects of computer-mediated communication. *Communication Research, 25*, 689-715.

R¿nby-Pederson, E., & Sokoler, T. (1997). AROMA: abstract representation of presence supporting mutual awareness. In S. Pemberton (Ed.), *Proceedings of ACM CHI'97 Conference on Human Factors in Computing Systems* (pp. 51 - 58). Atlanta, Georgia. USA.: ACM Press.

Singer, A., Hindus, D., Stifelman, L., & White, S. (1999). Tangible progress: less is more in Somewire audio spaces. In M. G. Williams & M. W. Altom & K. Ehrlich & W. Newman (Eds.), *Proceedings of the CHI99 Conference on Human Factors in Computing Systems* (pp. 104-111). New York: ACM Press.

Spears, R., Lea, M., & Postmes, T. (in press). Social psychological theories of computer-mediated communication: social pain or social gain? In H. Giles & W. P. Robinson (Eds.), *The handbook of language and social psychology* (2nd ed.). Chichester: Wiley.

Tajfel, H., & Turner, J. C. (1986). The social identity theory of intergroup behaviour. In S. Worchel & W. G. Austin (Eds.), *Psychology of intergroup relations*. Chicago: Nelson-Hall.

Tang, J. C., & Rua, M. (1994). Montage: Providing Teleproximity for Distributed Groups, *Proceedings of ACM CHI'94 Conference on Human Factors in Computing Systems* (Vol. 2, pp. 201).

Watts, L. A., & Monk, A. F. (1996). Remote assistance: a view of the work AND a view of the face? In M. J. Tauber (Ed.), *Companion proceedings of the CHI'96 conference on Human factors in computing systems: Common Ground* (Vol. Conference Companion, pp. 101 - 102). Vancouver, British Columbia, Canada: ACM Press.

Watts, L. A., & Monk, A. F. (1998). Reasoning about tasks, activity and technology to support collaboration. *Ergonomics, 41*(11), 1583-1606.

Watts, L. A., Monk, A. F., & Daly-Jones, O. (1996). Inter-personal awareness and synchronization: assessing the value of communication technologies. *International Journal of Human-Computer Studies, 44*(6), 849 - 875.

Zhao, Q. A., & Stasko, J. T. (1998). Evaluating image filtering based techniques in media space applications, *Proceedings of the CSCW'98 Conference on Computer Supported Cooperative Work* (pp. 11 - 18). New York: ACM Press.