Between Friends: Support of Workgroup Communications

Brian R. Johnson, Design Machine Group, University of Washington, USA

Abstract

The web offers both business and academic users potential benefits from on-line collaboration. On-line education presents universities with a means of handling the "baby boom echo" without expanding physical campuses (Carnevale 2000). Business "extranets" allow greater coordination amongst team members on projects where the cast of players involves experts in different locations. Both involve substituting computer-mediated communications (CMC) for traditionally face-to-face communications.

Over the past several years, the author has deployed several of the available CMC technologies in support of small group interaction in academic and administrative settings. These technologies include email, video conferencing, web publication, web bulletin boards, web databases, mailing lists, and hybrid web BBS/email combinations.

This paper reflects on aspects of embodied human interaction and the affordances of current CMC technology, identifying opportunities for both exploitation and additional development. One important but under-supported aspect of work group behavior is workspace awareness, or peripheral monitoring. The *Compadres* web-based system, which was developed to support workspace awareness among distributed workgroup members, is described.

These findings are relevant to those seeking to create online communities: virtual design studios, community groups, distributed governance organizations, and workgroups formed as parts of virtual offices.

1 Introduction

1.1 A Workgroup Scenario

Members of a design team are at work in their downtown office space. Mary is editing the draft specifications for the latest project using her computer, looking up information in a reference text. John enters and begins working at his desk. Sam enters, moves to John's desk and begins talking. Mary overhears the word "entry" as they speak, at which she approaches John's desk.

Earlier, before John came in, she had looked at the floor plan on his drawing board and was curious about his handling of the entry. Sam turns slightly to include Mary in the conversation as she approaches. John glances up and smiles. The three discuss the entry for some time.

Finally, Mary says, "Ok. We'll do it that way. Now, a while back you said ..." and the conversation veers onto a new topic. Eventually the three decide to go to lunch together. Mary returns to her desk, scribbles "Back at 2" on a Post-It, and sticks it to the front of her monitor. The three go to a nearby pub where they continue the conversation, but at a much higher volume because of the background noise.

1.2 Deconstructing the Scenario

The scenario describes a minor but common type of interaction within an office or design studio work-group. Members, working in proximity to each other, are passively aware, through audio and visual cues, of changes in the workspace without explicit communication attempts. In response to information gathered from this sense of place, they may initiate active communications. They uti-

lize a complex repertoire of task and interpersonal communications skills involving privacy, social distance, topic threading, and body language, skills that are context sensitive.

Can these behaviors be found in a computer-mediated communications (CMC) situation such as a distributed work group, distance education situation, or virtual design studio? Are they supported by the tools available, or hindered?

It is a common observation that distributed workgroups (indeed, all workgroups?) perform better when pre-bonded through face-to-face (f2f) interaction prior to beginning their task. It takes time to associate a "voice" with the way in which an individual writes their email.

What are the fundamental ingredients of this scenario and how are or can they be managed in a computer mediated interaction?

2 Background

It is important to review the common terminology used when discussing interpersonal and group communications in order to fully understand the following discussion. Much of this terminology predates the emergence of CMC, so some nuances relevant to the current discussion are also identified.

An **individual**, a single human being, may join with a knowable set of other individuals to form a **group** (Bass 1974). At any given time an individual may be a member of several groups. Similarly, the membership of a specific group changes from time to time. If they share a common task we might call it a **workgroup**. In order to satisfy the common interest or accomplish the task, they need to communicate with each other.

Interpersonal communication is often described in terms of the "conduit metaphor" (Bogen 1999). When an individual wishes to communicate, they produce an **utterance**. While utterances may take one or more of several forms—verbal, textual, body language, or graphical—this paper will refer to all utterances as *speaking*. If another individual responds to the utterance with an utterance of their own, which the first speaker understands as being related to their utterance, a **conversation** can be said to take place. Face to face conversations follow fairly complex rules or **protocols** for **turn taking,** backtracking and **repair** of the conversational thread (Knapp 1978). It is also possible that more than one **topic thread,** or sequence of related utterances, will be pursued during a single conversation.

The form and content of an utterance on the Internet is influenced by the temporal character of the communication. Face to face communication, with topically focused conversation, provides the model for **synchronous** (at the same time) communication. Written correspondence, with it's greater reliance on formality and context setting, provides the **asynchronous** (at different times) model. The final category found in the scenario above is the expository, or **achronic** (outside time) mode. Books, speeches, and web sites that include no mechanism for engaging the author in conversation, fall into this category.

The form and content of an utterance is also influenced by an awareness of the **social context** of the utterance (Barnlund 1973). This term is used here to refer to the character of the audience who will hear the utterance, ranging from *personal* (shared only with self), to *friend* (shared with one), to *group* (shared with a finite, knowable several), to *public* (shared with an unknowable, possibly infinite multitude).

The social context of an utterance is partly informed by the form and content of the utterance (shouts in a library are almost always of public scope) and partly informed by **workspace awareness,** an awareness of the presence and activities of others (Dourish, 1999; McGrath and Munro 1999), drawn from a mixture of direct observation and environmental cues (after closing, a pair of janitors might well shout to one another in a library while carrying on a personal conversation).

Workspace awareness, what Goffman calls "unfocused interaction" (Goffman 1963), is the mechanism through which individuals maintain an understanding of their surroundings, often without explicit thought. By monitoring disturbances caused by persons in our local environment, such as voices, shuffling feet, chair squeaks, keyboard and mouse clicks, and so on, we maintain a map of who is near us. Coupled with other considerations, the workspace awareness allows us to shift our active attention to events of importance, such as the arrival of a particular colleague, flirtation partner, etc.

Workspace awareness includes a variably detailed sense of the activities of others in the group. This may be gathered from knowledge of formal group responsibilities, and by overheard conversations (eavesdropping), desktop overview (looking at documents left open on a colleague's desktop), circulation of draft documents, meeting reports, etc.

The importance assigned to eavesdropping in the educational setting can be seen in policies such as that used in the first design studio course at University of Washington. Personal sound systems, even with headphones, are not permitted during studio hours and students are encouraged to listen-in on the desk crits of their peers, and even join in if appropriate (Ching et al. 1999).

Significant effort has been invested in research concerning face-to-face interaction, interpersonal communication in groups, and so on. Research into CMC social organizations, communications, and social mores is more limited and has tended to focus on casual associations such as those found in MUDs (multi-user dungeons) (Turkle 1995). Recent research in the field of Computer Supported Co-operative Work (CSCW) has demonstrated the value of workspace awareness in terms of enhanced task performance and worker attitude (Gutwin and Greenberg 1999).

Individuals do not always speak out the moment they establish a need to communicate. They may **queue** the utterance for a time when the social context better matches the content ("I'll tell you when we get home") or the form ("I wanted to tell you face to face."). They may also queue it for **refinement**, wishing to make the utterance more communicative in some way. Examples of refinement include polishing a poem for a heartthrob or a paper for publication.

2.1 The Scenario Reconsidered

Mary is working in semi-privacy, available to her group but not to the larger public. The document she is working on (the specifications) is private to her work-area at the moment and undergoing change, though she will accept and seek input from others within the workgroup. When the scene opens she is utilizing a reference document, which is assumed to change infrequently. She is able to observe the work on John's desk without violating social norms, though it remains a "read only" document, and she is able to passively monitor the conversation between John and Sam. That conversation is being conducted within the group's social context, though there are only two group members participating initially. Mary deduces this from the subject, and conversational volume. She approaches. Their awareness of her proximity, and their acceptance is signaled by their body language. The three participants continue on the same topic thread, and then backtrack to an earlier branch at Mary's request. The work task is suspended while they discuss lunch. When the lunch decision is made, Mary takes a moment to post a note in case someone comes looking for her at her desk (a group-context and group-maintenance communication). When the three arrive at the public domain of the pub, they find that they must employ much louder voices in order to carry on their conversation, but though they are almost shouting, they can still be said to be carrying on a group-scope discussion due to the background noise levels of the pub and the minimal likelihood of an eavesdropper caring about their subject.

There are several benefits that Mary's workspace awareness is able to provide. Mary is able to monitor the group's presence while working, probably without looking up from her work. By lightly eavesdropping on the conversation between John and Sam, she is able to identify an appropriate time in which to engage both of them in a discussion of a topic relevant to her task. Without workspace awareness she would have to invest more time in active monitoring (perhaps calling John and Sam every 10 minutes or so in order to set up a meeting), postpone or forego the desired communication (possibly requiring a more extensive rewrite later), or implement it through an alternative strategy (perhaps a "call me" Post-It on John's drawing).

3 Mapping CMC Tools to the Scenario

Computer Mediated Communication (CMC) technologies are many and varied and actually include many overlapping paradigms. Those shown in Table 1 have been organized according to the primary temporal domain and social scope within which their use makes sense. The table includes contact managers, calendars, electronic mail, web pages, videoconferences, chat rooms, bulletin boards, and web cams. Some (e.g., email and video conferencing) primarily support point to point communications linking two individuals, while others (e.g., chat rooms) support small groups, and some (web pages) are essentially public broadcast mechanisms rather than two-way communications.

These technologies are designed to enhance communication between individuals, where communi-

cation is the primary goal. Information access and data sharing while running programs where the primary goal is data editing, such as CAD and word processing, are other important areas of workgroup function. However, network file systems, ftp servers and clients, and http file uploads, are not addressed in this paper.

4 CMC Technologies and Small Groups

Table 1 categorizes technologies according to the social context and temporal conditions in which they are deployed. Clearly there are tools available for practically any combination of social context and interaction condition. Unfortunately, the number of separate applications and interfaces, as well as the weak penetration of standards in some areas, means that few users move fluidly among these many applications, or keep applications open against the modest chance that a colleague or coworker will need to make a connection. Instead, one mode of communication, often email, is used to orchestrate use of the others. That is, users derive their workspace awareness from their inbox.

	Social Context			
	Self, 1:0	Friend, 1:1	Group, 1:N	Public: 1:infinity
Achronous	Local file system	Sent-mail archives	Archives (email and Web BBS)	Web publications
Asynchronous	Calendars, to-do lists	Email	Email list Web BBS	Web BBs
Synchronous	Contact management, bookmarks, text editors	Email, chat, videoconference, whiteboard	Chat, whiteboard, Web BBS	WebCam

Table 1. CMC Tools Mapped to Temporal Domain and Social Context

The hypothesis, which this paper presents, is that one of the important requirements as yet unaddressed by the tools available in workgroup CMC is passive workspace awareness. In preparation for describing the prototype system developed to test this theory, let us consider some of the existing tools in terms of the workgroup communications issues discussed above.

4.1 Chat and Email

Face to face communications, by their very nature, involve participants in a synchronous process. When a CMC system is inserted into a communication situation the technology may require perceptible time to pass utterances between the participants. In spite of this, if all parties to an exchange are willing to maintain focus on the exchange for its duration, we may still call it synchronous, or *conversational* communications.

Communications that involve an appreciable delay between individual utterances, such that attention wanders or is directed elsewhere while waiting for the response, fall into the category of asynchronous exchange, or *correspondence*. This category includes both traditional letter writing and email. In such situations the topic thread is more readily lost, so email users frequently include copies of the mail to which they are replying.

Achronic, or *expository* communications are one-sided utterances not intended to be part of a conversation, such as books, static web pages, and archival data. As such, issues of response time, awareness, and so on are of much less importance, though the information accessed might still be important.

While physical reality is truly synchronous, few CMC systems are. Chat systems usually distribute your utterances only *after* you hit the enter key. We characterize such systems as synchronous in part because participants generally must be connected at the same time in order to follow the conversation. By that measure, two people on a fast network connection can carry out a fairly synchronous conversation via standard email software and careful turn taking. On the other hand, email becomes completely chaotic as a means of synchronous exchange for a group of people because there is no good turn-taking protocol and conversational continuity (threading) breaks down because separate simultaneous replies to a single email cannot be readily quoted in a subsequent reply, and the vagaries of email distribution sometime deliver a reply before the mail that sparked it.

This had led the author and others to the conclusion that discussions carried out via email, must be expected to operate on *slow time* (Tu 2000). That is, you must allocate extra clock time in order to conduct the same discussion, even when participants are actively engaged.

4.2 Web Bulletin Boards

The author, and others, have deployed bulletin board systems in support of various projects, often to find them wholly or largely ignored by the intended beneficiaries. One reason for this is that it is almost impossible to passively monitor a “conversation” on a web board. Users must actively call up

the relevant URLs in order to detect activity. On a low-volume board, this will not often be rewarding. Further, because of the perceived permanence of web BBS utterances, and confusion or ambiguity regarding the social context of the board, utterances are often queued for refinement, and finally abandoned.

Hybrid systems, employing a web bulletin board to maintain the conversational thread(s) and email to distribute new utterances (postings), has remedied some of these problems. Required utilization of the system can break down barriers relative to social context and permanence through familiarity.

4.3 CMC Dangers

Some writers are generally concerned about 'disembodied' communications technologies (Lakaff 1995). Certainly, when we employ voice, body language and written words to communicate with our self or with others, we select communication content and adjust the form depending on who is "in range" of the communication. That is, we tag content according to its appropriate social context and are constantly aware of the anticipated *social context* of the communication, and favor certain forms over others.

When we employ CMC the communication process is divided into stages, creation of the communication message (or "utterance"), and reception. We continue to use a model of the social context, based on our understanding of the intervening technology, but the technology often introduces opportunities for a mismatch to arise between the anticipated and realized scope.

Our understanding of the CMC technology influences the content and form of the utterance. For example, we may be quite comfortable with the use of a video camera to record a family gathering in our home for viewing by a distant family member, but be revolted at the idea of someone mounting a web cam in his or her home. While a camera is present in both cases, the social context of the utterance is entirely different.

Changes in the context, form or content of an utterance can have a large impact on its meaning. While we might object to having our activities filmed by an unknown videographer, actors and actresses perform for the camera with the intention of public viewing. Elevated environmental noise causes us to raise our voices, even when conducting a "whispered" conversation. It is embarrassing when the noise level drops suddenly and the "private" utterance becomes public. Most email users have witnessed, if not experienced, the difference between "reply-all" and "reply" when participating on an email list.

In addition, while we may sit in privacy to compose and read our email, we recognize that it has a different legal status than handwritten correspondence and that it may reside in someone else's email system for years, subject to accidental or malicious disclosure.

For these reasons even individuals with access to CMC often conduct sensitive communications via telephone, or face-to-face, where the chance of a surprise change in social context is unlikely (though not impossible, as Monica Lewinski discovered after talking to Linda Tripp!).

4.4 Web cams, Anonymity, and Voyeurism

Email and chat, those CMC systems that most directly support group communications, both provide some persistent sense of presence. Email systems display not only the name of the message source, but also who else received it. MUDs and chat systems often require users to log in, registering their screen name, and displaying a list of those "present" for all participants to use. Web BBS systems often permit the user to attach any name they wish to a posting. This has lead to rampant identity experimentation, and study of the same (Turkle 1995).

Physical environments offer fewer opportunities to masquerade, and fewer opportunities to present illusory personae. The lack of persistent, verifiable identity, while certainly a problem in public environments, should not be a challenge in workgroup environments, where access can be controlled and identity verified reasonably carefully.

Technologies that offer their users no workspace awareness can actively interfere with their use. I have an occasional web cam mounted on my monitor, a window at my side, and a glass panel in my office door. Each offers the potential for public intrusion into my office, but because it is impossible to tell when the web cam is being monitored, and by whom, that technology is the most uncertain. Even if I become aware of an observer, the medium lacks the symmetry of the glass door, where I can look out and see who is looking in.

5 The Compadres Workgroup System

As indicated in the "Group" column of Table 1, there is support available for basic asynchronous communication through mailing list software, and support for synchronous communications through chat applications. However, neither of these supports such aspects of workspace awareness as passive display/review, or peripheral monitoring of group "lurkers" (group members who are present, but not communicating). Neither do they present a single interface for both asynchronous and synchronous communications.

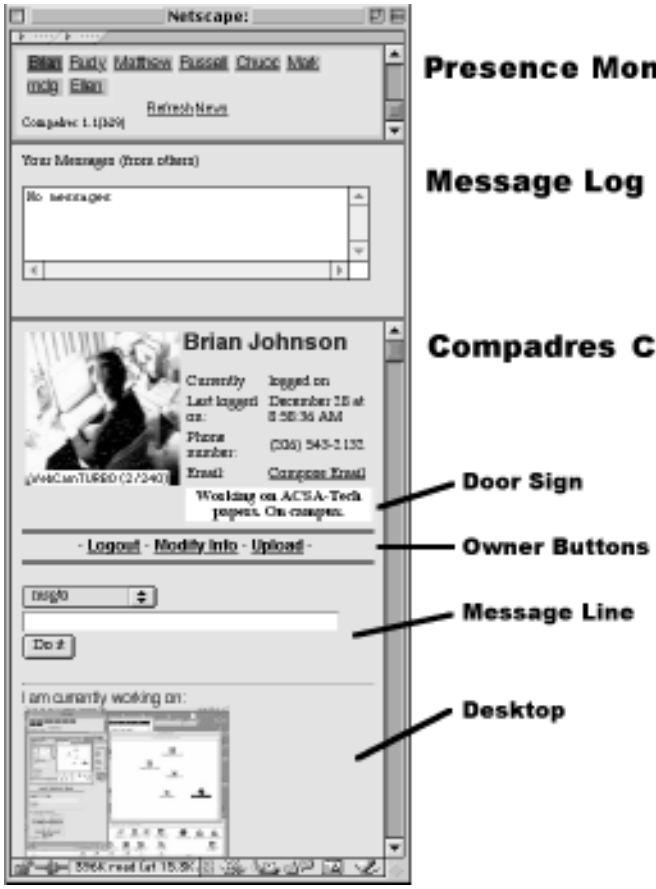

Figure 1. The Compadres workgroup console, showing the presence monitor (top) and a member's cubicle (bottom).

Obviously, none of the widely available CMC tools are truly passive. After all, they are programs that you run when you want to communicate! The most passive component of computing *per se* is probably the operating system, but few of us have access to developing applications at this level. The next most common application, and one which includes significant communications capabilities, might well be the web browser.

The **Compadres** workgroup system, illustrated in Figure 1, was developed to address the need for a shared group workspace, with individually customizable personal work areas, or desktops. These features provide a passive presence monitor, opportunity to display and review work-in-progress, and a unified interface to a variety of traditional CMC tools. Individuals, called *compadres* join a workgroup, or *cadre,* of co-workers.

Built on http tools, the Compadres console takes up minimal screen space, but provides both a group presence monitor and individually customizable personal data pages through which users may observe and communicate.

5.1 Presence Monitor: Cadre Membership and Connection Status Buttons

After a compadre (user) logs on, the console is displayed. It consists of three frames. The top frame of the console provides the workspace monitor for their cadre (group). It presents the names of each member of the cadre, with colored backgrounds indicating whether they are connected or not (red for no, green for yes). This frame is automatically refreshed at regular intervals using an HTML META refresh tag, so the user need take no action to become aware of a co-worker's "arrival".

5.2 Message Log and Communications Console

The middle frame of the console displays messages, provides access to the group level communications, and owner (personal) actions such as desktop modification, a file upload option, and logging out.

5.3 Compadres Cubicles: Personal Data Pages

Each user has a personal data page, or cubicle. These are displayed in the bottom frame of the console when the user clicks on the related name button in the presence monitor. The cubicle displays certain standard information, and provides the owner with options for the display of other information. It is also the channel through which others in the work group contact the individual.

Fixed data includes: time and date of last log-on, and a one-line messaging form for jotting quick notes to the owner. Variable data can only be modified by the page owner. Fields include an HTML <IMG> link to a personal graphic (usually a portrait), editable first and last name fields (separate from the permanent logon ID/PW), phone number, and email address. An easily modified "Door

Sign" provides the equivalent of Mary's quick Post-It note. Finally, an <IMG> link, coupled to an HREF link, provides a means of passive overview, by linking the visitor to the owner's most recent work.

The "Message Line" is not meant to replace email, chat, or face-to-face communications (when available), but it does provide a quick, means of asking simple questions, arranging for face-to-face discussion, etc. Messages to the individual are queued in the Compadres database until the next time their presence monitor is updated (which might be only a matter of seconds). At that time the message is embedded in a JavaScript ALERT and included in the cadre monitor page. This brings it to the active attention of the user, even if the browser window has been buried by other application windows.

6 Implementation

Compadres is currently implemented as an Applescript Common Gateway Interface (CGI) application running on a Macintosh web server with a FileMaker Pro database for compadres and cadre data.

6.1 Database Schema

Figure 2 shows the Compadres database schema in a schematic form and illustrates the connection between the cadre and compadres data. A database calculation field collects the individual "logged-in/logged-out" status button fields, which are calculated from the status field, and passes a complete HTML table to the CGI with just a single database access. By caching this table between changes in the numbers of connected users, the CGI makes updating the presence monitor a relatively quick process.

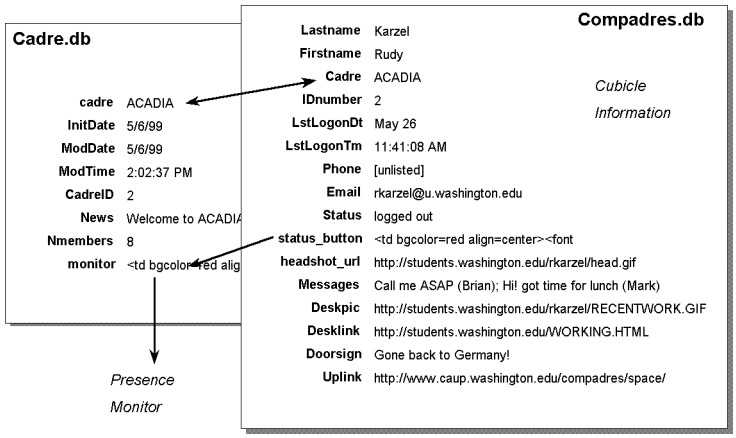

Figure 2. The Compadres database schema.

Access to the system is gained through a standard HTML form, with the username and password data being submitted to the Compadres CGI for verification. During login, the Compadres CGI sets the user's status in the database as well as recording the user's IP number and starting a countdown timer in a run-time database.

System functions, including the presence monitor, happen through varying invocations of the CGI. Each query is tested to make sure it originates from a known (trusted) IP number, giving the cadre it's privacy, and refresh queries from trusted IP numbers renew the user's countdown timer in the CGI's database. If the timer expires, the CGI automatically logs them out. Thus, while not immediate, closing the console window is equivalent to logging out.

6.2 The use of Live Feeds

Two interesting pieces of supplemental software, WebCamToo and WebCamTurbo, are currently available for the Macintosh platform and offer some particular insights into how a more mature version of this system may operate (Paperjet 2000). Both are HTTP servers in their own rights. Both stream images. One uses a camera such as the Logitech QuickCam as the data source. The other uses the computer's screen buffer as the source, streaming a full or reduced-size image of the host computer's desktop (including open application windows, etc.).

By running these applications in the background on a Compadre's desktop computer, and properly adjusting the "portrait" and "desktop" URLs in the Compadres database, other members of the workgroup can literally monitor, in real time, the activities of the group member running the software, both by looking *at* their screen and by (in a sense) looking *from* their screen. The existence and use of such tools radically transforms the nature of your "personal" computer. Fortunately, in the interest of privacy, it is possible to adjust the size of the streamed image, so that a somewhat abstract representation is broadcast. Still additional controls and feedback mechanisms are desirable (knowing who is watching, etc.)

7 Discussion of Results

7.1 User Feedback

Compadres has been used experimentally as part of two traditional courses in web content development. Students were encouraged to use the system, but were not required to, and had ready access to

face-to-face communications as a fallback. After using the system for a few days, they were asked to provide feedback. Table 2 shows some of the comments received.

Informal verbal suggestions for improvement included a more chat-like messaging service, and multiple-recipient messaging options. While some of these would require a different (non http) support base, others represent fairly minor modifications and are being explored for the next generation.

7.2 Opportunities for further development

Within the Compadres system, further development is focusing on enhancing message management, group message broadcasts, logging of messages, and configurable forwarding of messages via email. We are also looking at the use of non-screen cues (sound, environmental lighting, etc) as a means of presenting the presence data.

Student #1	"Works as well as any other instant messaging service." "A great feature is having the person's picture and bio on the page" "It would have been nice to have a place to archive messages, " "I [found] it annoying that any messages that [were] sent to you offline pop up instantly as you log in"
Student #2	"I think compadres works very well "
Student #3	"compadres ... is a wonderfull communication tool. I believe the two things i most appreciated were including the picture of the person you are talking to and the 'connected/disconnected' green buttons." "You could enable a 'history of messages received'"

Table 2. Comments from student users of Compadres.

Provision of personal workspaces is probably not necessary. The degree of privacy and separation of work that is provided by the typical personal computer file system seems adequate. As with individual communications mechanisms, the development of shared group workspace's, with managed circulation of files, so you know who has which file, would be a vast improvement over sharing of networked virtual disks, shared ftp server access, and so on. Existing tools, such as source-code management systems may be suitable for this task.

It would be interesting to explore the potential of interfaces in which increasing social proximity was explicitly displayed, monitored, and possibly rebuffed and where it might be possible to monitor the form, but not the content of a workgroup communication (e.g., where a user might detect that Mary is talking to John, but not what they are saying unless invited to join the conversation). Similarly automated eavesdropping through interest matching or communications monitoring ("Who is working on the entry?" or "Mary is talking to John about the entry") might offer opportunities for development.

7.3 Conclusions

Application of results from research on human-to-human interaction in small groups is useful in understanding the observed behaviors of users in computer mediated communications situations. While there are many CMC tools available, they generally lack adequate feedback to maintain workspace awareness, and do not support passive overview or informal monitoring of group activity. Initial response to the Compadres system, which blends different web-based communications systems, suggests that use of a communications console that offers workspace awareness can significantly enhance the group members' sense of participation. Issues related to management of privacy, social proximity, and automated eavesdropping remain.

8 Summary

There are numerous applications that support communication between individuals and within small and large groups in both the synchronous and asynchronous temporal domains. However, few of these presently support both synchronous and asynchronous workgroup presence monitoring and messaging in a unified interface. The Compadres system developed at the University of Washington represents one approach to such a system, providing a consistent group "workspace" with passive group presence monitoring, personalized "desks", support for different levels of intragroup communications, and simple messaging.

References

Barnlund, D. C. (1973). Introduction: Interpersonal Communication. In *Communicating Interpersonally: a reader*, eds. R. Pace, B. Peterson and T. Radcliffe. Columbus: Charles E. Merrill Publishing Co., pp 4-11.

Bass, B. (1974). The Definition of "Group". In *Small Group Communication: a reader*, eds. R. Cathcart and L. Samovar. Dubuque, Iowa: Wm. C. Brown Company, pp 19-27.

Bogen, D. (1999). *Order Without Rules: critical theory and the logic of conversation*. Albany: State University of New York Press.

Carnevale, D. (2000). "New Master Plan in Washington State Calls for More Online Instruction" in *The Chronicle of Higher Education*, vol XLVI, #22, February, 2000, p A50.

Ching, F., S. Hampden, B. Johnson, P. Maulden, J. Swain, D. Zuberbuhler (1999) Course Syllabus, University of Washington, Architecture 300, Autumn 1999, p 7.

Dourish, P. (1999). Where the Footprints Lead: Tracking down other roles for social navigation. In *Social Navigation of Information Space*, eds. A. Munro, K. Höök and D Benyon. London: Springer-Verlag, pp 15-34.

Goffman, E. *Behavior in Public Places*, The Free Press of Glencoe, 1963.

Gutwin, C. and S. Greenberg. (1999). The Effects of Workgroup Awareness Support on the Usability of Real-Time Distributed Groupware. In *ACM Transactions on Computer-Human Interaction*, v **6**, # 3, pp 243-281.

Knapp, M L. (1978). *Nonverbal Communication in Human Interaction*. New York: Holt, Rinehart and Winston, p 353.

Lakoff, G. (interviewed by I.A. Boal) (1995). Body Brain and Communication. In *Resisting the Virtual Life: the culture and politics of information*, eds. J Brook and I.A. Boal, City Lights Books, pp 115-130.

McGrath, A, & A Munro. (1999). Footsteps from the Garden - Arcadian Knowledge Spaces. In *Social Navigation of Information Space*, eds. A. Munro, K. Höök and D Benyon. London: Springer-Verlag, pp 253-278.

Paperjet. WebCamToo & WebCamTurbo web site. <http://webcam.paperjet.com/>

Tu, C.H. (1999). Critical examination of factors affecting interaction on CMC. In *Journal of Network and Computer Applications*, **23**, 39-58.

Turkle, S. (1995). *Life on the Screen: identity in the age of the Internet*. New York: Simon & Shuster.