



INFORMAL WORKPLACE COMMUNICATION: WHAT IS IT LIKE AND HOW MIGHT WE SUPPORT IT?

Steve Whittaker*, David Frohlich and Owen Daly-Jones†

Office Appliances Dept.

Hewlett-Packard Laboratories

Filton Road, Bristol, BS12 6QZ, UK.

steve_whittaker@crd.lotus.com, dmf@hplb.hpl.hp.com, odj@hplb.hpl.hp.com

ABSTRACT

We present new findings about the nature of informal communications, derived from a naturalistic study of people's everyday working activities. We identify why such interactions are so common, and valuable and how they are achieved in the workplace. We also address weaknesses in current systems that support such interactions remotely and identify further requirements for better support. We also discuss the implications of this work for conversational theories.

KEYWORDS: Informal communication, audio, video, CSCW, workplace activity, ethnography.

THE NATURE AND IMPORTANCE OF INFORMAL COMMUNICATIONS

Informal communications we define as taking place synchronously in face-to-face settings. They are distinct from other methods of office communication such as phone, documents, memos, email, FAX and voicemail. For most office workers, informal communication is a frequent workplace activity and for many jobs such as management it represents *the* most frequent workplace activity. Questionnaire data produce estimates of between 25% and 70% of time being spent in face-to-face interaction, with these figures depending on job type[8, 12, 14].

What then is the nature and function of informal communication? One of the few observational studies, showed it to be brief, unplanned, and frequent[8]. Informal communication supports a number of different functions: the execution of work-related tasks; co-ordination of group activity; transmission of office culture; and social functions such as team building[5, 8]. Its importance is shown by research into scientific collaboration demonstrating that physical distance is a strong predictor of whether scientists will co-publish, because

*Now at Lotus Development Corporation, 1 Rogers St., Cambridge, MA 02142

†Also at Dept. of Psychology, U. of York, York YO1 5DD, UK. odj1@york.uk.ac

Permission to copy without fee all or part of this material is granted provided that the copies are not made or distributed for direct commercial advantage, the ACM copyright notice and the title of the publication and its date appear, and notice is given that copying is by permission of the Association for Computing Machinery. To copy otherwise, or to republish, requires a fee and/or specific permission.

CHI94-4/94 Boston, Massachusetts USA

© 1994 ACM 0-89791-650-6/94/0131...\$3.50

people who are physically collocated are more likely to communicate frequently and informally. Questionnaire studies also suggest that physical proximity supports frequent opportunistic conversations which are vital to the planning and definitional phases of projects[7]. Other questionnaire studies support the effects of proximity and hence informal communications on social and cultural knowledge: Researchers are more likely to be familiar with, and to respect the work of colleagues who sit close to them[8].

This work indicates that physical proximity is crucial for informal communication, but trends towards telework, mobile work and the globalisation of business are geographically separating workers. Given its importance, what systems have been built to support informal interaction at distance? In contrast to other methods of remote communication, informal interactions are poorly supported by technology[8]. The two main types of prototype system that have been built both involve synchronous audio and video. The first provides a permanently open link between the common areas of two geographically separated sites, with the aim of facilitating unplanned conversations between workers at the two locations[3, 4]. Commons area connections have been moderately successful in promoting brief social interactions, with 70% of the Xerox Portland link conversations being short remote "drop-ins" in which greetings are exchanged[1]. Although these interactions would not have occurred without the link, the general conclusion was that while the link was "barely adequate to promote shared context and culture" it was "insufficient for accomplishing tasks (p51)"[5]. Bellcore's Videowindow generated similar conclusions, with unplanned interactions between remote sites also occurring over the link. However there was evidence that briefly seeing someone over the videolink was less likely to promote an extended interaction, than an equivalent face-to-face sighting[4].

The second class of system for remote informal communications involves Desktop video, either point-to-point[5] or between multiple locations [9]. Some of these systems provide additional visual information about the communication status of the call recipient, using a "glance" feature. Here callers can check the availability of their recipient, by opening a visual link for a few seconds, prior to initiating the conversation. An evaluation of one such system showed, however, that it does not effectively replicate face-to-face interaction[5]. The system was rated as closer to the phone than face-to-face in-



teraction, and less useful than face-to-face for doing work or learning about their conversational partner. Furthermore, an attempt to duplicate the process of opportunistically "bumping into" someone in the corridor, which was implemented by arbitrarily connecting two users was highly unsuccessful with 97% of such links being terminated immediately[5]. One positive result, however, was that people always chose to use videophone over phone alone. Another study found that Desktop videoconferencing partially replaced the use of other media such as email or brief face-to-face meetings. It also increased the use of Shared Workspaces and was also perceived to reduce phone use[17].

Informal communications also raise numerous questions for interaction theories. Informal conversations are mainly opportunistic, so how do participants co-ordinate and initiate them, given that they are unanticipated? There are also often time lags between informal interactions: how do people maintain and re-establish context, given such lags? Finally, informal communications often occur between frequent interactants who often share large amounts of background knowledge. What affect does this shared knowledge have on initiating conversations and managing conversation context?

We provide data on the **basic properties** of informal communications such as their frequency, duration, whether they are pre-arranged, and the role of documents in such interactions. For interactions away from desk, we also look at where they occurred. Next we look at their **structural properties**, examining how conversations are opened and closed and the ways that participants introduce and agree on conversation context. We also test predictions about frequency: frequent interactants should share background context as well as being familiar with each other. We therefore expected frequent interactants to show less formality in opening and closing interactions as well as reduced need for context setting.

METHOD

Many previous studies of workplace communication have relied on self-report techniques such as interviews, diaries and questionnaires[12]. Unfortunately these methods are found to be extremely inaccurate when reported estimates of activity have been compared with actual activity measures[12]. More recent observational studies of workplaces have begun to provide a more accurate picture of communication behaviour, usually by audio or video recording of activity within a single medium such as face-to-face meetings[11, 16], videoconferences[10], or a single setting such as control rooms[15]. The main problem with these studies, however, is that they do not allow an analysis of the evolution of longer term communication patterns across media and settings.

To overcome these problems, we developed a new method of workplace observation called "remote shadowing" in which we tracked and recorded the activities of individual office workers in the absence of an observer. We used a portable Sony camcorder (CCD-TR303E), with a wide angle lens and a radio microphone receiver, fixed in the corner of each subject's office. Participants wore a radio microphone transmitter which captured all their spoken conversations around the office site, even when they were out of camera shot. Whenever possible, arrangements were made to move the camcorder to

off-site locations and to special meeting rooms on-site when communication happened there, but for the majority of out of office communications, we have only audio data. Copies of written correspondence were also obtained, together with notes made in visually recorded meetings. Brief discussions about work practice also took place every day between observer and participant.

We recorded a full working week for both participants, excluding lunch hours, and confidential meetings. An inherent limitation of our method is that it produces huge amounts of video and audio data, which are time-consuming to process and analyse. We therefore have only two main participants in the study, but this is compensated for by the fact that they talked to 97 other people, in a total of 294 different synchronous interactions. We started with a total of 55 hours of original recordings, for both participants combined. After we excluded confidential data, interviews, solitary activity and equipment failure there were 29 hours of conversational data.

The first participant B., is Communications Manager for an industrial research laboratory. She manages public relations and marketing communication, and facilitates collaboration between research and manufacturing. She is often away from her desk interacting with others mainly on site. During the target week she was engaged in four main activities; organising a Lab visit involving 20 internal and external people, identifying the marketing and communication requirements for a research project, organising a press conference, and planning a communications strategy presentation.

The second participant, R., is a surveyor for a medium sized consultancy dealing with commercial property letting and valuation. He works as a professional negotiator for clients facing rent reviews or lease renewals. He is often absent from his desk, both within the office site and on frequent trips to client premises within the city. He interacts frequently with others, mainly using his office phone for business negotiations with clients who are off-site. During the target week he was engaged in about 30 ongoing cases. Three demanded particular attention: a written response to an opposition report about a rent review undergoing arbitration; arranging to act for a new tenant client in a rent review case; and completing three lease renewals.

We chose these participants because they are mobile professionals for whom communication is a central part of their job. They exhibit two main forms of local area roaming: in building roaming (B.) and out of building/metropolitan area roaming (R.). Together these forms account for 87% of the "mobility" exhibited by mobile professionals in the US, in contrast to wide area roaming outside the city or country base[2]. Future work should confirm how these results generalise to larger numbers of participants in different professions.



RESULTS

The Nature Of Informal Communications

Below we present some typical examples indicating the character and function of these interactions:

Example 1: R. and F.

R. IS STOOD UP READING A DOCUMENT BEHIND HIS DESK WHEN HIS COLLEAGUE F. WALKS INTO VIEW EN ROUTE TO HIS OWN DESK FROM ANOTHER OFFICE.

1. R: (LOOKS AT DOCUMENT)
 'F. can you reath read (--) this:s report for me?'
 (1.5s WALKING TOWARDS EACH OTHER BOTH LOOKING AT THE DOCUMENT)
2. F: (WALKING AND LOOKING AT THE DOCUMENT)
 'E:::rrh (.) now?''
 (1.0)
3. R: (LOOKING AT DOCUMENT)
 '.hhhhhhh 'Aiy if you've got a minute''
4. F: (LOOKING AT DOCUMENT)
 'Yeah - ''

In this 8 second interaction, R. sees that F. is moving around the office and hence is not currently directly engaged in work. He therefore opportunistically engages F.'s help. Note the importance of a shared visual environment in affording R. this information about F.'s availability and allowing F to look at the document.

Example 2: R. and F.

R. IS DICTATING AT HIS DESK. F. IS ON THE PHONE ACROSS THE OFFICE

1. F: 'A:lright thank you bye bye''
 (F PUTS DOWN PHONE)
 R IS REPLAYING HIS DICTAPHONE
 (0.7)
2. R: (TO F.)
 'Is he alright?''
3. F: .''Yeah''
- 4a.R: 'Which one's he-he's got-''
 (0.7)
- 4b.R: 'There's a restaurant''
 (0.5)
5. F: 'I said that I'll do this one initially and then further afield''
6. R: 'Which one's that?''
7. F: 'That's: eighdy two it's the offices''
- 8.R: '>Oh< th-(.) hhh (.) Yeah:h
 we act for the landlord on that one. I did a rent review against him on that''

This longer interaction fragment lasting 15s, also shows an unplanned conversation. It arose because R. heard F.'s phone call and wanted to monitor the outcome. It finishes by R. offering unprompted advice and assistance. The interaction displays the implicit shared context between the participants. Without being told, R. knows the identity of F.'s caller (L2), and details of the case (L4a,4b). Unprompted, R. proceeds to supply background information which F. may not already have known (L8). The shared context results in a condensed and cryptic conversational style. This conversation continued for several more minutes after the extract. R. gave more details and offered a warning about acting for both client and tenant. Thus an unplanned conversation led to a detailed task oriented discussion. A final example is an interaction consisting of a single utterance, interrupting a person on the phone: "It's twentyfive past four", with an acknowledgement "okay". This served as a reminder that materials had to be posted that evening to meet an important deadline. This again indicates the brevity and context-dependence of this type of interaction.

Figure 1 presents general data on: Own Office communication (face-to-face with others in one's own office), and Roaming (Out of Office: in others' offices, meeting rooms, offsite, public areas, including communication episodes in transit between these). A communication event was defined as a synchronous face-to-face verbal interaction, over and above a greeting. It excludes asynchronous or technology mediated communications such as phone, email, voicemail and FAX, as well as non-communicative activity, e.g. solitary actions at one's desk, or walking around the building. Arranged meetings were defined as being explicitly agreed and scheduled by participants.

Figure 1 shows that informal communication accounts for a large proportion (31%) of work time. This overall figure, however, is mainly composed of a large number of brief, unplanned, dyadic interactions. Extended, arranged, multiparty interactions are highly unusual. The brevity of the interactions is striking: in the Own Office case, 50% of interactions last less than 38s.

We also looked at where Roaming conversations occurred and their mean duration. The majority of these (67%) were in another person's office (mean duration, 1.94 mins), 15% in public areas (mean, 1.06 mins), and 17% whilst on the move (mean, 0.82 mins). A few longer interactions (1%) took place in dedicated meeting rooms (mean, 13.13 mins). These data show that the location of a roaming interaction influenced its duration. Consistent with other work[13], we also found that 62% of outgoing phone calls by our participants failed to connect with their intended recipient. This may be explained by the large amounts of time spend roaming, and it presents major problems for people trying to make synchronous connections, especially from offsite.

Structure

Due to the lack of mobility of the camcorder, we only have complete visual information about the activities of both participants in the Own Office case. Given the importance of visual information, for our analysis, we therefore only looked at conversation structure for the 152 Own Office interactions.



	Own office (N = 152)	Roaming (N = 142)	Overall (N = 294)
% Total Work	14	17	31
Mean duration (mins)	2.37	1.38	1.89
Mean frequency (mins)	11.57	12.38	5.98
% Unscheduled	89.47	96.48	92.86
% Dyadic	82.23	84.50	83.32

Figure 1: Informal communication characteristics, for own office, and roaming

In a typical scenario here, the recipient is engaged in prior activity which is interrupted to **initiate** the interaction. We noted the cues that the caller used to determine when to **initiate**. Very few of these interactions (11%) were prefaced by greetings (e.g. "hello", "hi") by either party. When the recipient was already engaged in activity, the callers only waited for a verbal or visual orienting sign of attention from the recipient on 32% of occasions, other times they just launched into the interaction. Visual orientation was defined as a physical body movement towards the caller, and such movements were obvious in the majority of cases, because attention had previously been directed at the desktop (reading, writing, phone) or at another person (talking), so that gaze at the caller produced a distinct head movement. There was only one instance of verbal orientation ("Take a seat").

The recipient's prior activity determined interruptibility. Activities involving talking were less interruptible than silent reading or writing, with callers being more likely to wait for an orienting cue before commencing ($\chi^2 = 11.21, p < 0.001, df = 1$). There were no differences in interruptibility, however, between the different forms of verbal activity, namely talking, dictating and phoning.

We also analysed interaction **closings**. Only 3% of occasions ended with formal farewells ("bye", "see you"). There were also few verbal or visual orienting signs (e.g. turning away) given to indicate conversations were about to close: these only occurred on 21% of occasions.

To determine how participants managed **context** we analysed the first utterance of each interaction, after the greeting. We noted whether or not this first utterance assumes a common reference to a previous interaction or issue, and prior knowledge on the part of the recipient. On 75% of occasions, participants assumed prior context, this was often accompanied by deixis, e.g.

`''mm - this invoice have you got the original quote and also the quote from Triangle?''`

`''I have taken a detailed look at this now, and the problem was ...''`

	Frequent	Infrequent	Chi-Squared
Duration (secs)	37.8	219.0	
%Greetings	2	23	12.06*
%Farewells	0	10	5.13*
%Interruption	91	64	11.90*
%Final arrangement	21	43	5.86*
%Previous context	24	19	0.37

Figure 2: Impact of interaction frequency

Contrast this with interactions which have no prior history or context.

`''Hello B., we're doing a bit of an audit around the site''`

`''B., I'm taking a couple of days leave, Monday and Tuesday.''`

Context management also involves planning the next time to converse. Given the opportunistic nature of most of these conversations, we examined when people formally made arrangements to meet again. We looked at the final utterance, or when there were farewells, the penultimate utterance. Arrangements were defined as agreed future directed actions or scheduling meetings. Formal arrangements were made on 28% of occasions only.

The Effect Of Interaction Frequency On Structure

Next we examined how Own Office communications differed depending on interaction frequency. Frequency affects the interactants' familiarity with the subject material and each other. We identified interactions between people who talked infrequently¹. This analysis was conducted only for the dyadic interactions.

As we expected, more frequent interactants had briefer conversations (Pearson $r = -0.24, p < 0.05, df = 103$). Frequent interactants were much less likely to be formal, producing fewer greetings and farewells and more interruptions (defined as an interaction that begins in the absence of a recipient visual/verbal attention cue). Asterisks in the Figure indicate significance levels at $p < 0.05$. Frequent interactants also made fewer future-directed arrangements within the meeting. Arranged meetings were also much less likely to occur between frequent interactants ($\chi^2 = 10.58, p < 0.001, df = 1$). Contrary to our expectations, however, frequency had little effect on whether participants chose to preface their conversations with remarks that reintroduced context. We had expected familiar interactants to have little need for explicit

¹Defined as those who over the whole week averaged fewer than two interactions per day. Thus we categorised 55% of conversations as occurring between infrequent interactants, and 45% between frequent interactants.



	Annotate	Cue	Answer	Prop
Report	56.3	73.2	83.3	85.7
Memo	43.8	2.4	4.2	0
File	0	14.6	8.3	0
Other	0	9.8	4.2	14.3
% Joint	25	41.5	50	46.4

Figure 3: Document usage: type and function

context reintroduction, but it may be that frequent interactants share many potential contexts and it is therefore necessary for them to be explicit about context in order to distinguish these.

The Role Of Documents

Documents were involved in 53% of all Own Office interactions. We analysed the episodes containing documents. The four main types of documents were reports (typed materials); memos (personal notes/postits/handwritten notes); files (material accessed from an archive); and other (including photos, viewgraphs, books). We also looked at how the document was used during the conversation: for annotation or signing; to ask a question; to answer a question; or as a conversational prop, where participants used the document to structure the conversation by repeated visual attention, reference and gesture at the document[16, 19]. When a document served multiple functions we noted each of these. Figure 3 shows that reports were the most common type of document involved in conversations, and that most of the time these were talked about (for question, cue or prop). Annotation of reports was less common, and almost half of annotation was personal notes. We also looked at when the document was shared (defined as joint visual orientation). Information cue, answer, and prop functions, normally involved sharing documents. Annotation in contrast, was normally a solitary activity.

SYSTEM IMPLICATIONS

How might we support informal interactions when groups are geographically distributed? Again we add the proviso that these findings are based on a very small sample and may be sensitive to job specification, physical layout and office culture. We should also test our analyses against people's **perceptions** of the structure and function of these interactions. This study did not determine, for example, the relative importance of office versus meeting room conversations for participants, or the perceived intrusiveness of different ways of initiating conversations. Nevertheless, our study documents the frequency of informal communications: they account for 31% of office activity. Taken together with other studies showing that removing such interactions significantly decreases effective collaboration [7], this reinforces claims that this is a major area for technology support.

Our results show that such interactions are generally dyadic, very brief, with few formal greetings or farewells, and callers often began without waiting for visible signs of recipient readiness. The absence of openings and closings and their

interruptive nature suggests a view of informal communications as one long, intermittent communication comprising multiple brief related fragments with an open channel. Figure 2 also shows that infrequent interactants tend to have longer conversations and be slightly more formal.

How might we support this in software? One possibility is persistent audio/video links to the set of frequent interactants, offering minimal cost in initiating conversation, and ready access to the current workgroup. For infrequent interactants, a connection model may be more appropriate but connection must still be quick and effortless: if the whole interaction only lasts a few minutes, then start up and close must be brief compared with this[5, 18].

How should we achieve initiation? Overall the data suggest that frequent callers begin almost regardless of recipient's visual activity. Thus current implementations of "glance" facilities[5, 9], in allowing the caller information about the presence/absence of the recipient, and the recipient an audio cue that they are being observed, may be sufficient here. It does not seem to be necessary to supplement this with more specific information about recipient's **visual attention**, e.g. whether they are reading or writing. Recipient's **verbal activity** was important in initiation, however, so that a brief "eavesdrop", giving an indication of whether the recipient is talking, may be useful here². More formal methods of initiation requiring recipient feedback may be needed with less frequent callers, given that they were more likely to wait for a recipient cue before beginning. Visual recipient feedback has been shown to be important for certain classes of video mediated interactions[6].

Over half the interactions involved documents, suggesting the need for an integrated Shared Workspace. Document use indicates a requirement for simple systems rather than full-blown shared editors. A system that allowed mutual viewing of documents, with the ability to point at and possibly make simple annotations, may be all that is required here[19].

Most interactions were dyadic, arguing for videophone rather than multiparty systems, although 88% of interactions were terminated by a third party joining an existing conversation. There may therefore be a need to support this type of interjection. Conversations in offices were more frequent than commons area conversations, with only 15% of conversations occurring in public areas. This implies that we should focus on desktop communications rather than commons-area applications[4], although further data should be collected about the relative importance to the participants of the different classes of conversation.

A relatively large number of roaming interactions take place in other people's offices. This indicates that the callers were deliberately looking for the recipients for a particular purpose, rather than "falling into" conversation with others they happened to bump into while out of the office. Thus interactions appeared purposeful even though they were not generally scheduled to take place in advance. This was suggested by the character of opening lines of interactions, and by the fact

²This may have to be masked to preserve privacy, but the important information to transmit is that the recipient is engaged in conversation



that the majority of roaming interactions were self-initiated (75%) whereas most own office interactions were initiated by others (60%). This again argues for desktop connections and explains the lack of success of attempts to connect arbitrary participants via videophones[4].

Consistent with other studies, our participants experienced problems in achieving connection outside the building[13]. People are often away from their desks, explaining the observed lack of success in making phone calls. Combinations of communication technologies are needed to address this problem. We need increased integration of synchronous technologies with those that do not require temporal co-ordination, eg. voicemail or electronic postits[18], for non-urgent messages. For urgent communications, that require immediate response, the requirement might be for a mobile phone or pager. Further studies about the urgency, and hence the requirement for synchrony for different types of interpersonal communications are needed to determine the appropriate technologies here. We also need to understand how to present these different communication options, eg. postit versus pager, to the caller, and to provide effective filters for the recipient to prevent intrusions in non-urgent circumstances. This integration should allow asynchronous technologies to play an important role in co-ordinating remote interactants in the absence of a shared physical environment.

THEORETICAL ISSUES

Our data also have ramifications for conversational theory. Conversations are traditionally regarded as having a beginning and ending, with conversational context evolving through the discussion. In contrast, we found that informal communications seem to consist of one long intermittent conversation consisting of multiple unplanned fragments often lacking openings and closings. This presents two major problems for participants that do not occur in standard conversations accounts (a) co-ordination to achieve co-presence, given the unplanned nature of the fragments; (b) regenerating context because of time lags and intervening activity between intermittent interactions.

How is co-ordination achieved given the amount of time that people spend away from their offices and in conversation with others? Currently co-ordination works most effectively for physically collocated people because they have multiple opportunities to find the other people available for conversation. The challenge for future technology is in supplying this type of information for geographically distributed groups. Communication frequency also affected the planning of such interactions: people who met often, had little need to pre-arrange meetings, because the frequency of interaction guaranteed multiple future opportunities to interact. The opportunistic nature also explains another finding. Two person conversations are more likely than multiparty because the chances of two people being at the same location at a given time are greater than for three.

There may also be degrees of opportunism and another issue concerns the differences between interactions that are: (a) pre-arranged by both participants; (b) brought about when just one participant seeks another out; (c) the result of genuinely chance encounters, where neither intended the interaction

to take place. Our findings were that interactions "on the move" are much shorter than those in meeting rooms, which may support the view that genuinely chance encounters are briefer than pre-arranged ones, but we need to validate this against participant's accounts of how different interactions come about.

Another related variable is **where** the interaction occurred, and we found differences in duration relating to location. Why is this? Conversational resources such as documents may be limited at out-of-office locations, such as commons-areas or "on the move", and this may reduce conversational duration, because of the absence of these resources. Locations may also differ in their perceived intrusiveness: in commons-areas or "on the move" the caller is not interrupting the recipient in mid-activity, so that even infrequent interactants may show little initiation behaviour.

How is context management achieved? Our initial view was that it would be closely related to interaction frequency, with frequent conversations among familiar people serving to preserve context across interactions. We expected more context-dependent, more cryptic and hence briefer interactions among frequent interactants. Although conversations among frequent interactants were shorter, however, we found no effect of frequency on context management. Future work should carry out more detailed analyses of other measures of context-dependence, e.g. anaphors, deixis, personal pronouns to find out whether these are prevalent among frequent interactants. We also only looked at context management at beginnings and ends of conversations, and future work should analyse the whole conversation. A further possibility is that documents carry context[16, 19], so we would predict more context-dependence when conversations include documents.

A final related issue is the sheer **brevity** of informal communications. The absence of openings, closings, and the reduced need to make arrangements for future meetings clearly reduce conversational length, but are other factors at work? The possibility that shared context allows participants to be cryptic remains to be substantiated. Another hypothesis relates to planning: if participants are uncertain that they will meet frequently they may condense multiple issues into a single interaction. In contrast, familiar interactants know that future conversations are guaranteed, so that only the most pressing ones need be done now. Again however, this needs to be tested.

ACKNOWLEDGEMENTS

Thanks to Brid O'Conaill and Phil Stenton for discussions and help with data analysis and to all the participants taking part in the study.

REFERENCES

1. M. Abel. Experiences in an exploratory distributed organization. In J. Galeger, R. Kraut, and C. Egido, editors, *Intellectual Teamwork: Social and Technological Foundations of Co-operative Work*, pages 489–510. Lawrence Erlbaum Associates, Hillsdale: NJ, 1990.
2. W. Ablondi and T. Elliot. *Mobile professional market segmentation study*. BIS Strategic Decisions, 1993.



3. S. Bly, S. Harrison, and S. Irwin. Media spaces: Bringing people together in a video, audio and computing environment. *Communications of the ACM*, 36:28–45, 1993.
4. R. Fish, R. Kraut, and B. Chalfonte. The videowindow system in informal communication. In *Proceedings of the Conference on Computer Supported Co-operative Work*, pages 1–12, 1990.
5. R. Fish, R. Kraut, R. Root, and R. Rice. Video as a technology for informal communication. *Communications of the ACM*, 36:48–61, 1993.
6. C. Heath and P. Luff. Disembodied conduct: Communication through video in a multi-media environment. In *Proceedings of Conference on Computer Human Interaction*, pages 99–103, 1991.
7. R. Kraut, C. Egidio, and J. Galegher. Patterns of contact and communication in scientific research collaboration. In J. Galegher, R. Kraut, and C. Egidio, editors, *Intellectual Teamwork*, pages 149–173. Lawrence Erlbaum Press, Hillsdale, N.J., 1990.
8. R. Kraut, R. Fish, R. Root, and B. Chalfonte. Informal communication in organizations: form, function and technology. In R. Baecker, editor, *Groupware and Computer-Supported Co-operative Work*, pages 287–314. Morgan Kaufmann, 1993.
9. M. Mantei, R. Baecker, A. Sellen, W. Buxton, T. Milligan, and B. Wellman. Experiences in the use of a media space. In *Proceedings of the Conference on Computer Human Interaction*, pages 203–209, 1991.
10. B. O’Conaill, S. Whittaker, and S. Wilbur. Conversations over video-conferences: An evaluation of video-mediated interaction. *To appear in Human Computer Interaction*, 1993.
11. G. Olson, J. Olson, M. Carter, and M. Storrosten. Small group design meetings: An analysis of collaboration. *Human Computer Interaction*, 7:347–374, 1992.
12. R. Panko. Managerial communication patterns. *Journal of Organisational Computing*, 1992.
13. R. Rice and D. Shook. Voice messaging, co-ordination and communication. In J. Galegher, R. Kraut, and C. Egidio, editors, *Intellectual Teamwork*, pages 327–350. Lawrence Erlbaum Press, Hillsdale, N.J., 1990.
14. L. Sproull. The nature of managerial attention. In L. Sproull and J. Larkey, editors, *Advances in Information Processing in Organizations*. JAI Press, 1984.
15. L. Suchman. Constituting shared workspaces. In D. Middleton and Y. Engestrom, editors, *Cognition and communication at work*. Sage, 1992.
16. J. Tang. Findings from observational studies of collaborative work. *International Journal of Man-Machine Studies*, 34:143–160, 1991.
17. J. Tang and E. Isaacs. Why do users like video: Studies of multimedia-supported collaboration. Technical Report SMLI TR-92-5, SUN Microsystems Lab, 1992.
18. J. Tang and M. Rua. Montage: Providing teleproximity for distributed groups. In *Proceedings of the Conference on Computer Human Interaction*, 1994.
19. S. Whittaker, E. Geelhoed, and E. Robinson. Shared workspaces: How do they work and when are they useful? *International Journal of Man-Machine Studies*, 1993.