Informal Communication in Organizations: Form, Function, and Technology

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Abstract

The intricate choreography necessary to do work in organizations requires effective coordination. This paper uses a variety of data from R & D organizations to describe informal communication and its functions in organizations. It argues that informal communication, generally mediated by physical proximity, is crucial for coordination to occur. Informal communication is frequent in R&D organizations, it aids organizational members in learning about each other and their work, it supports both production work and the social relations that underlie it, and it provides a critical facility that collaborators rely on to start joint work, maintain it, and drive it to conclusion. Without informal communication, many collaborations would undoubtedly not occur and others would break up before becoming successful. In this light we present two telecommunication systems designed to support informal communication through artificial proximity. The VideoWindow system is a wide-screen video teleconferencing system continuously linking public places, and Cruiser is a switched, desk-top video communications system that implements a metaphor of a virtual hallway. Both systems have the potential to support informal communication, but experience with the VideoWindow and analysis of Cruiser suggest that careful attention to implementation detail will determine if they are successful.

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Most of the work that people do in organizations requires some degree of active cooperation and communication with others. This is true of routine clerical work, it is equally true of creative work, like scientific research or engineering development. Indeed, in some scientific fields over 65% of publications are jointly authored (Over, 1982), and most research projects, regardless of authorship, require support staffs of clerks, research assistants, or technicians.

Individual members of groups need to communicate with each other to accomplish their production and social functions, and within organizations, groups need to communicate with other groups. The communication they use is both formal and informal. Our goal as authors of this chapter is to understand the communication processes underlying group work in order to improve the communication technologies that groups have available to them. Our assumption is that by understanding how groups and organizations work and by comparing their communication needs to current communication technologies, we will be able to identify gaps in the array of communication tools that people in organizations have available to them. We are especially interested in communication tools to support distributed groups. For instance, what would it take to have a nation-wide task force meet and write a report as easily as if they were housed in a single building?

When we look around our places of work, we notice that informal communication seems to be a dominant activity. People read at their desks but are interrupted by phone calls. They leave to attend a department meeting but stop on the way to discuss a matter with a colleague. To answer questions about office procedure, they call to the person at the next desk rather than consult the appropriate manual. The conversations seem fluid and undesigned and yet, clearly, work is being accomplished. In looking at the contrast between formal and informal communication, it occurred to us that the more spontaneous and informal communications was, the less well it was supported by communication technology. We realized that we had well established procedures for scheduling meetings and writing reports but little technology to support bumping into a colleague in the hall. Hence, our interest was drawn toward understanding more about the nature and value of informal and spontaneous communicative activity and toward seeing whether technology could be fruitfully employed to aid it.

While our attempts to understand informal communication have taken a number of empirical approaches, our interest in enabling technologies has been focused on the uses of audio-video combinations as communication media. The history of video as a communication technology has been a mixed one, showing great successes as a method of broadcasting entertainment, a mixed record as a method of disseminating education, and a dismal record as a mechanism for interpersonal communication. The lack of market success for such items as video telephones and video conferencing

systems seems to contradict our intuitions about the value of visual contact in interpersonal communication. However, because these technologies had been primarily geared toward relatively formal communication occasions, we began to explore whether video's employment in systems for informal communication might be more successful. In particular, we thought that because video simultaneously reminds a person of a need to talk to someone and provides a communication channel through which to carry on the conversation, it might become the technology to support spontaneous, informal communication.

The remainder of this chapter elaborates our thesis that informal communication is an important mechanism to help achieve both the production goals and the social goals of groups. The chapter starts by more fully describing what we mean by informal communication, conceptually and through example. Next it details some features common to informal communication episodes. Then it examines some of the ways that informal communication supplements more formal communication processes to aid both the production and social components of group work. While the examples and data in this chapter come from studies of informal communication in research and development environments, we do not think the insights gained are limited to these environments. Finally, the chapter describes two experimental telecommunication systems aimed at supporting informal communication at a distance.

The Nature of Informal Communication

Theorists have long recognized that organizations make use of communication methods varying in formality, that they deploy these different methods for tasks varying in uncertainty, and that matching the informality of the methods with the uncertainty of the task leads to better organizational outcomes. At both the organizational and the small group level, the coordination of activity is the production-oriented task that has been examined in most detail. Coordination is the activity of directing individuals' efforts towards achieving common and explicitly recognized goals (Blau & Scott, 1962). As Van de Ven, Delbecq, and Koenig (1976) describe it, "coordination means integrating or linking together different parts of an organization to accomplish a collective set of tasks" (p. 322). Explicit coordination is necessary in part because individuals within an organization have only partially overlapping goals. Thus, one of the aims of coordination is to insure that the disparate individuals come to share the same goals. But even if this aim were achieved, and their goals were identical, the input-output dependencies among individuals require that their efforts be sequenced and interrelated efficiently.

The coordination mechanisms used by organizations differ in their degree of formality -- that is, in their degree of pre-specification, conventionality, and rule-boundedness. At the formal end of the dimension, coordination is accomplished by adherence to common rules, regulations, and standard operating procedures, through pre-established plans, schedules, and forecasts, and through memos, management information reports, and other standardized communications. These formal coordination mechanisms have in common communication that is specified in advance, is unidirectional, and is relatively impoverished.

Informal communication is a loosely defined concept and is often treated as the residual category in organizational theory. According to this perspective, informal communication is that which remains when rules and hierarchies, as ways of coordinating activities, are eliminated. More positively, informal communication is communication that is spontaneous, interactive and rich. Coordination by feedback (March & Simon, 1958), through organismic communication networks (Tushman & Nadler, 1978), or by clan mechanisms (Ouchi, 1980) are alternate ways of describing coordination by informal communication. The essence of these informal communication systems is their lack of pre-specification. Information is not prepackaged and then shipped intact to a recipient; courses of action are not pre-computed and then executed without modification. Rather, information is often exchanged interactively, through meetings and conversations, and courses of action are worked out in the context of the circumstances into which the actions must fit.

Figure 1 illustrates several of the variables that we think distinguish formal from informal communication. At the heart of what we term informal communication is its ad lib nature. Conversations take place at the time, with the participants, and about the topics at hand. None of these characteristics - timing, participants, or agenda - is scheduled in advance. Moreover, during its course the communication changes to take into account the participants' current interests and understandings. In this sense, informal communication is truly interactive, with all participants in the communication being able to respond to what they perceive to be the current state of affairs, including the communication up until that point and their perception of the other participants' reactions to it. Through this feedback mechanism, informal communication can be more effective than formal channels, as participants in the conversations elaborate or modify what they have to say in order to deal with someone else's objections or misunderstandings (e.g., Kraut, Lewis, & Swezey, 1982).

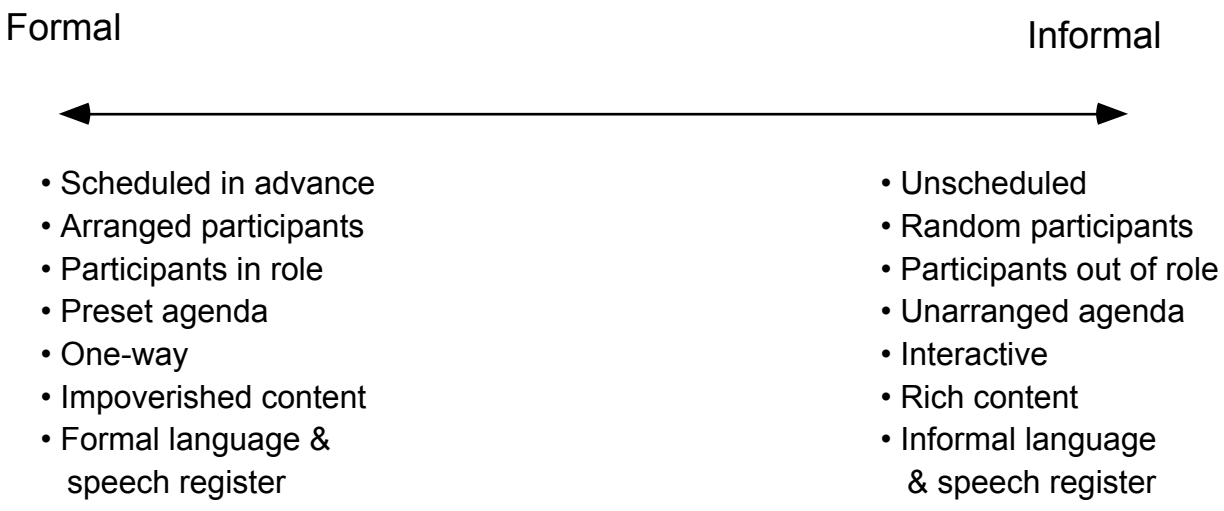

Figure 1: The formality dimension of communication

Our distinction between formal and informal communication parallels Daft and Lengel's (1984) distinction between impoverished and rich communication channels. We add to their criteria of bandwidth and interactivity, the additional criterion of spontaneity. According to Daft and Lengel (1986), rich communication channels are ones that "can overcome different frames of reference or clarify ambiguous issues to change understanding in a timely manner" (p. 560). In order of decreasing richness, they consider (1) face-to-face communication, (2) telephone, (3) personal documents such as letters, (4) impersonal documents, and (5) numeric documents. (See also Stohl & Redding, 1987 for further discussion of the formal-informal distinction.)

There are both structural and functional characteristics of communication occasions that cause the communication to be more or less formal. among structural characteristics, the nature of the relationship among the participants and their social roles influences its formality. For example, conversations among strangers or among those with highly unequal status will be more formal than conversations among close friends or among peers. Similarly, conversation among people acting in their offical roles will be more formal than conversation among the same people out of role. The frequency of communication also influences its formality. If communicational partners have the ability to communicate with each other multiple times a day, they need not stand on ceremony in their communication, and communication moves from a formal to informal style (Brown & Fraser, 1979). The nature of the communication setting also influences the formality of communication in it. A discussion in a board room is likely to be more formal than one in the corporate fitness center. Finally, the communication channel itself may partially determine the formality of a communication event. By their nature, for example, telephone and face-to-face discussion are more interactive and richer than are computer mail systems and as a consequence, more informal. Subdividing media more finely, computer generated information systems reports and human generated memoranda are more formal than are scheduled meetings and electronic bulletin boards, which in turn are more formal than telephone calls or hallway chats.

In terms of functional characteristics, formal and informal communication systems seem best suited to different types of activities. Formal communication tends to be used for coordinating relatively routine transactions within groups and organizations. For example, in a large corporation, one might go through a procurement process simply by following the steps specified in the corporate purchasing guide. The material specification, purchase requisition forms, bidding procedures, desiderata for selecting one vendor over another, and stages in the approval process would all be specified in advance. In the extreme, the rule book could so totally describe the conditions under which certain actions should occur and the precise ways of executing them that a factory's computerized, just-in-time procurement system could place orders with suppliers without human intervention.

However, these formal coordination mechanisms often fail in the face of novel or unplanned events. Novelty, unexpectedness, and uncertainty are frequent in organizations and are often components of what appear to be routine procedures (e.g., Suchman & Wynn, 1984). Under these circumstances, informal communication seems needed for coordination in the face of uncertainty and equivocality (Daft & Lengel,

1986). Thus, while a group might purchase a new desk by delegating the responsibility to one member and then following the purchasing rules, they would not think of hiring a division manager simply by following the procedures laid out in the personnel guide. Instead they would have plenty of informal communication with each other about the type of person they wanted as a leader and with the candidate to assess his or her qualities. Inferinal communication is needed in this case because, compared to buying furniture, personnel procurement is a rare event, with large consequences, and because it is also highly uncertain, given the difficulty of predicting the characteristics of people.

Research findings lend support to these hypotheses. For example, when work groups are engaged in more complex tasks - that is, tasks that are varied, lack routine procedures, and require group members to think through solutions - they are far more likely to communicate directly with other group members and to have more scheduled and unscheduled meetings to coordinate their activities (Van de Ven 1976). Daft and Lengel (1984) have shown that organizational members prefer rich and interactive media, such as face-to-face meetings, when they have value conflicts and other disagreements to work out. And Argote (1982) has shown that when groups with greater task uncertainty do engage in meetings and unscheduled communication to coordinate their activity, they are more successful in performing their work than if they rely on standard procedures.

In sum, we have argued that informal communication supports organizational and group coordination, especially under conditions of uncertainty. Coordination is an example of a production function of groups. When people work in groups within organizations they must achieve three goals to be successful: production, group maintenance, and member support (Hackman, 1987; McGrath, 1984, 1989). That is, they must actually accomplish productive work -- write the reports, make the decisions, construct the software, allocate the budgets, defend clients, or do whatever the particular group is assigned to do. In addition, groups must achieve two social goals. First, they must sustain themselves over time, and most groups have life spans of multiple projects. To sustain themselves, groups have to recruit and socialize members, keep them happy enough so that they want to maintain membership, garner external resources, and do the sundry other activities that insure the group's continuing survival. The second social goal that the group must attempt to achieve is to support the needs of individual group members so that they feel satisfied with their work, their relationships, and their membership in the group. By most criteria, a team whose members are unhappy with their work and hostile toward each other would be deemed a failure, even if they accomplished their tasks. In scientific research teams, for example, scientists must feel that they are making useful contributions and that their contributions are being recognized; such teams often break up if this recognition is not forthcoming (Kraut, Galegher, & Egido, 1988).

There is reason to think that informal communication is particularly useful in supporting the social functions of groups. This is because organizations are less explicit in regulating social relationships than than they are in regulating other aspects of work procedures. For example, corporate personnel guides frequently describe the bureaucratic procedures for annual performance appraisals, but they neither attempt to

nor could they regulate the ad hoc personal judgments that supervisors make of the people reporting to them. A vast literature in social psychology suggests that relatively unstructured and informal communication is at the basis of social processes, such as person perception and liking, which underlie group maintenance and member support (e.g., Festinger, Schacter, & Back, 1950; Zajonc, 1968). To give one example, Gabarro (1987) describes the development of mutual expectations and trust that sustains the work relationships among managers; when a CEO no longer trusts the judgments of his or her subordinates, the subordinate is frequently transferred, demoted or fired. "[Mutual expectations] ... are ... typically worked out over time during a succession of routine interactions, such as ad hoc encounters, meetings, progress reviews, and discussions of task-based problems" (p. 184). These are the mechanisms of informal communication.

The Dynamics of Informal Communication in R&D

Moving from abstract discussion of communication styles, groups, and organizations in general, this section and succeeding ones will discuss several examples of informal communication and examine its functions in the context of the research and development process among scientists and engineers. We focus on informal communication in research and development for two reasons. First, as we have seen previously, most research is collaborative, requiring coordination and communication. Second, the central feature of this domain is dealing with uncertainty in both production and social relations. In terms of production, the object of research in both science and engineering is to create novelty. In embarking on a research project, scientists and engineers must make the equivocal judgments of whether their goal is a valuable one and whether their methods are appropriate and will meet with success. Even when the project is completed they are still left with these issues, as suggested by the recent controversy about the value of research on room temperature nuclear fusion. In terms of social relations, the uncertainties are in establishing trust in potential and actual research collaborators and in defining an equitable division of labor and credit for jointly planned work (see Kraut, Galegher, & Egido, 1988, for a fuller discussion of these dilemmas in scientific research). For these two reasons - the importance of collaboration and the essentially uncertain nature of the research enterprise - we believed that informal communication would play an extremely important role in research and development, and as a result, the R&D domain would provide an interesting lens through which to view the dynamics and functions of informal communication.

In this section we describe three examples of informal communication. The episodes come from samples of videotaped interactions we collected from hallways, copy centers, entry ways, and other commons areas in one building of a large R&D laboratory. These episodes were collected by turning on an unattended videotape camera at random times for hour-long intervals. The camera was large, plainly visible, and identified with a sign stating that recording for research purposes was occurring. A total of 12 hours were recorded. During most of the time at the recording sites there was no social interaction because only one person was present. When two people were present, most social interactions were minimal. A typical scenario would be for

two people to walk past each other in the hall, acknowledging each other's existence by a stereotyped pattern of glances toward and away from each other (Goffman, 1963) or by a brief "hello" in passing.

Given this context, the excerpts we present below are by no means random selections from episodes in which at least two people were videotaped. Rather, we selected them to discuss in more detail because they illuminate both the dynamics and functions of informal communication. Thus, they provide a useful counterpoint to the more schematic and quantitative descriptions of informal communication presented in later sections.

Episode 1: The call

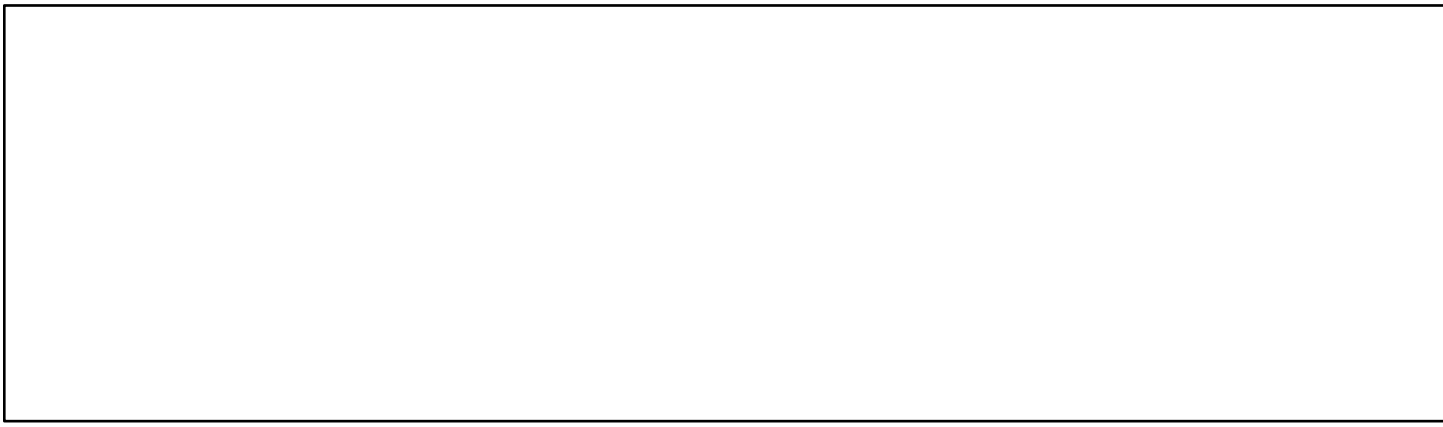

Figure 2: The call

The first episode illustrates the beginning of what we have called an opportunistic, work-related conversation. Andrew is returning to his office when he sees Bob backing out of a meeting in an office at the end of the hallway. Bob is unaware of Andrew's presence. Andrew calls to Bob, timing his call by observing when Bob has stopped his engagement in the meeting. Bob turns around, recognizes Andrew and acknowledges his presence with a smile. He starts walking toward Andrew, who remains stationary until Bob reaches him. In the final scene of the episode, Andrew and Bob are walking off together down the hallway, discussing the difficulties they have had contacting a mutual colleague.

Both Bob and Andrew abandoned their original goals of concluding a meeting or returning to an office, respectively. Instead, as a result of serendipitously seeing each other in the hallway, they were able to pass information about the status of a project and to solve a problem that was hindering the project's progress. Andrew told Bob that he had not been able to contact a colleague and Bob suggested a way of doing it. This is a common mechanism through which small collaborative teams do project management (cf Kraut, Galegher, & Egido, 1988 for a description of communication in scientific research teams). For small groups, this informal project management serves the production function of coordination and problem solving efficiently, assuming team members run into each other enough. It has the additional benefit of keeping group

members informed of and involved with many of the minor decisions and crises that occur in any project . Thus it serves the social functions of groups, by keeping group members committed to the projects of which they are a part.

Episode 2: Stop Short

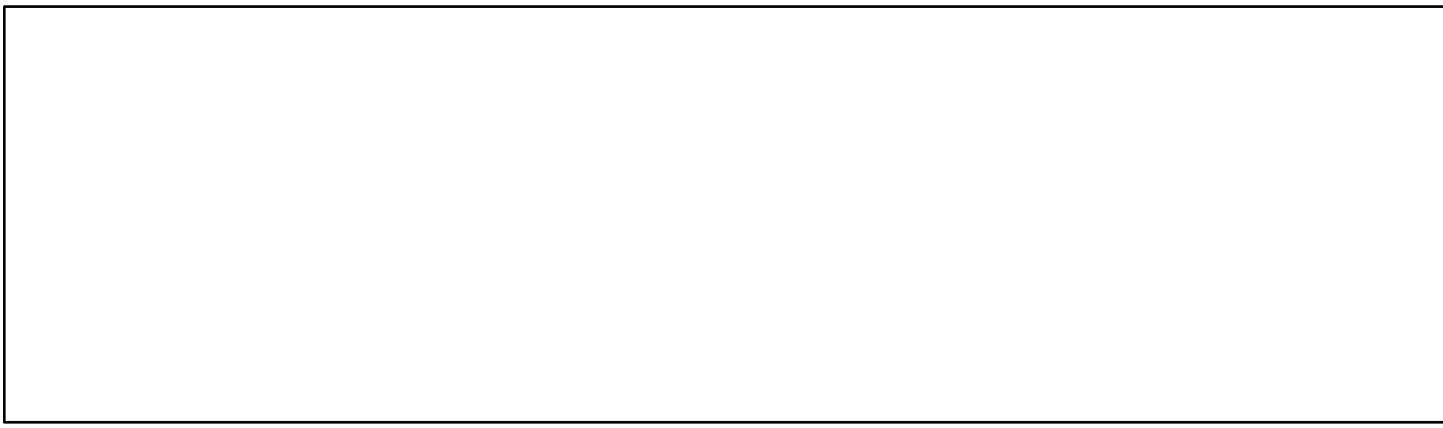

Figure 3: Stop short

Episode 2, like episode 1, shows the chance initiation of a work related conversation. In addition, it also demonstrates how people pick up background information about their work environment by merely navigating its hallways. A typical sequence observed as people walk down the halls is for them to peer into open offices and public spaces as they go to the printer, copy machine, bathroom, or other ultimate destination. They usually do not slow down, but simply turn their heads as they pass open doorways. This process of browsing the social environment while on other business provides people with a substantial amount of information about the world in which they live. They learn or are reminded of who the local inhabitants are, and the goings-on in their offices give some indication of their characteristics, interests, and current activities. While much of this information is not immediately relevant to tasks at hand, these observations of the work place provide some of the background knowledge through which people make sense of subsequent information they acquire. For example, they provide a basis for the mutual knowledge that people need to understand each other (Clark & Marshall, 1981; Krauss & Fussel, 1989) and the firm-specific knowledge that employees acquire in the first years of working for a company.

In this episode Able, a researcher,is walking down the hallway glancing into offices as he goes. He sees another researcher, Baker, whom he knows, notices that Baker has spotted him, and says hello while passing by. The next scene occurs 7 seconds later when, even though Able has already passed Baker's office, two phenomena cause him to reverse his steps and stop to have a brief discussion with Baker. First, the mere sight of Baker served as a stimulus that jogged Able's memory that he had something to say to him. Second, the "hello" served as a channel checking routine, indicating that Baker's attention was free and that he was available for conversation. This confluence of topic and availability, which Baker's visual presence provided, were the minimum preconditions for a conversation to occur.

In the third scene another researcher, Charlie, walks down the hall, also glancing in offices as he goes. He passes by, observes Able and Baker in conversation, and turns his head farther to see them as he is walking. Although he does not slow down, his actions indicate that this is an interesting event for him. This observation provides Charlie with background information that may be useful in the future. By catching a glimpse of the participants in on-going conversation, Charlie may be able to make inferences about the relationship between the participants or the topic of the conversation. In this way he learns about social relationships, alliances, crises, and collaborations in the laboratory. In the final scene Able finishes his discussion with Baker and continues on to his original destination. During this 35 second sequence Able and Baker, who had not planned to speak, got a little bit of work done and provided some information to Charlie, which he can use to better understand his work environment.

Episode 3: At the Candy Machine

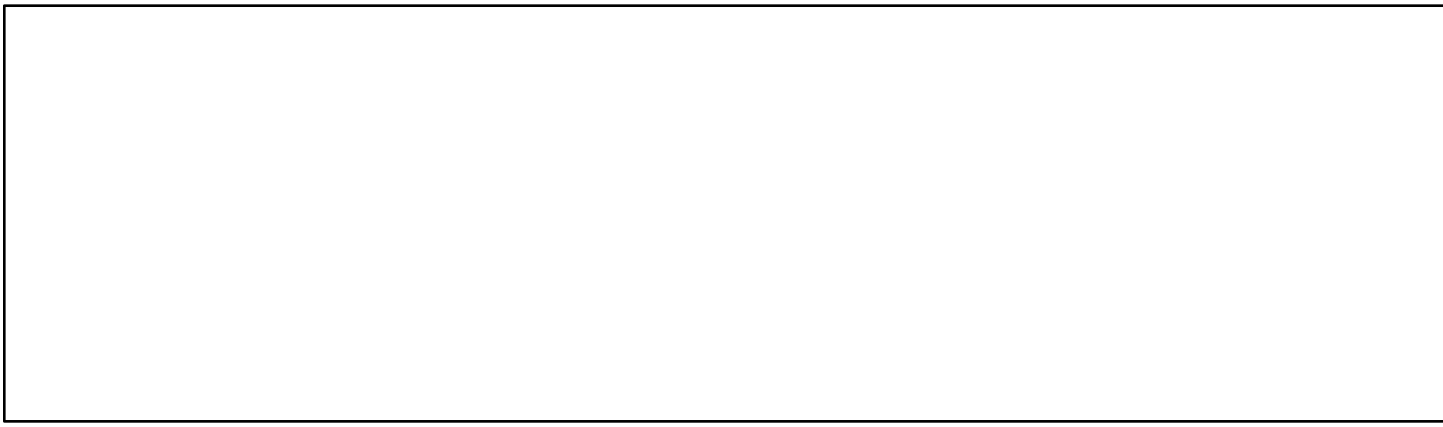

Figure 4: At the candy machine

Episode 3 is more blatantly social than the previous two. In the first scene Ann and Barry are having an informal, social discussion in front of some vending machines as they take a break from work. Barry sees Chester walking by on his way to the elevator and hails him. Chester stops and Barry, with Ann in tow, approaches him. Ann, who did not know Chester, is introduced, and the three have a discussion of Chester's wedding. Barry asks, "When's the big day?" He recognizes that Ann does not know Chester and explains that Chester is to be married. Chester replies that his wedding was last weekend, and both Ann and Barry congratulate Chester.

Three functions are served in this brief episode. First, Barry is maintaining social bonds with two co-workers, Chester and Ann. These minor social pleasantries are undoubtedly useful in developing and maintaining social networks in organizations. They form the basis of many mutual obligations and work exchanges in organizations. If, for example, Barry needs information, it should be easier for him to call upon either Ann or Chester for help than it would be if they had never engaged in these social

pleasantries. Second, Barry acted as a social catalyst by introducing Ann and Chester and providing information to each about the other. Ann should now have an easier time talking to and dealing with Chester than she would have if the introduction had never occurred. Finally, during the discussion of Chester's wedding Barry inadvertently reveals to Ann information about the closeness of Barry and Chester's relationship: they are co-workers who know each other, but not well, and who marginally keep up with each other's affairs through work place gossip. Ann can store this as potentially interesting background information that helps her understand her work environment.

Shared Features of the Episodes

None of these brief episodes of informal communication was especially significant in its own right. If any one of them had failed to occur, no careers would have been ruined nor projects stymied. Yet episodes like these occur hundreds of times per day even in small departments. We believe that in the aggregate they are fundamental methods that organizations use to get their work done, transmit organizational culture and firm specific knowledge, and maintain the loyalty and good will of their members.

The episodes we reviewed here share several features that are noteworthy. First, all were unplanned and unanticipated. The participants all engaged in more or less useful conversations, but did not know they would be having them even seconds before they occurred.

Second, the visual channel was a prerequisite for these interactions to occur. In each example, the visual channel was instrumental in identifying a partner for conversation, in identifying the precise moment when the potential partner was available, and in establishing a topic for the conversations. In each case, the initiator of the conversation first saw and recognized a potential partner whom he already knew. As Kendon and Ferber (1973) describe it, sighting is a necessary pre-interaction phase of a greeting. Recognizing someone to talk to is not simply a passive process of following one's mother's advice and not talking to strangers. Rather, seeing someone often brings with it a social obligation to acknowledge their presence with a greeting. In the candy machine example, Barry seemed to be responding to this social obligation as he went out of his way to greet Chester.

In addition, the visual channel was used to verify the opportunity for conversation. That is, by looking at a potential target of conversation, the initiator can often interpret the target's locus of attention and infer whether and when he or she is available for conversation. In the call example, the initiator could see when the target had disengaged from his previous conversation and was available to be hailed. Potential conversationalists often use the visual channel to synchronize their behaviors (cf, Kendon & Ferber, 1973) to make sure that they have a clear channel between them. For example, in the call episode, after Andrew hailed Bob, he did not engage in conversation until Bob had turned around, engaged in eye contact, and acknowledged his presence with a smile.

Seeing someone also serves as a potent stimulus to evoke topics of conversation. In the call episode, the sight of Bob appeared to remind Andrew of project information that Bob should know about. In the stop short episode, seeing Baker and saying "hello" to him clearly reminded Abel of a topic of conversation, and he reversed his tracks to follow it up. In the candy machine example, Barry's sighting of Chester appeared to remind him of Chester's wedding and Barry's social obligation to enquire about it. Thus the visual channel is often instrumental in establishing topics of conversation.

A third characteristic which the examples illustrate is that both production and social goals are often served in these informal conversations. Though one might characterize a conversation as having a main purpose, the production and social goals frequently co-occur, and whether a conversation is work-related or social is a matter of degree. Sometimes a conversation is directly related to production. In the call episode the participants coordinated their activity, updated each other on the status of their project and solved a minor problem impeding progress. Yet it is clear, from the smiles and positive affect displayed in this episode, that the participants were enjoying each other's company as well. Other times a conversation is basically social, as in the candy machine example, where members of an organization were able to establish and reaffirm their bonds to each other. But even here, it appears that co-workers were forging bonds that would underlie later work activity. Many times informal conversations do not directly support work at hand. However, these often provide background information that might potentially be useful for completing a work assignment or for acquiring more general organizational competence.

Surface Characteristics of Informal Conversations

The following two sections describe some features and functions of informal communication more systematically and quantitatively. Casual observation suggests that brief encounters of the sort we described above are extremely common in organizations. We concentrate, although not exclusively, on these brief and unplanned encounters because they are so common. Like an ethologist, we start with the assumption that if a behavior pattern occurs frequently enough, it is likely to be important for a species or group. As social observers we have a responsibility to describe these behavior patterns and to understand functions that they might serve.

Some features of these conversations are easily observable. These surface characteristics, as we will call them, comprise information about informal communication that can be obtained through simple methods. In this section we present descriptive data about the surface characteristics of informal communication Specifically, how frequently do informal conversations occur, how are they initiated, where are they likely to take place, and how long do they last?

If we use the frequency with which informal communication occurs as a measure of importance, then numerous studies have shown that informal communication is vitally important in organizations. For example, organizational researchers since at least the time of Mintzberg (1973) have observed that informal communication is the dominant

activity of managers. Sproull (1984) reviewed the evidence from seven studies of managerial communication, where managers in these studies ranged from mid-level rank (e.g., factory heads and school principals) to those at the most senior level (e.g., CEOs of moderate-sized corporations and college presidents). Data collection included both direct observations of the managers by researchers who shadowed them during their work day and managers' self-reports of communication in daily diaries. Across the seven studies, verbal interaction accounted for about three-quarters of managers' work days. About 50% of this verbal interaction consisted of unscheduled face-to-face meetings and another 12% consisted of unscheduled telephone calls. Together these figures indicate that almost 50% of the typical manager's time is consumed by unscheduled conversation that we would consider informal communication. In general, informal communication appears to be a frequent and hence important activity through which managers find out information, communicate opinions, and make decisions.

This characteristic of managers is also true of researchers in R&D environments. This statement is based on data we collected in a study of conversations occurring in buildings of an industrial research laboratory and a state university. The aim of the study was to examine the characteristics of a sample of face-to-face interactions among members of these two organizations. We identified conversations occurring in a sample of locations in buildings within the organizations at randomly determined times. When a conversation was identified by a researcher, participants in the conversation were asked to complete a brief questionnaire describing it.

To sample conversations, a researcher first identified blocks of seating locations in a building such as offices located along a corridor or desks within a large, group office.[1] The researcher went to these blocks at random times and made a single pass through the area (i.e., each individual was observed only once). The researcher interrupted every face-to-face conversation observed during the sampling period explaining, "We are trying to understand what functions conversations serve in organizations," and asked all people involved in the conversation to complete a brief questionnaire at the end of the conversation. The questionnaire requested a description of the conversation (e.g., how it came about, where it occurred, its length, and its topic), the usefulness of the conversations for various functions (e.g., maintaining a working relationship, coordinating work, keeping up with work place information), and the relationship between the participants (e.g., their organizational ties, their project status, and their frequency of other communication).

The researchers identified 522 sites (occupied desks or offices) where conversations could have occurred and observed 695 individuals. At the time of observation, 121 (23%) of these sites actually contained a conversation representing 267 individuals (38%). We had at least one usable response from 117 of the conversations (97% response rate). In terms of individuals, the response rate was 83%.

[1]Sunita Ashar and Jonathon Shulman served as able research assistants in this data collection.

Frequency and Initiation of Informal Conversations

At any moment in the R&D organizations we observed, 38% of the people present were engaged in face-to-face conversation. As one index of the informality of conversation, we asked respondents to indicate how these conversations came about. This was operationalized as the degree to which the conversation was scheduled or spontaneous. Unlike previous researchers (e.g., Ven de Ven ., 1976), we distinguished among degrees of spontaneity, assuming that the more spontaneous the conversation was, the more informal it was likely to be on many dimensions. All participants were asked to categorize the degree of preplanning that characterized the conversation they had just been involved in. The four categories were: (a) a conversation that was previously scheduled or arranged (we term this scheduled), (b) one in which the initiator set out specifically to visit another party (intended), (c) one in which the initiator had planned to talk with other participants sometime and took advantage of a chance encounter to have the conversation (opportunistic), or (d) a spontaneous interaction in which the initiator had not planned to talk with other participants (spontaneous). Each respondent characterized the meeting individually. Because each participant was likely to have a different view of how the conversation began, we organized the data by conversation and assigned an initiation value to the conversational unit. This value was defined as the most preplanned number (least spontaneous) of any respondent's classification, where scheduled < intended < opportunistic < spontaneous on the spontaneity dimension. Thus, if the initiator of a conversation categorized it as intended and the other party classified it as spontaneous, we categorized the conversation as a whole as intended. This scheme both provided a conservative estimate of spontaneity and also handled rating differences based on participants' role in the conversation.

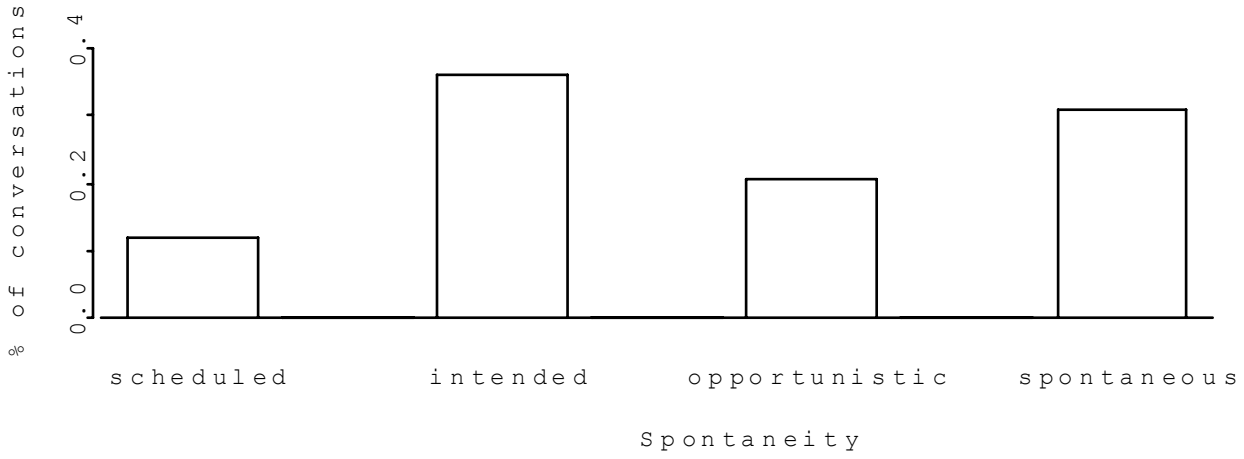

Figure 5: Frequency of conversations

The distribution of 117 conversations that we identified was a follows: 12% were scheduled, 36% were intended, 21% were opportunistic, and 31% were spontaneous. (See Figure 5) If we assume that only scheduled meetings are formal, then by this definition 88% of the conversations we sampled were informal. This is a conservative estimate because many scheduled meetings, particularly in an R&D environment, contain elements characteristic of informal communication. For example, a research

planning meeting is typically highly interactive. This type of scheduled meeting is in sharp contrast with the elaborately choreographed activity at an annual shareholders' meeting or a product rollout meeting, for example.

The 36% of conversations which were classified as intended by at least one of the parties are functionally equivalent to ambulatory phone calls, in that one person has intentionally gone in search of another in order to have a conversation. From the perspective of the intended object of this search, however, the conversation may appear entirely spontaneous because he or she has not anticipated its occurrence. The remainder of the conversations, about 50% of the total, happened by chance, with no preplanning on the part of any participant in the conversation. These conversations would not have occurred if the participants had not wandered past each other's offices on their way to the copier machine, chanced upon each other in the hallway, or otherwise bumped into each other as they moved around in their physical environment. About 40% of chance encounters (21% of the total) were opportunistic; that is, they were triggered by the sight of a person with whom one party had previously formed an unacted upon intention to talk. In the remaining 31% of the cases, no party to the conversation had anticipated its occurrence, and it was only the opportunity for conversation presented by the physical proximity of the participants that led to the spontaneous initiation of conversation.

Initiation of conversation seems to be a joint function of the salience or importance of the conversational topic and the ease of the conversational execution. In the case of both scheduled and intended conversations, the topic is important enough for someone to initiate action that will lead to a discussion of that topic; groups schedule a meeting or individuals leave their offices in search of a suitable conversational partner. Opportunistic conversations are somewhat more complex. In some cases, there may be no topic that is important enough to warrant immediate action, and a conversation is simply deferred. Often, however, a manager or researcher in the course of making a decision feels the need to consult with a colleague, but other events or thoughts intrude (cf Mintzberg, 1973; Reder & Schwab, 1988; Sproull, 1984, for evidence on the short attention spans of managers and researchers), and both the decision and the need to consult are placed on hold. In either case, when the decision-maker later comes across the colleague in the hallway, two phenomena occur. First, seeing the colleague, by simple association mechanisms, reminds the decision maker of the original need for consultation and increases the temporary salience of the suspended decision, perhaps even reinstating the original decision-making context. Second, being in the colleague's presence simultaneously lowers the cost of communication. The decision maker can see whether the colleague is available and has a clear channel through which the conversation can start (cf, Kendon & Ferber, 1973, on the initiation of interaction).

Spontaneous interactions are even more interesting. In these cases there is no previous topic or need for consultation. Instead, the mere opportunity for conversation created by the presence of a suitable partner and availability of a clear channel serves to generate a conversation. Observations that we will review later in this chapter suggest that conversations, especially spontaneous ones, tend to occur among people who already know each other from other contexts. At any occasion they may have nothing in particular to say to each other, but norms of politeness require that they at

least acknowledge each other's presence and perhaps exchange greetings. These passing social encounters occasionally evolve into substantive conversations. The topics for these conversations may be based on other activities in the environment or some other experience of joint interest that is remembered or generated during the course of the conversation. The candy machine conversation described previously is a typical case.

Location of Informal Conversations

Conversations that differ in their degree of spontaneity also differ on other characteristics. First, most conversations involve people who are housed close to each other. In our survey, each participant reported the location of the sampled conversation in relation to the location of his or her office. The choices given were: (1) the participant's office, (2) next door, (3) the same corridor, (4) the same floor, (5) the same wing/section of building, (6) a different wing/section of building, (7) the same campus/site, (8) a different campus/site. Each conversation was coded to reflect the farthest distance that any participant in the conversation had to travel in order to participate in that conversation.

Work place conversations are, in general, quite local events, usually involving people who are physically in close proximity to each other. As Figure 6 shows, 52% of all conversations involved people located within the same corridor, and 87% of them took place among people who shared the same floor in a building.

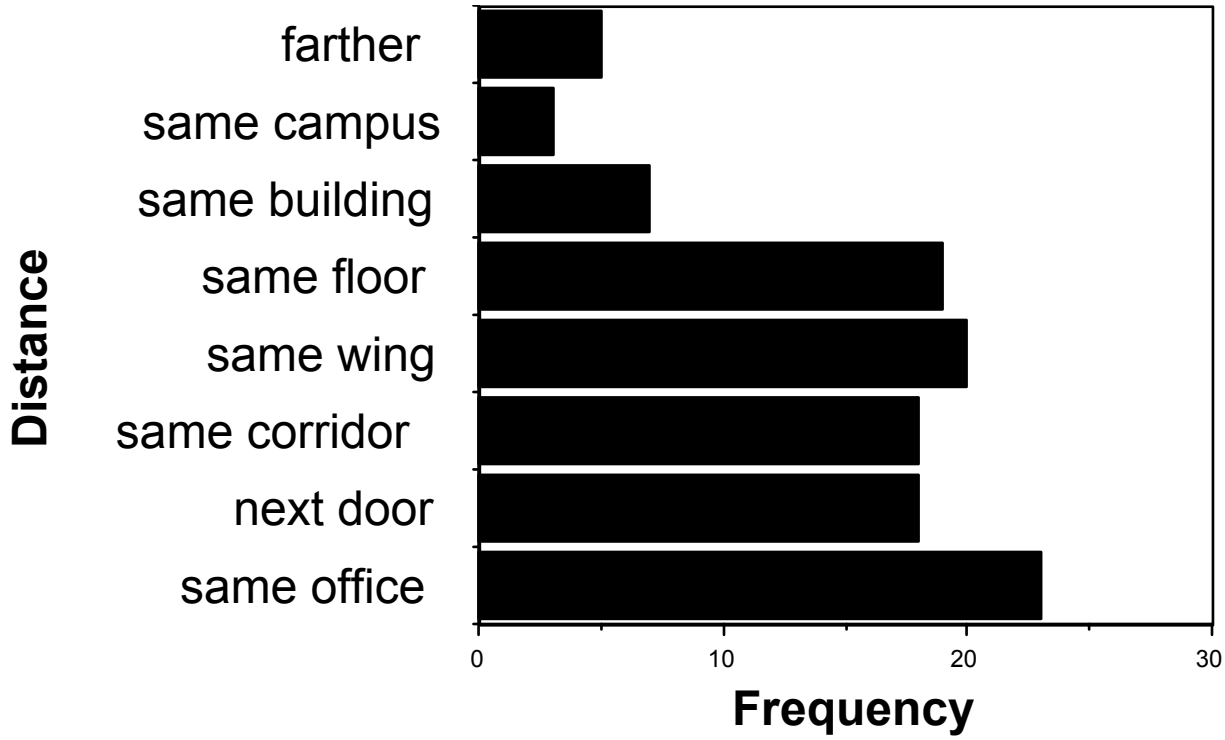

Figure 6: Distance of conversation from participant's office

Our data are thus consistent with other observations showing the exponential decay of conversations with physical distance. Indeed, Zipf's (1949) principle of least effort predicts that the closest colleagues will have the most conversations. Whether it is because random motion causes people to have greater interaction by chance with those to whom they are closest, because people intentionally try to limit their contact efforts to those who are closest, or because organizations co-locate people who need to have the most communication, studies have shown time and again that physical proximity is strongly associated with frequency of interaction (see also Allen, 1977; Kraut, Egido, & Galegher, In press; Zipf, 1949; Festinger, Schacter, & Back, 1950). Floor boundaries are an especially important functional barrier for all types of face-to-face communication.

These distance effects, however, are more powerful for more spontaneous conversations. That is, in general, the data show that the more spontaneous the conversation, the greater the likelihood that participants' offices were located close to each other (r (111) = .23, p < 02.). For example, fully 40% of the spontaneous conversations occurred among inhabitants of the same office. Of the spontaneous and opportunistic conversations, 91% occurred among people on the same floor, while only 82% of the combined intended and scheduled meetings did.

It is probably for this reason that the more spontaneous conversations were composed of people who frequently communicate with each other. We asked participants to indicate how frequently they had spoken to their conversational partner in the preceding five work days; we scored the mean of their responses per conversation. In general most of these face-to-face conversations were but one of a series. The mean frequency of communication was 12.5 times in the preceding five days (s.d.= 14.6). But on top of this, the more spontaneous (and hence, informal) conversations tended to occur among those who talked together most frequently (r(112) = .18, p < .06).

Duration of Informal Conversations

Differences in spontaneity and hence in the degree of informality of a conversation were also associated with differences in conversation duration. Each participant in our survey estimated the length of the conversation in which they were involved; the mean of all participants' estimates was used as the duration for a given conversation. To reduce outliers in the data, conversations that lasted longer than 60 minutes were assigned a length of 60 minutes. In general, the more spontaneous the conversation the briefer it tended to be (r (115)= .26, p < .02). In particular, Figure 3 shows that scheduled and intended meetings were substantially longer than other types of conversations which, in turn, did not differ from each other. The median length of a scheduled meeting was about 30 minutes, while intended, opportunistic, and spontaneous meetings tended to last less than a third of this time, each with a median of less than 10 minutes.

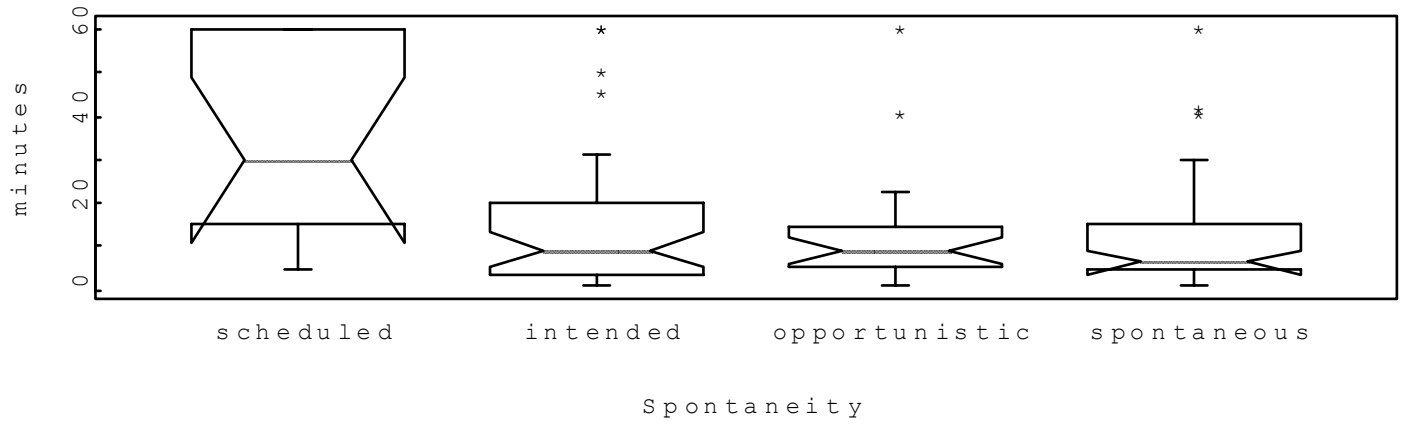

Figure 7: Duration of conversations

Summary

Some of the characteristics of informal conversation are readily apparent from observations of conversations in progress. Informal communication tends to be frequent, accounting for over 85% of the interactions in our sample of conversations in R&D environments. While some of the informal interactions we sampled (about 35% of all conversations) were intended in that one of the participants sought out another, about 50% of the conversations were unplanned in that participants did not know they were going to speak to each other until they physically happened across each other. This result is consistent with the principle that informal communication, like most other sorts of communication, is distance sensitive. That is, it happens most often with people who are physically proximal to each other. Finally, informal conversations tend to be shorter than more formal communications. This tendency may be indicative of the types of uses to which informal communications are put in the work place, a topic we take up more fully in the next section.

The Content and Uses of Informal Conversation

Having looked at some of the surface characteristics of informal conversations, we now turn our attention toward understanding the uses to which it is put. This includes understanding something about the content of conversations that we consider informal as well as the role that conversations of this sort play in the functioning of the work place. Four studies of different aspects of this problem are reported below. These studies investigate the functions for which people perceive informal communication to be useful, the effects informal communication has on familiarity with and liking for one's co-workers, the effects on collaboration when informal communication is not allowed, and finally, the relationship between informal communication and the success or failure of research collaborations. As each of these topics is discussed in turn, we describe the methods of the studies that provide the relevant data.

Perceived Value of Informal Communication for Production and Social Functions

Perhaps the most direct way of determining the value of conversations of different sorts is to ask participants to evaluate them immediately after they have occurred. We employed this strategy for 57 of the conversations from the study described earlier in which researchers sampled ongoing conversations in an R&D environment. Respondents rated on 5-point Likert scales the outcomes of their conversation. Scores for a conversation were based on the mean judgment of all participants in it. Adopting a variant of McGrath's (1989) model for group functions, we measured the degree to which conversations supported the production and social functions of group work, including both member support and group maintenance. The production function was measured by a 5-item scale with questions like "How useful was this conversation in getting your work done?" "How productive was this conversation?" and "How useful was this conversation for coordinating your work?" The social function of the conversation was measured by a 3-item Likert scale with the questions "How enjoyable was this conversation?" "How much did you learn about each other through this conversation?" and "How useful was this conversation for maintaining a working relationship?" The production measure was quite reliable (Cronbach's alpha = .89); the social functions measure was less so (Cronbach's alpha = .46). While we expected that the theoretical distinction between production and social functions of a conversation would be sharply reflected in the rating responses, results of a factor analysis indicated otherwise. In particular, the question about maintaining a working relationship loaded on both the production and the social factors. As a result, the two scales were moderately correlated (r = .26), lending support to the idea that both social and production functions are intertwined in real work groups. If one is going satisfactorily, the other is apt to do so as well.

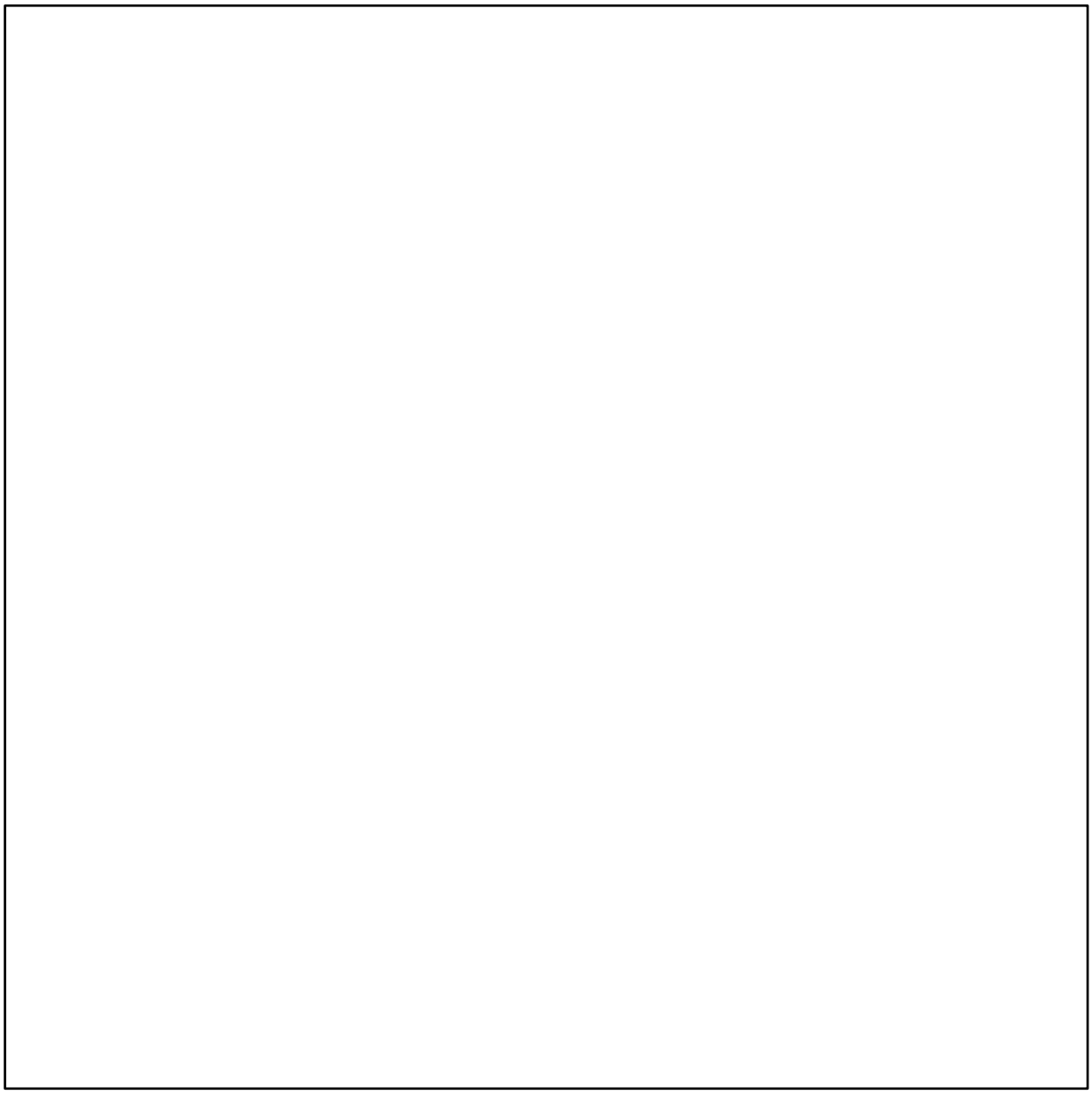

Figure 8: Value of conversations for production and social functions

A repeated measures analysis of variance on these data revealed that, overall the more spontaneous a conversation was, the less valuable it was perceived as being ($F(1,55)=3.9$, $p = .05$). However, this conclusion must be tempered by the interaction revealed by Figure 4, which shows that the effect for spontaneity exists only for the production dependent variable ($F(1,55)=3.5$, $p<.07$). Figure 4, top panel, shows that both scheduled meetings and intended meetings were perceived as more valuable for getting work done than were opportunistic meetings or spontaneous meetings ($t(52)=2.6$; $p = .01$). The relationship between preplanning and perceived value for production was partially a function of the length of the meetings, as the data above have demonstrated. Planned meetings were longer and, as a result, allowed more time for planning, discussion, and decision making. However, the relationship between

preplanning and perceived value for production remained even when the duration of the meeting was held constant through multiple regression (standardized beta = .37, df=(1,54), p < .01). On the other hand, as shown in Figure 4, bottom panel, the value of conversations for social functions was unrelated to their spontaneity (standardized beta = .008, df=(1,54), p >.50). Brief hallway encounters were as valuable as hour-long, scheduled meetings in terms of getting to know coworkers and maintaining working relationships with them.

If one simultaneously considers the value of different types of conversations, the frequency with which they occur, and their duration, it is clear that much important work in R&D organizations occurs in unscheduled meetings. Both our own data and the earlier prior literature show that much of the detailed planning associated with a project gets done in relatively long, arranged meetings in which participants with their research ideas and set research direction (Kraut, Galegher, & Egido, 1988). Yet many smaller decisions and much of the coordination during the execution of the project itself get done in briefer and more spontaneous encounters. In terms of production, intended meetings are as valuable as scheduled ones for getting tasks accomplished; they occur four times as frequently as scheduled meetings, yet take only a third as much time to accomplish. Scientists, engineers, and managers use these meetings as "just in time" consultation and decision-making opportunities. When they are working on a problem and need information or advice, they go down the hall and solicit it during a brief chat, rather than scheduling a time, agenda, and participants in advance.

In terms of social functions, all types of conversations provided some opportunity to enjoy the company of coworkers, to learn more about them, and to build bonds with them. Again, though, because scheduled meetings occur relatively infrequently and consume larger amounts of time, they fulfill the social functions inefficiently. Here, the brief and informal intended, opportunistic, and spontaneous conversations have an edge, because they represent the vast majority of conversations in organizations.

The Effects of Informal Communication on Person Perception

Much research in both industry and academia is developed through voluntary collaboration. A fundamental requirement for these collaborations to occur is for researchers seeking partners to identify others with appropriate research interests and personal characteristics (see Hagstrom, 1965 Kraut, Galegher, & Egido, 1988, for a fuller discussion of the initiation of research collaborations). All else being equal, researchers want to work with people who are competent enough to contribute effectively to a joint project, trustworthy enough to do their share of the work and take only their share of the credit, and likeable in their personal characteristics. Here we test the hypothesis that informal communication is the mechanism that researchers use to size up the pool of potential collaborators before becoming committed to working with any one of them.

We have seen that communication, especially unscheduled communication, increases as the proximity between conversational participants increases, and that participants in conversations report that unscheduled communication is especially

useful for supporting the social functions of groups. Our hypothesis is that increases in informal communication will also have an effect on one's perception of co-workers; in particular, the more one communicates with someone, the more one is familiar with their work, is accurate in judging them, and likes them personally. These questions were examined through a survey of 51 scientists and engineers within a single building in a research and development laboratory. The major purpose of the survey was to examine the relationship of informal communications among these researchers to measures of person perception and attitudes toward each other. For the purposes of this study we treated physical proximity as a surrogate for frequent, informal interaction.

Each participant in this study completed questionnaires in which they rated their familiarity with other participants and with those participants' work. In addition, for those participants with whom they were sufficiently familiar they rated the degree to which they liked the other participants and the degree to which they found the participants' work to be interesting, important, and well executed. In the analyses that follow, results are reported as mean Pearson correlations between proximity and other measures of interest. Because each participant had a spatial relationship to and judged 50 other participants, we can compute a Pearson correlation between proximity and the person perception measures for each participant. Analyses are based on the means of these individual correlations, corrected by the Fisher formula.

Indices of proximity . Participants in the survey were located on two floors of a single research building. We developed two proximity measures for each respondent. Like Allen (1977), Festinger, Schacter, and Back (1950), and Monge and Kirste (1980), we treated proximity as more than the linear distance between offices. Rather, functional proximity is the opportunity to engage in interaction and is moderated by architectural and organizational features as well as mere linear distance. We assumed that locations on different corridors, sections of the building, or floors were separated by more than physical distance. The first index of proximity (within-floor proximity) for each pair of participants was the shortest-path distance[2] between office locations, (adjusting these distances if the shortest path crossed hallways, or wings of the building) times minus one, Approximately half the targets of person perception had offices located on the same floor as a rater and half had offices on an adjacent floor. We assumed that for each respondent, targets on the same floor were functionally closer than targets on an adjacent floor. Thus, the second proximity index (between floor proximity) was coded 1 if a target was on the same floor and 0 if the target was on a different floor.

Familiarity . Respondent rated on 7-point Likert scales how familiar they were with 50 other members of the organization and their work. In addition, if they were sufficiently familiar with these organizational members and their work, respondents had the opportunity to rate how much they liked each of them and respected their technical work. We treated willingness to make the ratings as a sign of familiarity and failure to do so as a sign of lack of familiarity. The correlations among these four measures ranged from .70 to .84. We therefore constructed a single measure of familiarity from these measures by standardizing and averaging them (Cronbach alpha = .87).

[2] Steven Rohall wrote the program to compute the distances.

Participants were much more likely to be familiar with colleagues on the same floor than with colleagues on an adjacent floor (the mean Pearson correlation between the familiarity scale and between-floor proximity = .41, $t(50) = 19.6$; $p < .0001$). For example, respondents thought that they knew enough about their colleagues' technical work to judge it for 42% of their colleagues whose offices were on the same floor as theirs, but made this judgment for only 17% of their colleagues on an adjacent floor. For researchers with offices on the same floor, the closer their offices the better they knew each other, however, this proximity effect within floors was smaller than the between floor effect (the mean Pearson correlation between the familiarity scale and within-floor proximity = .11, $t(43) = 3.8$; $p < .001$). On the other hand, among colleagues on different floors, further increases in distance had no relationship to judgments of familiarity. Essentially, when two people were already a floor apart, increasing the distance by a hallway or more had very little effect on their perceived familiarity.

Liking . Just as proximity was associated with familiarity, it was also associated with liking for colleagues and respect for their work . Among those whom respondents knew well enough to judge, participants reported liking colleagues on the same floor far more than those on a different floor (the mean Pearson correlation between liking and between-floor proximity = .40, $t(50) = 118.1$; $p < .0001$). For those with offices on their own floor, they tended to like others more the closer their offices (the mean Pearson correlation between liking and within-floor proximity = .08, $t(46) = 1.87$; $p < .07$).

The results for respondents' respect for other people's work showed a similar pattern. They had greater respect for the technical work produced by people on their own floor than for work produced on a different floor (the mean Pearson correlation between the respect for work and between-floor proximity = .31, $t(50) = 13.2$; $p < .001$). Moreover, for others with offices on their own floor, they tended to have more respect for the work of people closer to them than people farther away (the mean Pearson correlation between the respect for work and within-floor proximity = .09, $t(44) = 1.68$; $p < .10$).

Summary . We have shown that physical proximity, which we have treated as a proxy for frequent and informal communication, is associated with several measures of person perception. As the opportunity for informal communication with colleagues increases, so does one's familiarity with them and their work, as well as liking for them and their work. While these findings are not new (cf, Allen, 1977; Bossard, 1932; Maisonneuve, Palmade, & Fourment, 1952; Segal, 1974) and our use of physical proximity means they are not definitive either (e.g., Berscheid & Walster, 1969; Pelz & Andrews, 1966; Tajfel, 1970; Zajonc, 1968), they are interesting because they suggest the power that informal communication and the physical proximity that supports it can have on important social psychological processes in real-world organizations.

Informal Communication and Momentum in Collaboration

Another method of gaining some insight into the uses of informal communication in the work place is to investigate situations in which informal communication channels are

limited or eliminated. We explored this possibility by conducting an experiment comparing two small work groups, one of which could use both formal and informal means to communicate while the other was limited to relatively formal mechanisms. The first of the groups was successful and the second was not. We suspect that their difference in success was caused by their differences in informal communication, although a case study cannot prove this.

The experiment compared two collaborations, a "remote" collaboration that was constrained to use relatively formal communications channels, and a "standard" collaboration that used both formal and informal channels (Fish, 1988). Both collaborations involved researchers interested in investigating new concepts for a telecommunications system. The remote collaboration consisted of two people, a Ph.D. in electrical engineering and a Ph.D. in psychology; the standard collaboration consisted of three people, two Ph.D.s in psychology and one in computer science. All members of both teams had successfully collaborated in the past, completing projects of a similar nature and difficulty, but had never collaborated together. Hence, going into the experiment, each collaboration was judged as having a reasonable chance of success.

In addition to the pre-existing differences in group size and personnel, the imposed constraint on which the collaborations differed was the communication mechanisms available for them to carry on their work. Two members of the standard collaboration had adjacent offices and the third was on an adjacent floor of the same building. They had no constraints on their communication and communicated via scheduled project meetings, impromptu discussions in the hall, electronic mail, and telephone. In contrast, for the purposes of the experiment, the remote group agreed to have no face-to-face meetings in which they discussed their project. They refrained from both scheduled face-to-face meetings and impromptu discussions. Although their offices were on the same corridor and they continued to see each other casually and to have informal discussions, they refrained from discussing their joint project during these get-togethers. This restraint had the practical consequence of shifting their communication to more formal channels, such as scheduled video teleconferences or non-interactive electronic mail.

The video teleconference available to the remote collaboration consisted of a full motion, two-way, small-screen, video/audio connection between their offices, supported by a shared electronic blackboard. These technologies, however, had in common the requirement that a member of the collaboration had to schedule a meeting and then set up a connection with the other member to interact with him. Thus, like a genuinely remote collaboration, the opportunity for unplanned interaction was lowered although, with some effort, collaborators had at their disposal the means for high quality interaction.

In order to understand how these collaborations proceeded, it is helpful to examine the data on two levels, process and outcome. The first level involves communication episodes, where we can compare the nature and quality of particular interactions; the second is a global level where we can compare the outcomes of the collaborations, as measured by their joint output such as papers, programs, or artifacts. The data

collected for this study consisted of records noting the date, length, and content of meetings between collaborators, video tapes and transcripts of each meeting made from the tapes for both the remote and standard groups, and the papers, programs, and other artifacts produced by the collaborators.

Process . The first dimension for comparison is the quality of the meetings each collaboration held. One might expect substantial differences here because the remote collaboration could only hold meetings using their video/audio/data linkup while the standard collaboration could hold their meetings face-to-face. Using the transcripts from the meetings, their quality was compared with criteria extracted from handbooks for running meetings (Doyle & Strauss, 1985; Gordon, 1985). These criteria judge a meeting on whether the participants know why they are there and what they want from the meeting, whether during the course of the meeting some work is done toward meeting these objectives, and whether the participants are able to arrive at some common understanding of the meeting's outcome. To assess the quality of meetings by these criteria, one coder judged samples from the beginning, middle, and end of transcriptions of each meeting and noted whether (a) participants explicitly mentioned their purposes for the meeting, (b) the content of their conversation was relevant to these purposes, (c) they summarized the meeting's accomplishments, and (d) they planned what they wanted to accomplish by their next meeting. By these criteria, and contrary to our expectations, all of the meetings, of both remote and standard groups, were of uniformly high quality. In particular, the remote, electronic meetings seemed as successful by these criteria as the face-to-face meetings of the standard group. This observation is consistent with the prior literature showing only minor differences between face-to-face and video-mediated meetings (e.g., Williams, 1977).

Qualitatively, the remote meetings seemed concentrated and intensely focused on work. Most of the collaborators' time was spent talking. In about 10% of the time during two meetings, they supplemented their discussions with drawing on the video terminals to illustrate user interface concepts. This was similar to the behavior among the standard collaborators who used a white-board about 10% of the time during two meetings to illustrate user behavior and to outline their paper. Primarily, participants in the remote collaboration attended to and talked to each other on the video screens. Indeed, even though the video images in this teleconferencing system were not very large, nor of very high quality, and did not support eye contact, they seemed to compel a polite attentiveness that was similar to the behavior found in the face-to-face meetings of the standard collaboration.

The remote and face-to-face meetings did differ in two major respects and one minor one. First, scheduled meetings in the standard collaboration were almost twice as long as the scheduled remote group meetings (mean length = 1 hour, 18 minutes for the standard collaboration versus 38 minutes for the remote collaboration, $t(25) = 4.12$; $p < .001$).

Second, meetings in the standard collaboration were more social and less task focused than were the remote collaboration meetings; that is they were filled with episodes of talk not directly related to the work at hand. Thus, they were less efficient from a production point of view. Anecdotes, work place gossip, humor, and polite chit-

chat all occurred relatively frequently. We examined 342 30-second segments of conversation from the standard and remote collaboration and coded whether they contained any social, non-task oriented, conversation. About 20% of the sampling units (38/188) in the standard collaboration were social, while only 5% of the sampling units (8/154) in the remote collaboration were social $t(340) = 3.0, p < .05$

Third, participants in the remote collaboration spent substantial time talking about the technology for their communication and work, while this was rarely an issue in the standard collaboration. The remote collaboration discussed tools for collaboration in about 14% of the sampling units, while participants in the standard collaboration mentioned tools in only 2% of the sampling units. This difference in attention to technology may reflect the greater difficulty which the members of the remote collaboration had in using their communication tools, or it may simply be an artifact of the novelty introduced by the experiment.

Outcomes . Even though the remote collaboration had "good" task-oriented meetings when examined one at a time, they had great difficulty in communication when considered more globally. In particular, the remote collaborators communicated too infrequently to get their work done. Figure 5 shows the timing of meetings for the two collaborations over the course of their first dozen meetings. Each actual meeting and scheduled meeting is numbered chronologically. The remote group took more than twice as long as the standard group (a year versus 20 weeks) to accomplish their first dozen meetings.

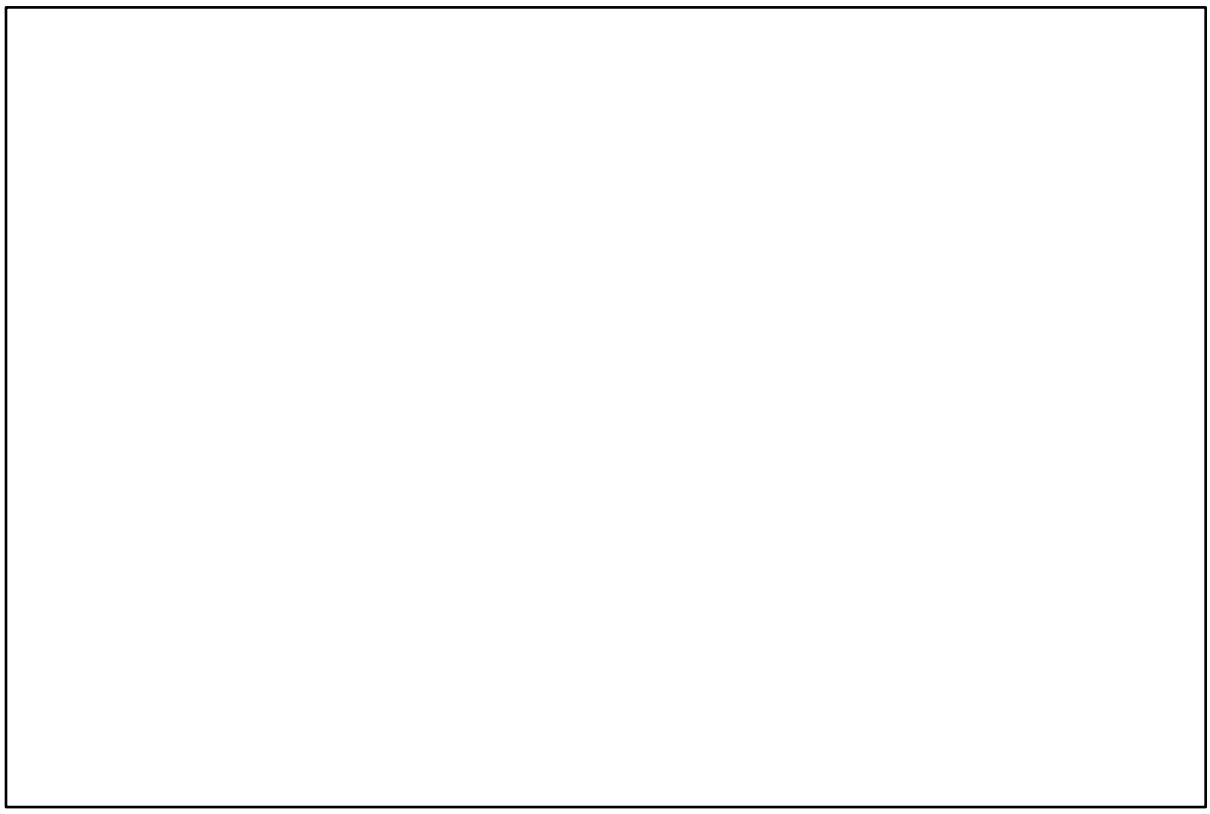

Figure 9: Scheduled versus actual meeting dates

Figure 5 also compares when meetings actually ocurred with their initially scheduled date. As can be seen, not only did the remote collaboration meet infrequently, but they were also less likely to meet close to the date they had originally scheduled for a meeting. For example, they had planned their second meeting to occur within two weeks of their first meeting, but it didn't actually take place until almost three months later. Thus, while each of the remote collaboration's meetings was task focused, their lower frequency meant that less work was accomplished in a given elapsed time.

If we examine meeting transcripts for the degree to which collaborators used the meetings to motivate their partners and coordinate their work, we find few differences between the remote and standard collaboration. On this episodic level, the participants of both collaborations used their meetings to find out what their collaborators had accomplished and to motivate their partners. However, if we look at the global outcome of this effort, we find that the standard collaboration settled on the direction of their work quickly and then was able to produce a steady stream of outputs, while the remote collaboration continually redefined and reallocated their work roles. Although the remote collaborators always came out of a meeting highly motivated and sure that they would fulfill their promised work assignments, in the long run they were never able to deliver any significant work outputs, and the collaboration eventually petered out.

The collaborators had other mechanisms for communication besides scheduled meetings. The standard collaboration had impromptu meetings which they engaged in frequently; they held pairwise conversations several times per week. These impromptu meetings were either spontaneous, where a chance encounter evolved into project talk, or intended, in which one collaborator sought out another to discuss a specific problem. Sometimes scheduled meetings were worked out this way. One collaborator would run into another in the hall, and after exchanging a few comments, they would realize that a meeting involving all team members was in order and would fetch the third partner to see if a near-term meeting was possible.

In addition, both groups used electronic mail. By the criteria of Figure 1, electronic mail falls between scheduled meetings and impromptu hallway meeting on the formality dimension. It is more spontaneous than a scheduled meeting, but less interactive. Because the remote group was prevented from using informal face-to-face conversation to motivate their work, they might very well have taken advantage of electronic mail to carry some of the coordination burden. However, excluding exchange of document drafts, participants in the standard collaboration exchanged 190 electronic mail messages among themselves containing about 22,000 words while participants in the remote collaboration exchanged only 51 messages, containing about 8,000 words. On average, these numbers represent about 6.8 messages per person per month (about 1,250 words) for the standard group and 1.8 messages per person per month (about 170 words) for the remote group. On the basis of these data, collaborators in the standard group had both a higher rate of communication and longer messages than members of the remote group. Here we find some evidence that both the content of the interaction, as measured by the length of the messages, and the coordination

process, as measured by the frequency of the messages, was compromised in the remote collaboration.

Interpretation . These results suggest that the suppression of informal communication opportunities between members of the remote collaboration had a negative, perhaps fatal, effect on the work of these collaborators. Because the opportunities for informal interaction did not exist, the participants had to rely on more formal, scheduled meetings to get their work done. However, because scheduling meetings takes time and effort, a lower overall frequency of meetings resulted. This lower frequency of meetings in turn resulted in less work being done by the collaborators on their joint problems, particularly the problem of refining and coordinating their work plan. Thus the collaborators were not as timely in giving each other feedback on the directions their joint work should go, and hence they took longer to construct and select among the alternatives that guided the course of their work. This problem never became clear to the participants in the remote collaboration because each meeting, in and of itself, seemed productive and useful, and they did not have other, more informal contacts that they could use to supplement these meetings.

In contrast to this, the participants in the standard collaboration used their high frequency of meetings, both formal and informal, to construct and and select among alternatives quickly. The frequency of contact increased the utility of each meeting because questions that were posed could be answered quickly without too much intervening time dulling their memory regarding the point of interest. The informal contact served to reinforce decisions once they were jointly made and to create meetings spontaneously if an issue had to be addressed. The velocity of the cycle of interchange among the collaborators was increased in this way, and this served to hasten the pace of the entire collaboration.

This case study illustrates, to some degree, how formal and informal communication are used within the context of a working relationship to complement and supplement each other in driving a piece of work toward completion. Each serves a role in maintaining the social underpinnings of the relationship, and each provides some elements necessary for coordination of the production aspects of joint work.

Informal Communication and the Success of Collaborations

The previous section argued, on the basis of admittedly weak data, that more informal communication can lead to more successful collaboration. This section looks at a similar question using archival data to assess the patterns of authorship among working scientists and engineers. We attempted to determine whether physical proximity, which we view as a proxy for informal communication, was associated with successful collaboration. If a research team works together and publishes a joint paper, at some level they have solved the problems of group work, including identifying suitable partners, planning and executing work, and maintaining personal relationships.

We generated a dataset based on the population of working scientists and engineers in an industrial research laboratory. The research laboratory consisted of

approximately 500 Ph.D. and M.S.-level researchers in the physical, engineering, computer, and behavioral sciences. The organizational structure had three levels (laboratories, with approximately 125 members each; departments, with approximately 30 members each; and groups, with approximately 7 members each). The company was split between two campuses, located approximately 40 miles apart. Each building consisted of several floors with several wings per floor. We focused our analysis on a sample of 164 collaborating researchers, all those who had published at least two internal research reports in the preceding two and one half years at least one of these reports had to have a coauthor, and the other was either a solo-authored report or had a coauthor not included in the first report. For each of the 13,366 unique pairs of researchers (164 * 163 / 2) in the sample, we obtained data on four measures:

Collaboration: Data on whether each possible pair published at least one internal research report together were obtained from a company–maintained database of internal publications (scored 0 for no publication and 1 for a joint-authored report). Of the 164 scientists and engineers in the sample, 126 had published at least one joint article with another in the sample.

Physical proximity: Using the organizational phone book, which listed office addresses with codes for building, floor, and corridor, we computed a measure of physical proximity. Offices were coded 4 if they were on the same corridor of the same building, 3 if they were on same floor of the same building, but a different corridor, 2 if they were on different floors of the same building, and 1 if they were in different buildings.

Organizational proximity: Proximity on the organizational chart was coded 4 if the pair were in the same group, 3 if they were in the same department, 2 if they were in the same laboratory, and 1 if they were in different laboratories.

Research similarity: For each pair, we estimated the similarity of their publications on which they did not share authorship. The research similarity index is based on information retrieval techniques developed to identify semantic similarity in large text sources (Deerwester, Dumais, Furnas, & Landauer, in press). Basically, one derives the concepts in large samples of texts by computing a singular value decomposition of a text by word matrix, akin to factor analysis. The texts we used were abstracts of each author's non-collaborative articles. The centroid of the words in each author's abstracts was used to represent his or her work in a 30-dimensional space. The similarity of a pair of abstracts is the closeness of the concepts they contain in this semantic space. Although this is a continuous measure, for some measures we treated it categorically, differentiating the top quartile from the rest (see Kraut, Galegher, & Egido, 1989, for a more complete description of this methodology).

These four measures were then examined in a number of ways. We found, for example, that researchers were most likely to achieve successful collaborations with those who were physically close to them: 83% of collaborations occurred among researchers with offices on the same floor, even though these represented only 26% of potential collaborators. This is consistent with our earlier hypothesis that proximity leads to informal communication and informal communication aids successful

collaboration. However, the interpretation of this relationship is not this straightforward. The influence of physical proximity occurs partly because this organization, like many others, physically co-locates those who have needs for sustained and frequent communication. That is, researchers in the same organization and those with research interests in common are far more likely to have offices on the same corridor than are arbitrary pairs of researchers.

A logit analysis of the bibliographic data showed that research similarity, organizational proximity, and physical proximity all independently increased the odds of collaboration. Holding constant both research similarity and organizational proximity, the coefficient for physical proximity = .613 (standard error = .143, t= 4.26; p < .001). Table 1 shows the relationship between proximity and collaboration in a contingency table. It demonstrates that increases in physical proximity are associated with increases in successful collaboration both for researchers in the same department and those in different departments, and both for researchers with similar and dissimilar research interests.

Location	Research similarity				Organizational proximity			
Location	Lowest 3/4		Highest 1/4		Different departments		Same departments	
.	Potential collab-orators	% actually collabor-ating	Potential collab-orators	% actually collabor-ating	Potential collab-orators	% actually collabor-ating	Potential collab-orators	% actually collabor-ating
Same corridor	260	.77	333	14.41	399	6.02	194	13.4
Same floor	1755	.45	1122	4.19	2416	.70	469	8.10
Different floor, same building	3463	.06	1012	1.17	4447	.29	42	2.38
Different building	4534	.01	858	.69	5387	.13	12	0
Total	10023	.13	3343	3.38	12649	.48	717	9.07

Table 1. Association of Proximity and Collaboration

All of the phenomena we identified above probably contribute to this association of physical proximity and successful collaboration. Researchers who have offices close to each other have many more opportunities for conversations. As a result, they are likely to know and like each other and to know of and respect each other's work. The frequent, low-cost contact made possible by physical proximity creates many opportunities for potential collaborators to become acquainted, to identify common interests, to assess interpersonal compatibility, and to do preliminary planning before they become committed to working together. In a typical collaborative relationship, neither partner starts out specifically seeking a collaborator to help carry out an already well-defined project. Rather, research projects frequently emerge from the pre-existing interests and expertise of the participants in the course of casual discussion. These initial discussions became more intense and focused after researchers become committed to working together (See Kraut, Galegher, & Egido, (Under review). These

observations suggest that informal communication is important because it allows researchers to know about and to develop common interests with their neighbors.

Once a project is started, frequent, informal communication serves as a coordination and project management tool that helps keep the project moving forward. The coordination required of researchers becomes substantially more difficult to perform when they are not located in the same place or, as we discovered in the preceding section, when they have other constraints on their informal communication.

Summary

The preceding sections have shown that informal communication is frequent in R&D organizations, that it aids organizational members in learning about each other and their work, that it supports both production work and the social relations that underlie the work, and that it provides a critical mechanism that collaborators rely on to start joint work, maintain it, and drive it to conclusion.

Proximity leads to increased frequency of communication in general, and of informal communication specifically. Proximate colleagues have more opportunity for intended, opportunistic, and spontaneous conversations. Increased informal communication between colleagues leads to greater familiarity as well as increased satisfaction with colleagues and their work. One would expect that the familiarity and mutual respect fostered by informal communication would be a prerequisite or at least a powerful facilitator for successful working relationships and collaborations. Colleagues need to be familiar with one another in order to seek and dispense information to appropriate others. They must be familiar with one another and share a similar perspective, context, and working culture for successful collaboration. Colleagues who collaborate must also like one another and the work that each does in order to maintain their working group and continue successful collaboration over time.

Technology for Informal Communication

In many circumstances the ideal of close physical proximity for a working group cannot be realized. The realities of organizations may preclude individuals who are supposed to be working together from having their offices near each other. Communities of scientists, in particular, are often distributed across the nation or world. University departments often hire for breadth and may have only a single researcher covering a subspecialty. Graduate students on the job market, junior faculty denied tenure, and other faculty lured to a new institution by prestige or money frequently move far away from their advisors or colleagues. These factors mean that in the world of science, colleagues who would make the most suitable collaborators are often hundreds of miles away. In addition, in industry many projects, such as software development, are so large that physical proximity for the entire staff becomes a topological impossibility. For this reason, we became interested in creating artificial proximity through the use of technology.

In the previous sections we have seen some of the characteristics of physical proximity that make it especially suitable for informal communication. Here we review some of these characteristics and draw implications for features that artificial proximity must provide.

A concentration of suitable partners: Any system that wishes to support informal interaction must provide access to a suitable population of others. In the physical world concentration is accomplished by putting people who need to communicate close together. For example, as Table 1 showed, researchers in the same subunit and those who share research interests tend to be located in the same area in a building.

In the telecommunications domain, everyone who is connected to a common network is in some sense equally accessible, absent the constraints of distance-sensitive charges and lost phone numbers. Thus, as long as a sufficient proportion of the relevant population is connected, a population of suitable partners is also available (cf Markus, 1987). Yet, because everyone is equally accessible - friends and strangers, similar and dissimilar people - the availability of suitable partners may be too diffuse to create an effective community for informal interaction. Dialing a phone number at random or posting a message to a nation-wide electronic bulletin board is unlikely to put the initiator in touch with an appropriate research partner. The requirement for a telecommunications system to support informal interaction is to concentrate suitable partners.

Co-presence: For informal interaction to occur, people need an environmental mechanism that brings them together; in the same place at the same time. In the physical world, this mechanism can be a lunchroom, coffee lounge, or other space where people convene, or it can involve the complexity of movement around a work place. In the R&D laboratories we studied, people were constantly moving around. At any time almost 50% of the staff were out of their offices, and the episodes presented previously show that unplanned interactions occur frequently during these travels. Yet much information technology, such as electronic libraries and databases, reduces the need to move about in order to get work done, and therefore reduces the opportunities for casual interaction (e.g., Kraut, Dumais, & Koch, 1989). Similarly, separating people (into branch locations, for example) reduces the likelihood that they will occupy a common physical space, thereby reducing the likelihood of informal interactions as well.

The essence of telecommunications - literally communication from afar - is co-presence without physical proximity. While most telecommunications assume intentional action to initiate communication with a particular other, it is possible to devise other idioms for non-intentional telecommunications. Electronic bulletin boards, in which readers come across the postings of other users to the bulletin board, is one such example. Another example is commercial telephone services in which callers are connected to and participate in an on-going group conversation with strangers.

Low personal cost. The cost of communication, in terms of the amount of effort needed to initiate and conduct a conversation, is very low in the casual encounters we described previously. Often the contact is a side effect of other activities and, as such, involves no extra cost. To provide this low cost communication when people are

dispersed, we need to make getting in touch with one another as easy as bumping into another in the hallway. The behavioral costs of accessing a communications system and getting in touch with a desired other party are an important determinant of that system's usefulness. If the costs of using a communication source are too high (e.g., Cullan, 1983), as is the case with many of the "traditional" teleconferencing systems (Egido, 1989), the user will be either unable or unwilling to use that system for the brief, frequent, spontaneous conversations that are characteristic of informal communication.

Visual channel. The visual channel plays an important role in informal communication. As discussed previously, seeing someone can serve several purposes. It provides a means for recognizing the presence of another person, determining who they are, and assessing their availability for interaction. It also serves as a stimulus for picking a topic of conversation - reminding one person of something they wanted to speak to the other person about. Finally, the visual channel combined with the audio channel provides a medium to actually accomplish the conversation. A technology for informal interaction must support both audio and video communication if we are to successfully stimulate chance encounters.

These characteristics of physical proximity suggest some boundary conditions on potential telecommunication technologies to support informal communication. We use them to form the initial requirements for technologies to support informal interactions. In the next sections we describe two prototype telecommunication systems that take different approaches to solving these problems.

The VideoWindow Teleconferencing System

Imagine sitting in your work place lounge having coffee with some colleagues. Now imagine that you and your colleagues are still in the same room, but are separated by a large sheet of glass that does not interfere with your ability to carry on a clear, two-way conversation. Finally, imagine that you have split the room into two parts and moved one part 50 miles down the road, without impairing the quality of your interaction with your friends. That scenario illustrates the goal of the VideoWindow project: to extend a shared space over considerable distance without impairing the quality of the interaction among users or requiring any special actions to establish a conversation.

The VideoWindow (Bellcore, 1989) connects two public lounge areas with high-bandwidth video channels and full-duplex four channel audio. Figure 6 illustrates the VideoWindow system in use. The video images are projected onto a three foot high by eight foot wide "picture window," roughly twice the width of usual projection TV. This allows nearly the entire lounge area to be visible, with people appearing about the same size they would be if sitting across the room. The four channel audio provides sound localization, so that the speaker's voice appears to originate from the location of the speaker's image. When used for informal interaction, the system is left on 24 hours a day. To use it, a person need only walk into the room, glance at the window, and say "hello" to a person at the other end. At first glance, the VideoWindow system offers a very powerful sense of shared space and presence at a very low behavioral cost to the user.

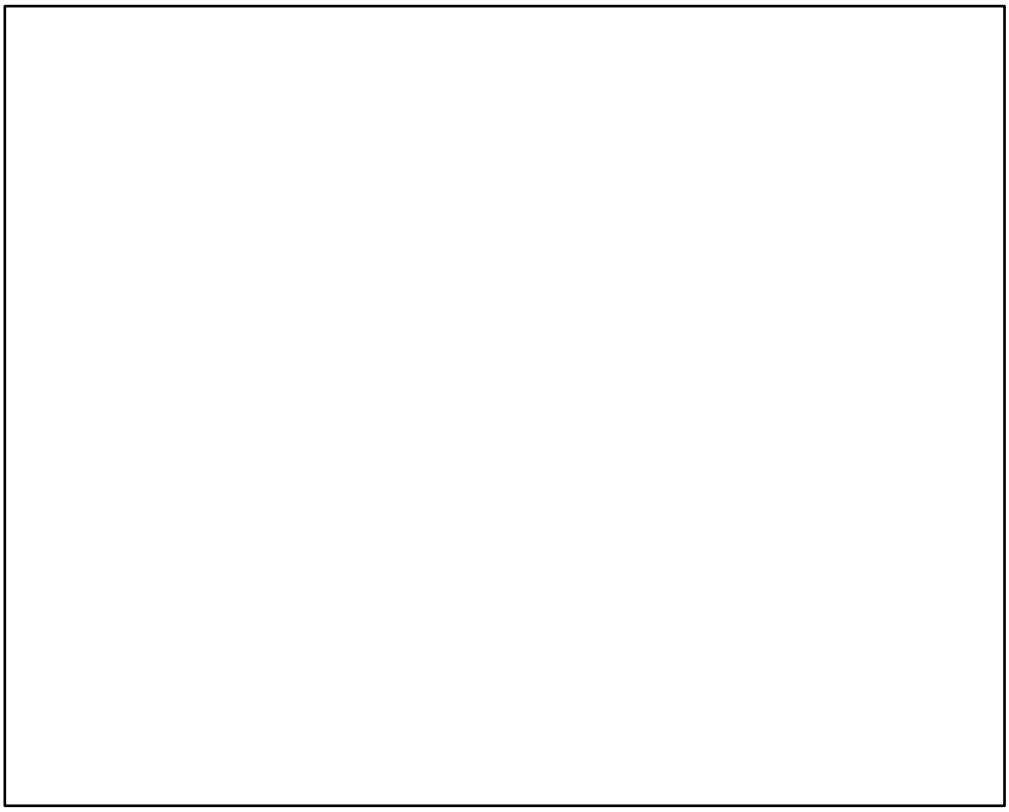

Figure 10: The VideoWindow Teleconferencing System

To look more closely at the effects of the VideoWindow system on informal communication, we conducted a three month trial in our laboratory. Two commons areas on different floors of a building were connected using the VideoWindow system. Over the course of the experiment, participants were questioned about their use of the system, their knowledge of other participants both local and remote, and their feelings about the technology. Video records were kept both of face-to-face interactions in the lounge areas and interactions that took place over the VideoWindow system.

We observed a total of 628 instances in which at least one person was present at each end of the VideoWindow system (364 cases of exactly two people, 264 cases of more than two people). Each instance represented an opportunity for people to strike up a conversation across the VideoWindow system link. On 153 occasions these opportunities were actually converted into verbal interaction, that is, either a greeting or a conversation. The average conversion ratio was thus 24%;11% of the two-person opportunities and 32% of the three-or-more person opportunities were used for interaction.

The videotapes of these interactions across the VideoWindow system suggest that in some cases the system was a transparent medium. Many interactions that took place via the window seemed indistinguishable from similar face-to-face interactions. People often spoke and acted in a fashion that, at least superficially, seemed altered in

only minor ways by the technology. They spoke a little louder and often embedded a discussion of the VideoWindow system itself in their discussion. Most of the 153 interactions we recorded would not have occurred had the system not been in place.

Yet the conversion ratio across the VideoWindow system was substantially lower than the conversion ratio for face-to-face opportunities. For this comparison, we examined 81 cases in which two people were together on a single side of the VideoWindow system -- i.e., in the same room -- and thus had an opportunity to converse face-to-face. Disregarding the 29 cases in which the face-to-face people were already talking prior to entering the VideoWindow system room, we found that 31% of face-to-face opportunities were converted to interaction. This is almost three times the conversion rate for pairs across the VideoWindow system.

This version of the VideoWindow system had some properties that worked against the initiation and maintenance of informal interactions. Some of the missed opportunities to converse across the VideoWindow system were due to design flaws in the user interface. About 18% of observed missed opportunities could be attributed directly to problems with camera and microphone placement. For example, people often tried to strike up a conversation by moving closer to the window. This caused their head to move out of the picture, so they could not be recognized, and put them out of microphone range, so they could not be heard. This type of flaw could be fixed with feedback, letting a communicator know whether he or she could be seen at the other side of the system. Other problems may be more endemic to the underlying technology. Eye contact is an example. Humans can shift their gaze to meet another's eyes wherever that person may be, but conventional cameras have a fixed point of view. This leads to anomalies in apparent eye contact that do not occur when people are face-to-face. Another problem is that it is easy for people to stand out of camera range where they can see the image in the VideoWindow system but not be seen by people at the other end. (Note the man at the left edge of Figure 6, who can see others in the VideoWindow system, but cannot be seen by them.) This contrasts with face-to-face interaction, where covert observation rarely occurs and requires extra effort on the observer's part. Solving these sorts of problems requires rethinking how video cameras and monitors are designed and placed in personal communications systems.

Once a conversation was initiated, communication over the VideoWindow system sometimes broke down. One problem was that the VideoWindow system made it difficult to establish private conversations in otherwise public areas. In fact, the ability to make a conversation private was one of the most frequently requested improvements mentioned by users in our sample. When people in a conventional meeting room wish to exchange private information, they simply move closer together and lower their voices. This capability is not supported by the VideoWindow system or any teleconferencing systems designed to link public areas together with hands-free audio. Teleconferencing technology is designed to allow several people to converse clearly at the same time. The case of private conversations illustrates a more general point: technology-mediated systems do not currently have the communication flexibility and ability to manipulate media characteristics that we take for granted in face-to-face conversations.

Another class of problems stems from the social and environmental context in which the VideoWindow system is situated. A VideoWindow system installation requires that users go to the room in which it is installed in order to use it. This imposes a moderate behavioral cost on users to access the technology, unless they are already using the public space. The centralized nature of the VideoWindow system also results in a sampling problem: potential encounters are limited to the set of people who occupy VideoWindow system's extended space at the same time. On average, people are more likely to be someplace other than in the VideoWindow system room. In addition, the probability of being acquainted with persons at the other end may be low, given the low degree of familiarity with people at remote locations. As we have seen, even within a single building, a person is less than half as likely to know a person whose office is on an adjacent floor than a person on his or her own floor.

Although the VideoWindow system can support informal interaction at a distance and may be useful in some contexts, its implementation requires careful attention to social detail. One could imagine connecting the cafeterias of two research organizations whose members already know each other and who have reason to work together. In other circumstances - where the VideoWindow system connects strangers, and where people occupy the VideoWindow system locations infrequently - the probability of encountering a suitable partner and striking up a conversation is low. So, even though VideoWindow system may extend the boundaries of one's physical space and increase the absolute number of people with whom one can interact, it does not necessarily extend the effective work space or the social environment in which most people work and in which most informal conversations take place.

However, even when all these problems are accounted for, the VideoWindow system was not as effective as we had expected, due to factors we still do not understand. One problem may be that the apparent distance/size constancy mechanisms that the human perceptual system uses to judge the distance and size of objects do not operate correctly in this technology. In addition, it may be that even with life sized images, the psychological distance to someone at the other end of a VideoWindow system link is greater than that in a comparable face-to-face situation. People had to work hard in the face-to-face situation to ignore someone who was physically in the same room. When they wanted to avoid conversation, people went to great lengths to avoid eye contact . In contrast, ignoring another person on the opposite side of the VideoWindow system was much easier, and looking at them didn't seem to create the obligation to engage in conversation. In spite of its value, then, VideoWindow system currently does not provide the same degree of social intimacy as does face-to-face interaction.

The implications of this experiment are clear. First, we must pay close attention to the human factors of system design. Simply connecting two locations is not enough - we must also ensure that the technology can be used easily and without errors. Problems must be engineered out of the system. This is especially important with audio/video systems, because while these technologies appear to be like face-to-face communication, the subtleties of camera framing and audio placement
lead to important differences that users can't be expected to understand. To solve these problems, we must learn more about how the characteristics of basic video

technology affect the usability of telecommunication systems and about the difficulties caused by fixed camera positions and audio that is insensitive to user behavior. Second, we must reduce the behavioral cost to the user of gaining access to the technology in the first place. One solution to this problem is to bring the system to the user. Finally, we must address the person-sampling problem; the user must be able to get in touch with the right people regardless of location.

Cruiser

The Cruiser system (Root, 1988; Fish, 1989) is a switched telecommunication system (like the telephone) that allows a user to have an audio and video connection to any other user in the Cruiser network. It was designed to support informal communication at a distance among colleagues, while solving several of the problems identified during the VideoWindow experiment. In particular, it lowers the behavioral cost of communication by placing audio and video equipment on the user's desk top. In addition, Cruiser provides innovative mechanisms for initiating connections between users to encourage frequent, informal, and unplanned communication among members of a distributed community. These mechanisms provide access to a large but select group of conversational partners independent of location.

Cruiser and informal communication. Users of this network can treat it merely as a video telephone and call any other user directly. But Cruiser was explicitly designed to support serendipitous interactions, and a measure of its success is the extent to which it leads to fruitful or enjoyable conversations that were unintended. One mechanism for these chance encounters is the "cruise." Here, Cruiser tries to simulate the experience of walking through a hallway and stopping to chat with whomever one encounters along the way. The virtual hallway is the set of offices and other locations connected to the system. The set of locations the user actually visits is called a path; this can be one or several stops along the cruise. A single command causes Cruiser to switch to each location on the user's path in turn, pausing to give the user a brief audio and video "peek" into each office along the way. Both parties can see each other and can determine if they wish to have a conversation and if their partner is available. If the user spots someone to chat with, another command interrupts the cruise and connects the two locations until the user decides to move on again. If the user does not wish to converse, the connection times out after a few seconds.

The path can be explicitly set by users who type a list of other users to visit. More interestingly, the path can be determined by the Cruiser system itself, by selecting from a pool of potential conversational partners. Users, a system administrator, or intelligent software can create a separate pool for each user and assign to each person in the pool a weight indicating the relative probability of that person being visited on a cruise. For example, users may list people whom they would like to see more frequently. The system administrator may add other people to this list based on criteria such as similarity of background or current work projects. In an R&D organization, for example, one might have researchers in small specialty areas "running into" each other and keeping in touch over the Cruiser system. Finally, the pool of potential partners might be updated by computer programs that monitor the environment, add to the pool, and

change probabilities depending on current conditions. For example, if a member of a research organization publishes a new research report in a user's area of expertise, software might automatically increase the weight for that partner in the user's cruise list. Similarly, a computer program could change the weight of individuals in a user's pool depending on the recent history of that user's other communication activities (e.g., telephone calls or electronic mail). For example, Cruiser might increase the opportunity for chance encounters with people one is already going out of one's way to reach.

Cruises can be explicitly initiated by typing the "cruise" command. The motivation may be work-related (e.g., "I need an answer to a question. Who is around to help me?") or social (e.g., "It's lunch time. Who is available?"). In addition, cruises and opportunities to converse with other users may happen as side effects of other noncommunication-oriented activities. Just as a person might stop to converse with someone while walking down the hall to pick up a computer output, the Cruiser software itself might initiate a cruise when a user types the "print" command on a computer. Linking a cruise to the reading of electronic mail or bulletin boards is especially appropriate because by executing these computer commands a user is implicitly saying, "I am interrupting my on-going activities to be put into contact with social information."

Cruiser connections may also be initiated when two users are participating in the same event. Cruiser can connect offices with public conference rooms, so a user might attend a lecture through Cruiser. Just as side-conversations often break out among the audience at a lecture, so too with Cruiser, one can scan and be connected to other people using Cruiser to attend the lecture. Combining special video hardware (called picture-in-picture devices) with audio switching allows side-conversations to take place without disrupting the main lecture.

Issues in the Tradeoff of Access and Control

We hypothesize that these technologies can be used to overcome some of the barriers to informal interaction that physical dispersion introduces. Although we have conducted a behavioral experiment with VideoWindow system and discovered some of its limitations, at this writing (October, 1989) we still have little experience with the use of Cruiser.

The capabilities that the VideoWindow system and Cruiser provide come at a price. In particular, the value of informal communication is often asymmetrical. While we want easy access to other people, we want to control access to ourselves. Examining conventional conversations in the work place, we see that a convenient, intentional communication for one person is an interruption for the person who is being addressed. We are discovering in building our technology prototypes that important design issues consist of resolving the trade-off between achieving access to others and protecting their time and their privacy.

One characteristic that determines the social quality of some offices is the relatively free access coworkers have to each other. People often gather in hallways, cafeterias,

and other common areas where they are free to converse. Offices are often open to coworkers, providing accessible communication channels for both signaling and interaction. It is considered appropriate behavior to glance into an open office while walking down the hallway, and it is usually acceptable to drop in and have a chat on the spur of the moment. While these characteristics of offices are undoubtedly culturally variable (Hall, 1966), and depend on the relative status of coworkers and current trends in architectural and job design, they are common in the relatively open and relaxed research and development environments we observed. For these mechanisms to work, people need to make themselves available. The bulk of this chapter has tried to demonstrate that people do indeed make themselves available and that, as a result, informal interaction is one of the primary communication tools of the work place.

For telecommunication systems to support informal interaction, people need to make themselves available through this medium as well. With the VideoWindow system, public spaces must be continually connected to support drop-in conversations. Cruiser requires that users leave a camera and microphone on in their office. As a result, both of these technologies raise questions of privacy and control that pose fundamental problems for the design of telecommunication systems for informal interaction.

At the heart of the matter is the tradeoff between easy access for informal communication and the ability to control one's communication environment. Users have two major concerns. First, they are worried that their privacy will be violated; others will see them and learn information about them without their ability to control it or without their knowledge. Users are concerned about displaying both visual and verbal information (Sundstrom, 1987). Surprisingly, most potential users of Cruiser and other video communication prototypes with similar goals (Abel, 1989) believe that audio information is more revealing than video. Compounding this general concern about privacy is the worry that those with power might abuse the system by snooping surreptitiously. The second major concern of users is about uncontrolled intrusions; telecommunication provides an additional channel through which visitors can intrude into the user's work space. For all the value of informal communication, it has the drawback of consuming a scarce resource - time. Telecommunication systems like Cruiser enlarge the pool of people who can steal time from priority tasks. High status people in organizations rely upon both social and technological mechanisms, such as secretaries, appointment calendars, and answering machines, to prevent interruption. In a sense, Cruiser subverts these mechanisms. Potential users of Cruiser do not want to be open to a large number of people who intrude upon their space and consume their time.

In the physical environment of the office, these matters are partially regulated through social conventions that dictate who can interrupt whom, when to knock, and so on. In a public space, a conversation may be made private by the participants lowering their voices or moving to a private space. Office occupants may exert direct and explicit control over their local environment, for example, by closing the door to the office. This simple act both creates barriers to the flow of information in or out of the office and signals to potential visitors about the occupant's availability for interruption.

These considerations have led us to design a number of features for providing users with control over their privacy and access. First is the use of reciprocal views, or the "see and be seen" strategy. When a person visits another office using Cruiser two things happen: the visitor can see and hear what is happening in the other office, and the occupant of the visited office also sees and hears what is happening in the visitor's office. This feature insures that occupants are not spied upon or observed without their knowledge. Next, to give users the ability to look into an office to ascertain the occupant's presence, or simply glance in while passing by, we have adopted the notion of a limited duration "peek" (Goodman & Abel, 1987) still following the principle of reciprocal viewing. This feature provides sufficient time to see if the occupant is available but limits the duration of an intrusion. Third, we have heard from many people that one advantage of the real office is that they can hear someone walking past the doorway. We simulate this in Cruiser by providing an audible signal when someone peeks into a user's office.

Finally, we can provide a number of controls to give occupants the functional equivalent of a door between them and Cruiser's virtual hallway. Occupants have the option of setting a busy flag on the audio and/or the video signals emanating from their offices. When a busy flag is set, visitors will receive a notice on their workstation indicating that a channel is not available. If, for example, the video is open but the audio is unavailable, a visitor will still get the short visual peek into the office but will not be able to hear anything. If an interaction ensues, the occupant may, of course, allow audio communications at any time. These privacy flags may be set explicitly, with a workstation command, or implicitly, by sensors attached to the physical door or telephone. When the office door is shut or the telephone is in use, the busy-flag can be activated automatically.

Many of these features - selective media blocking, reciprocal views, visual status cues -will be incorporated into Cruiser and evaluated in trials, but again there is a design tradeoff: at what point do the protection schemes increase the cost of communication to the point that drop-in interactions will simply not occur, thereby defeating the goals of the system? One intent of our experimental trials is to reveal whether these manipulations are either necessary or sufficient for users' acceptance of the system.

Conclusions

The intricate choreography necessary to do work in organizations requires effective coordination. Throughout this chapter we have argued that informal communication, generally mediated by physical proximity, is crucial for this coordination to occur. Informal encounters are useful means of getting people to know and like each other, of creating a common context and perspective, and of supporting planning and coordination in group work. Indeed, without them, collaboration is less likely to start and less productive if it does occur. Physical proximity helps by allowing appropriate people to encounter each other frequently, by supporting visual channels to induce and assess readiness for communication, and by supporting highly interactive conversation.

What happens when groups get too large or spread out to allow physical proximity to support informal communication? Telecommunication and computer technology may be able to take the place of proximity. In this light, we presented the VideoWindow system and Cruiser. The VideoWindow system is based on the concept of extending a large shared space and providing informal communication access via video and audio. The system is available 24 hours a day, and workers merely enter the room, "bump" into someone on the other end, and converse. Cruiser is based on the metaphor of walking along a hallway and stopping to talk with whomever is encountered along the way and is available for conversation. Cruiser provides informal communication access by putting the audio and video equipment on the user's desk top and by using a switched audio-video network to connect offices and other locations together, leading to a large number of potential connections.

We have discovered that designing telecommunication systems to support informal interaction at a distance requires the resolution of many tradeoffs. System designers must understand and be sensitive to the needs and concerns of system users. They must be alert to the subtleties of etiquette and the protocols that govern social interactions, be concerned with the possibility of unwanted intrusions or surveillance, and balance the need for casual access against the desire for control of one's personal space. A system must provide access and openness as well as restrictions and privacy. There is a need for mechanisms which support subtle communication protocols and are sensitive to the social context in which communication systems are embedded. We need to explore these issues "in vivo" with real prototypes and users, and we need to develop appropriate design and evaluation methodologies for innovative system design and effective evaluation. It remains to be seen whether we will be able to solve these problems in the VideoWindow and Cruiser systems.

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Figure 1: The formality dimension of communication.

Episode 1: The call

Episode 2: Stop short

Episode 3: At the candy machine

Figures 2-Figues 4: Episodes of impromptu meetings

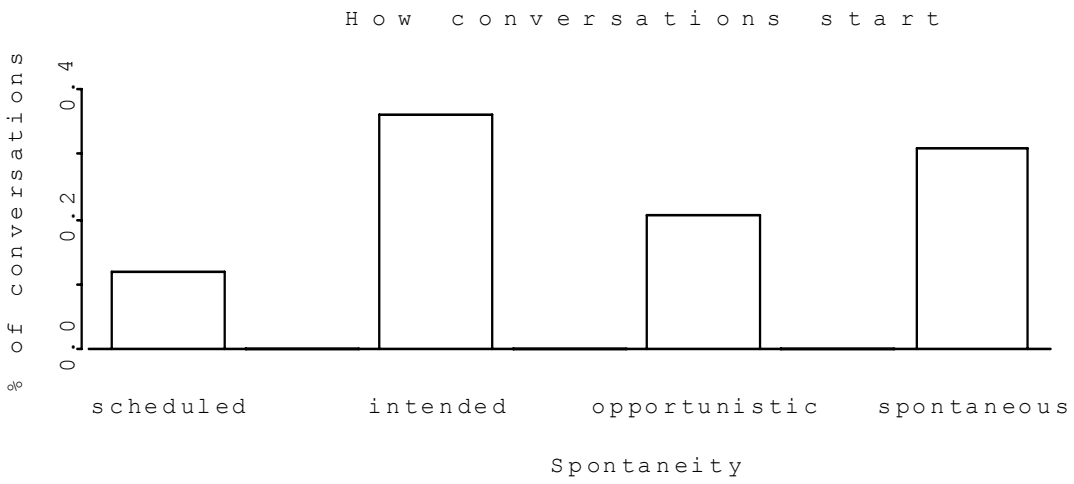

Figure 5: Frequency of conversations

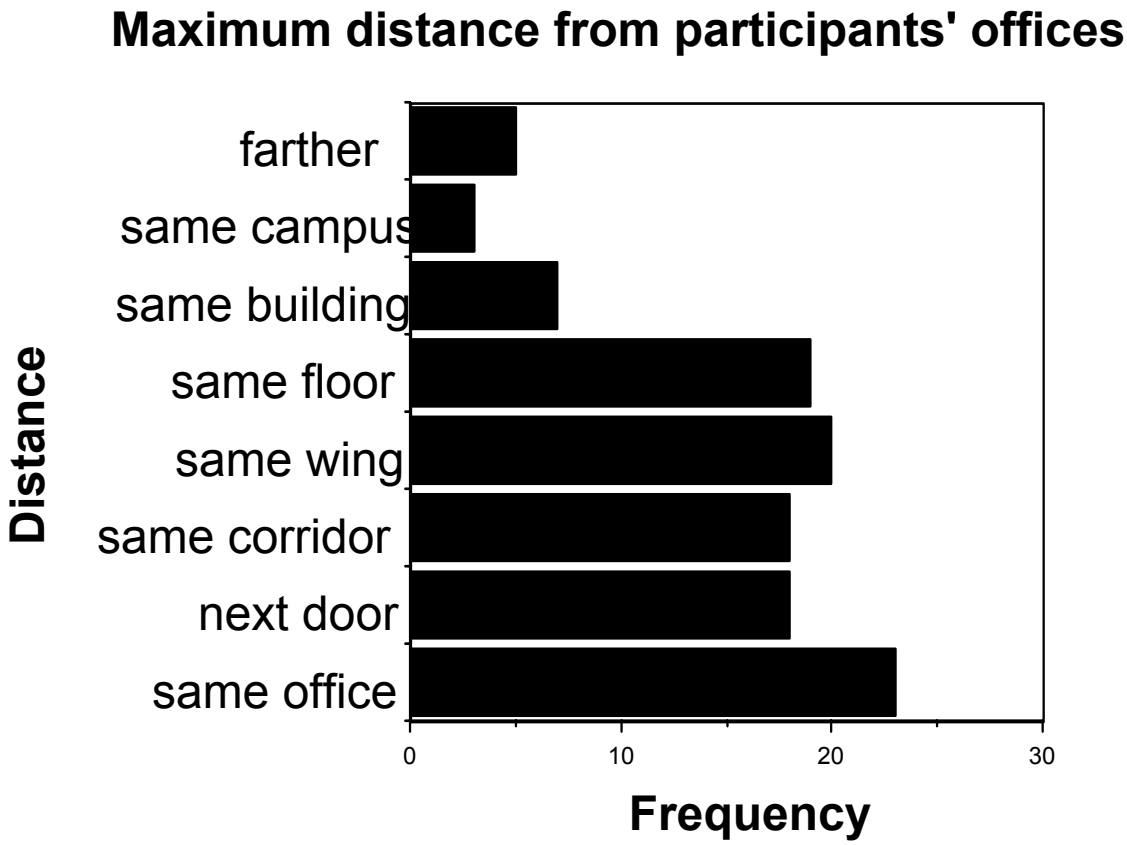

Figure 6: The location of conversation

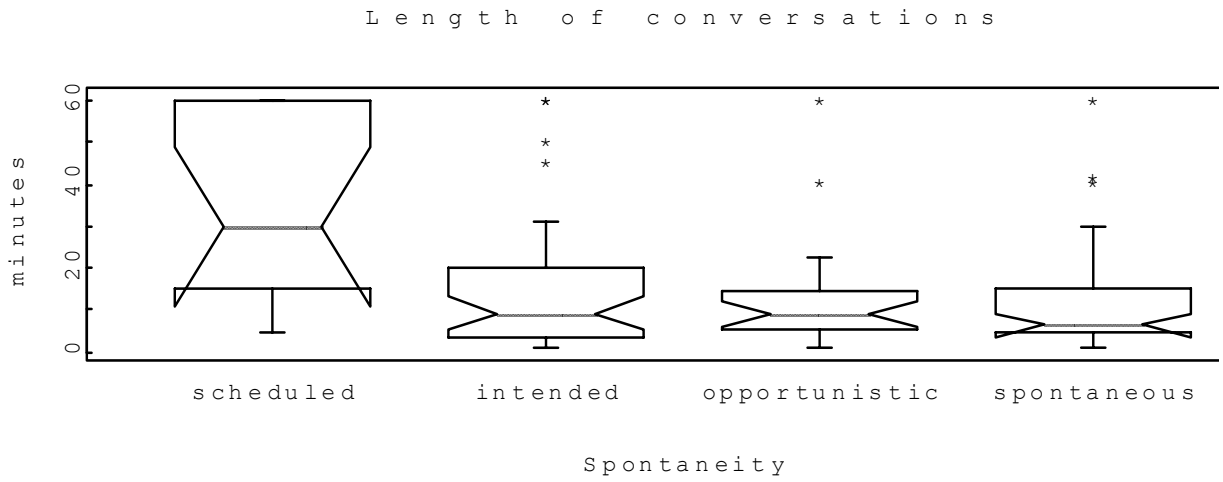

Figure 7: Duration of conversations

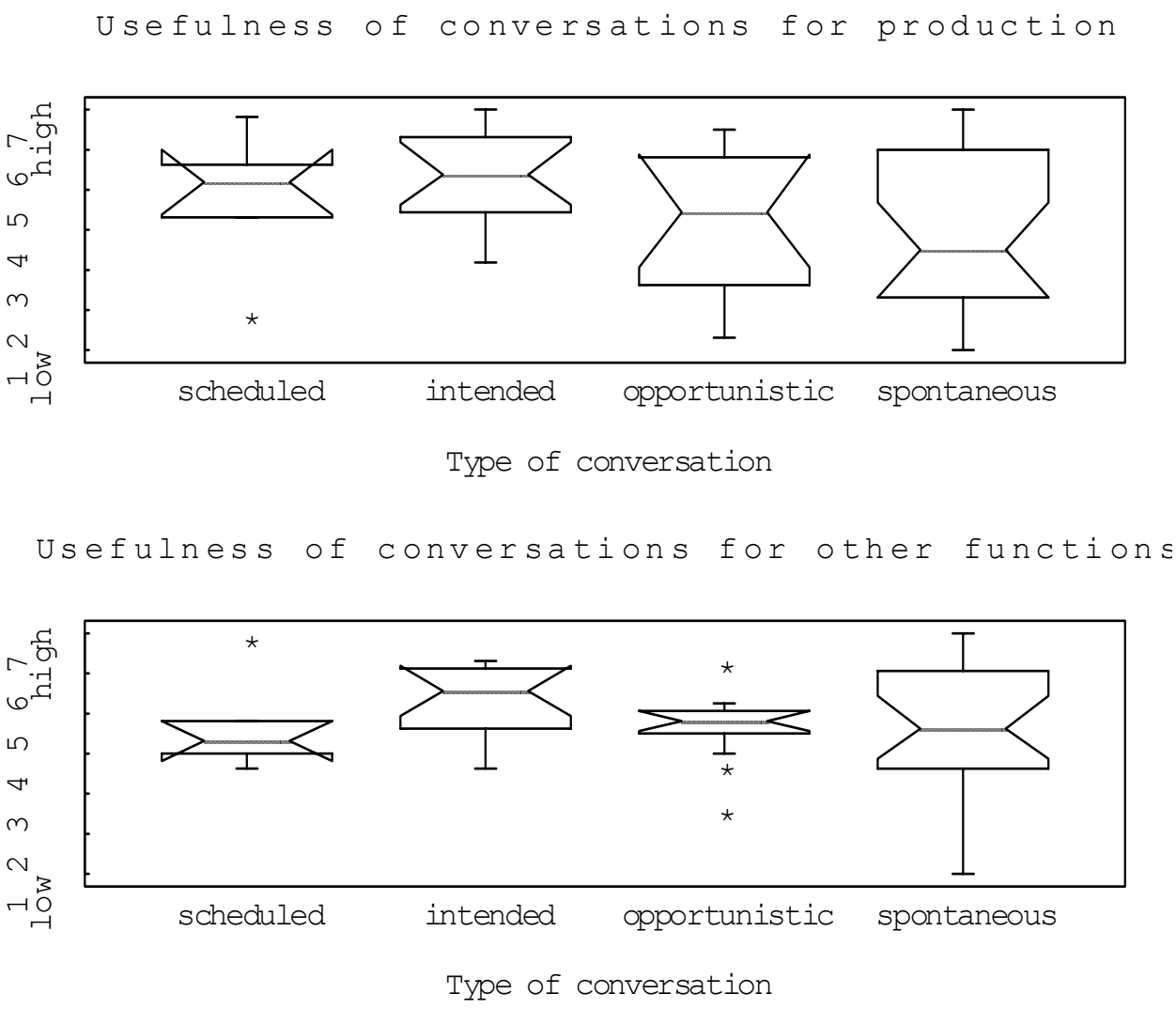

Figure 8: Value of conversations for production and other functions

Schedule versus actual meeting times
for the remote and standard collaboration

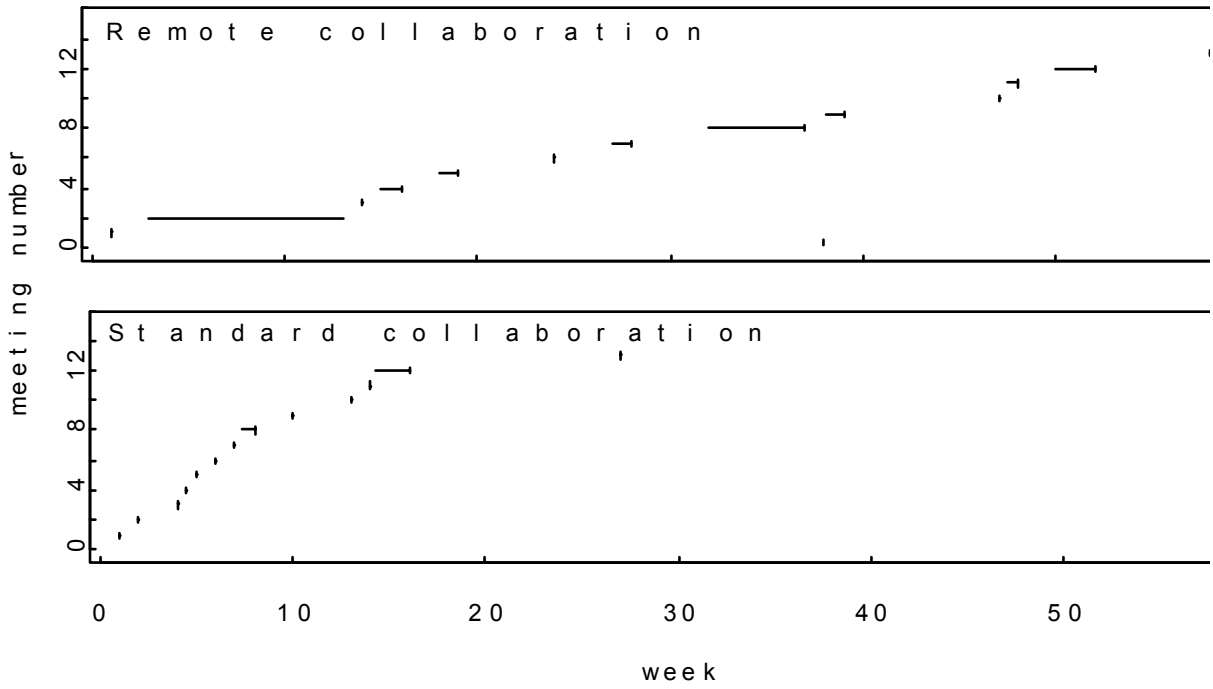

Figure 9: Timing of collaborative meetings

The VideoWindow Teleconferencing System

Figure 10