

Communication across Boundaries: Work, Structure, and Use of Communication Technologies in a Large Organization

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Abstract

Recent popular and theoretical literature emphasizes the significance of communication technology for collaboration and information sharing across organizational boundaries. We hypothesize that due to the collaborative nature of their work and the way they are organized in work groups, technical employees, as compared with administrative employees, will communicate laterally, and will use the telephone and email for this purpose. We studied technical and administrative employees in seven departments of a large telecommunications firm. From logs of communication over two days, we examined vertical and lateral communication inside and outside the chain of command and department, and the use of telephone, email, and voice mail for this communication. Technical employees did have more lateral communication than administrators did, but all lateral communication (not just that of technical employees) tended to be by telephone. Over 50% of employees' communication was extradepartmental; extradepartmental communication, like lateral communication, tended to be by telephone. When employees used asynchronous technology, technical employees used email whereas administrators, especially those at high levels, used voice. Differential boundary-crossing by technical and administrative employees could be explained in part by the flatter structure of the technical work groups. Our results are consistent with Powell (1990), Barley (1994) and others who have argued that the rise of technical work and the horizontal organization of technical workers increases collaboration and nonhierarchical communication. Organizations can encourage communication flows across organizational boundaries by strengthening horizontal structures (for technical workers, especially) and supporting old and new technology use by all employees.

(Boundary Spanning; Communication Technology; Electronic Communication; Hierarchy; Structure

In the early days of computers, visionaries foresaw offices and factories humming with self-propelled robots. Today, a more likely vision has the firm humming with communicating employees. Many large organizations have installed a complex network of computer-based telephone, facsimile, printing, voice mail, email, and even videoconferencing technologies. These technologies increase the potential for communication in the organization. They also can support changing patterns of communication. Because technology reduces the cost and unreliability of relaying orders, management can tighten control (Casson 1994, p. 73; Sproull and Kiesler 1991, Ch. 6). The rhetoric of recent popular, business, policy, and organizational analyses, however, has emphasized a different kind of change, reflected in terms such as "self-managed teams," "computer-supported collaborative work," "flat organization," and "horizontal corporation" (e.g., *Business Week* 1993, Drucker 1988, Krachenberg et al. 1993, Quinn 1992). In this view, communication technology is used to foster collaboration and information sharing rather than control.

We propose in this paper that collaboration and information sharing imply employees communicate wherever and however they need to in order to solve

problems and exchange know-how (e.g., Malone and Rockart 1991, Miles and Snow 1986, Nickerson 1992, Sproull and Kiesler 1991, Walton 1989). Hence, employees who need to collaborate and share information will use communication technology to communicate across organizational boundaries. Here, we define crossing boundaries as communicating nonhierarchically, that is, laterally, at the same level of the authority structure, and "diagonally," vertically outside the chain of command (Wilson 1992). Second, we propose that since technical work and workers particularly rely on collaboration and information sharing with peers, technical employees will use communication technology laterally more than administrative employees will. Finally, we propose that communication technologies can be ranked by how well they suit collaboration, particularly the intense exchange of information required for planning and technical exchange (Kraut et al. 1990). From an analysis of the attributes of three popular technologies—telephone, voice mail, and email—we predict that crossing boundaries in communication, and communication by technical workers, will be associated with the use of the telephone, and secondarily, with the use of email. We examine these ideas in a study of the use of these communication technologies in a large organization.

Influence of Work on Structure and Communication

From a large recent literature on communication and structural change in organizations has emerged a picture of a new ideal type of organization "radically different from the Weberian bureaucracy [and] characterized by relations that are based on neither hierarchical authority nor market transactions..." (Nohria and Eccles 1992, p. 288). This new ideal type has been given various labels, among them "network organization" (Powell 1990, Thorelli 1986), "heterarchical organization" (Hedlund 1986), and "post-bureaucratic organization" (Heydebrand 1989). Communication in such an organization is dense, fluid, and flexible, crossing organizational boundaries of formal authority and department.

But is all network organization the same? We suggest a distinction between the networks of technical and administrative workers. We define technical workers as employees who exercise analytic or manual skills developed through extensive formal training in a specialized field (Barley 1994). Administrative workers exercise management skills, frequently developed in on-the-job training and experience (Hall 1986). In an influential paper, Powell (1990) has discussed how crafts and high-technology industries and some profes-

sions are characterized by a skilled labor force with fungible knowledge, ill-defined boundaries, overlapping work roles, and ties across teams and members of other organizations. Barley (1994) argues that firms are exploring structures and cultures of collaboration in response to technological advances and a long-term shift towards a horizontal division of labor along lines of technical expertise and occupation. These analyses suggest we take a more differentiated view of the network organization. In this more differentiated view, technical employees and administrative employees cross boundaries differently. Hence technical employees might especially communicate laterally within and across departments, reflecting their horizontal organization and need to collaborate and share know-how.

Researchers have long argued that when work is nonroutine, employees communicate both laterally and "diagonally" outside their immediate chain of command (Ancona and Caldwell 1992, Perrow 1967, Randolph and Finch 1977, Wickesberg 1968, Wilson 1992). However, technical work has been particularly associated with lateral communication both because of the nature of this work and because of the way technical workers are organized. Technical work involves "unanalyzable tasks" (Perrow 1967, Rice 1992) and is frequently complex, contextual, and interdependent with other technical work (e.g., Brooks 1987, Curtis et al. 1988; Kraut and Streeter 1990, Nohria and Eccles 1992). Mistakes or problems in one part of a complex technical system can have disastrous, unanticipated consequences (Travis 1990). Technical employees need to continually discuss nonroutine problems and integrate solutions. Doing so requires ongoing lateral coordination that may not be necessary in standardized production or administrative, bureaucratic work (Ouchi 1980).

Lateral communication among technical workers is fostered not only by the nature of technical work but also by the way technical workers are trained and organized, frequently in teams and within a strong horizontal structure.¹ Horizontally structured organizations can be traced at least to the specialized craftsmen found in medieval feudal manors and monasteries and later in crafts guilds (Kieser 1989). Professional, technical, and crafts people have long been considered to be organized horizontally, by occupation or specialization. Collaboration and information sharing are hallmarks of horizontal structure. Consultation across specialists is not only required for coordination but also to overcome excessive specialization, which may result from hierarchy (Raelin 1986, Barley 1994). Consultation through informal lateral channels also improves indi-

viduals' ability to keep up with changes in techniques and new knowledge, and to understand and adopt innovations (Abbott 1991, Burt 1980, Papa and Papa 1992, Rice and Aydin 1991). Finally, a strong horizontal structure tends to undercut power within the hierarchy, leaving employees in divisions and specialties with considerable autonomy (Raelin 1986).

As compared with technical work, administrative work has been associated with hierarchical communication. In its most common form in the industrialized world, the hierarchical relationship of superior and subordinate requires an authority structure, a mechanism to ensure superiors can control and monitor subordinates (Galbraith 1973). Theoretically, authority offers an efficient alternative to direct communication under conditions of complexity and interdependence (Aldrich 1979, Cyert and March 1963, Simon 1962). Rather than everybody repeatedly discussing what each person should do, management distributes and exercises control of work through layers of supervision, which in turn buffer managers from unnecessary communication (Downs 1967, March and Simon 1958). Hierarchical organization is designed to thrive upon the division of labor and unity of command. That is, in order to increase efficiency and control, employees work in functional units or departments (Thompson 1967); each employee specializes in a few tasks for his or her department and reports to a single superior (Galbraith 1973). Strictly held, the division of labor into functionally specialized units and unity of command constrain communication linkages to specified vertical connections within the chain of command (Galbraith 1973).

Administrators, by virtue of their role in the hierarchy, communicate within a chain of command. However, it has long been known that administrators often face nonroutine problems and exchange information with those in functional areas outside the chain of command, and especially diagonally (Randolph and Finch 1977, Wickesberg 1968, Wilson 1992). Research on the value of weak ties (Granovetter 1982) suggests at least two reasons why administrators, especially, may engage in nonhierarchical communication. First, managers need to survey people widely in order to identify and make sense of organizational events (Kiesler and Sproull 1982). Greater diversity of weak tie contacts across levels and departments increases the probability of finding out new information and identifying problems and solutions (Granovetter 1982, Burt 1983). Second, managers might need to contact people outside their group, and especially upwardly, in order to obtain resources for their group. Lin and his colleagues

(e.g., Lin 1982), argue that linkages to weak ties are useful to the degree they put people in touch with those offering superior resources. If so, we would expect administrative employees to initiate communication diagonally because those at higher levels in other departments may have more resources not offered by their own superiors.

In sum, we argue that all employees will communicate across organizational boundaries using technology. However, we posit that technical employees will be distinctive in the degree to which they engage in lateral communication both because of the nature of the work they do and because of the way they are organized. Among technical workers, coordination occurs primarily through direct communication among different specialists within and across departments (e.g., Adams 1976, Allen 1977, Lave 1988, Pelz and Andrews 1966, Tushman 1977). Therefore we offer the following hypothesis.

HYPOTHESIS 1. *Technical employees, as compared with administrative employees, will have proportionately more lateral communication as compared with vertical communications.*

Influence of Work on Use of Communication Technology

If employees' work influences how they communicate across boundaries, and if communication technology aids in this communication, then it follows that employees' work influences their use of communication technology (Bizot et al. 1991, Conrath 1973, Eveland and Bikson 1987, Rice and Case 1983, Rice et al. 1989). Daft and Lengel (1984, 1986) and Daft et al. (1987) have argued that people need to use "rich" channels for uncertain and equivocal communication (see also Dubin and Spray 1964, Hannaway 1985, Putnam and Sorenson 1982). Uncertainty means that data are missing; equivocality means that values, schema, or meanings for interpreting events are ambiguous or conflictful. From this argument, Daft et al. have predicted that managers at higher levels will need to use rich means of communication, face-to-face being the richest of all channels. This prediction resembles an earlier argument by Short et al. (1976) that people who must solve nonroutine complex problems perform better when communication channels convey "social presence."

To test the information richness formulation, researchers have examined the links between task characteristics and use of technology, and between managers' positions in the organization and their preferences for technology. The first relationship, that is,

between task uncertainty and equivocality and technology use has received support. People working on complex, nonroutine, "unanalyzable" problems prefer and benefit from working face-to-face or if that is not possible, from talking by relatively "rich" technology such as telephone (e.g., Kraut et al. 1992, Rice 1992, Straus and McGrath 1994, Weeks and Chapanis 1976). The second relationship, that is, between managerial position and preference for technology, has received only mixed support. Managers do have many face-to-face meetings, a "rich" medium, but managers also advocate and use email, a "poor" medium (e.g., Feldman 1987, Markus 1994, Rice et al. 1989, Trevino et al. 1987). Researchers have proposed that email is not, in fact, information poor, or that other virtues of email, such as its convenience or positive symbolic value, or the large number of coworkers using email, can outweigh its faults (e.g., Feldman 1987, Markus 1990, Trevino et al. 1987).

Researchers have suggested that information richness (or social presence) may involve multiple dimensions (e.g., Rice 1993, Steuer 1992, Zmud et al. 1990). Two physical dimensions are bandwidth and synchrony. Bandwidth refers to the ability to exchange information from all human senses: sight, hearing, smell, and so forth (Nohria and Eccles 1992). Telephone has more bandwidth than voice mail, and voice mail more than email (Fish et al. 1993). Synchrony refers to whether people can communicate at the same time. Telephone is synchronous (except when one leaves a message.) Email and voice mail are not synchronous.

The technology attributes of bandwidth and synchrony may have different functions in communication. Bandwidth might be especially important when people need to exchange social information and social context cues, for example, when trying to establish trust with a stranger or when trying to establish dominance over a subordinate (Nohria and Eccles 1992; Zmud et al. 1990). Social information and context cues increase involvement, comprehension through back channel cues, and social pressure (Kraut et al. 1992, Reid 1977, Siegel et al. 1986, Sproull and Kiesler 1986, Straus and McGrath 1994). We propose that telephone, voice mail, and email, which differ in bandwidth, also differ in how much social information they provide. Telephone allows people to exchange more social information than voice mail. Voice mail allows people to exchange more social information than email (Rice and Shook 1990). Hence people who need to convey social information will use telephone over asynchronous technology, and within asynchronous technologies, voice mail over email.

Synchrony might be especially important in exchanging and discussing complex information such as the details of a technical plan, draft of a document, or interpretation of a statistical finding. Synchrony permits a great amount of information to be exchanged in a given unit of time, and ongoing feedback so that people can adjust what they say to one another, correct misunderstandings, and fill in details. People perceive rapid exchange to be important for lateral communication (e.g., Zmud et al. 1990) and collaborative planning and problem solving under uncertainty (Finholt et al. 1990, Kraut et al. 1992, Reid 1977). We propose that telephone, voice mail, and email differ in how much substantive information they provide. Because telephone is synchronous, it allows people to exchange more content in a given unit of time than asynchronous technologies (Barry and Bateman 1992). But telephone not only affords synchrony; it also requires synchrony: that people be available at the same time. So, in some situations, asynchronous communication may be preferred. Email, because both parties can edit, store, forward, and print the same text, allows for more exchange of content in a unit of time than voice mail. Hence people who need to discuss large amounts of content, for example, in detailed technical coordination, will use telephone over asynchronous technology, and within asynchronous technologies, email over voice mail.

Our arguments suggest the following hypotheses.

HYPOTHESIS 2. *Technical employees, as compared with administrative employees, will use the telephone proportionately more than administrative employees use the telephone.*

HYPOTHESIS 3. *When employees use asynchronous technology, technical employees, as compared with administrative employees, will use email proportionately more than voice mail.*

HYPOTHESIS 4. *All employees will use the telephone rather than asynchronous technology proportionately more for lateral communication than for vertical communication.*

HYPOTHESIS 5. *All employees will use the telephone rather than asynchronous technology proportionately more for communication outside the chain of command than for communication inside the chain, and more for communication outside the department than for communication inside the department.*

Hypothesis 2 derives straightforwardly from the argument that telephone provides for discussion of complex content which is so essential in technical col-

laboration. Hypothesis 3 derives from the companion argument that email allows easier discussion of complex content than voice mail. Hypothesis 4 assumes lateral communication is more likely to be collaborative than vertical communication (Watson 1982). Therefore, lateral communication is likely to require more discussion, hence employees engaged in lateral communication will tend to use the telephone. Hypothesis 5 assumes that communication outside the chain of command and outside the department is more likely to connect people having weak ties than strong ties (Granovetter 1982). Establishing and maintaining weak ties requires social information exchange to establish trust (Nohria and Eccles 1992). Because telephone offers the most bandwidth, and the most exchange of social information, it should be preferred over asynchronous technologies for out of chain and out of department communication.

From our arguments on the attributes of telephone, voice mail, and email technology we can derive one further hypothesis, pertaining to administrators. Substantial evidence suggests that administrators will prefer high bandwidth technologies because these technologies allow for the exchange of social information that is important in maintaining trust, observing others' responses, and communicating dominance. For instance, people can use their voice tones to express dominance (e.g., Ferguson 1977, Meltzer et al. 1971). These behaviors are particularly related to administrators' concern with monitoring, control and influence (e.g., Jones 1964, Kipnis et al. 1980, Watson 1982, Yates 1989, Yukl and Falbe 1990). Administrators' lives also are punctuated with a great many communications (Mintzberg 1973, Sproull 1983). Accordingly, administrators might wish to use a technology that is not only high bandwidth, but also helps them control their time, namely, voice mail (Reinsch and Beswick 1990). In upward communication, particularly, administrators might favor voice mail in order to control their self-presentation and convey information without intruding. In downward communication, particularly, administrators might favor voice mail in order to broadcast messages to many people at once, delegate work and request status reports, choose their topic, limit intrusion, and avoid being sidetracked into unplanned, less important discussions (e.g., Rice and Shook 1990; see also Whitely 1984). Yet because it works through a voice channel, managers can present themselves as accessible and approachable or give a favorable but dominant self presentation.

We propose that the need to convey social information and time pressure on administrators will exist

more strongly at higher levels, and for administrators communicating vertically. Therefore we suggest the following hypothesis:

HYPOTHESIS 6. *Administrators at higher levels of authority in the organization, and administrators communicating vertically, will use asynchronous communication, particularly voice mail, proportionately more than other administrators.*

Overview of Study

To examine our hypotheses empirically, we collected communication data from technical and administrative employees of a large telecommunications company on the west coast. Employees who participated in the study kept a log of all of their communication that used technology for two days. By matching personnel information about senders with personnel information about recipients we were able to classify each communication as lateral or vertical, and as in the chain of command, out of the chain but in the department, or outside the department. Each communication also was classified as by telephone (or voice answering), voice mail, or email. We performed logit analyses to test the likelihood that a lateral communication would be sent by a technical employee (H1), that a technical employee would use the telephone or email (H2, H3), that lateral, out of chain and out of department communication would be by telephone (H4, H5), and that high level administrators and administrators communicating with subordinates would use voice mail (H6).

Method

Research Setting

We conducted this study in four technical departments in a technical division and three departments in an administrative division of the firm. Employees in these divisions are placed in one of two mobility tracks. Administrative employees follow a management track; when promoted, they move into higher levels of management with more authority. There are eight levels of management within the firm: level 1, level 2, department manager (level 3), division manager, assistant vice president (AVP), vice president, executive vice president, and CEO. Technical employees follow a technical track whereby those with more technical expertise and experience receive more recognition and pay. Within the formal authority structure, technical employees are placed at the first level of management, but do not manage others.

At the time the data were collected, the administrative division had 168 employees. This division provides

support services such as contract management and procurement for the firm. The division is considered an administrative organization and has few responsibilities and employees that the firm considers technical. Employees in the administrative organization generally receive no formal training in contract management and procurement. For the most part, they learn their tasks on the job and through short training classes provided by the firm.

The second division we studied had 356 employees. This division develops and maintains computer systems used in the firm and its nonsupervisory employees are predominantly technical. Many of the technical employees have programming, mathematics, or engineering degrees. Others attend a formal, extensive training program provided by the firm to build programming skills. All technical workers are expected to analyze the needs of the firm and create software, networks, or data models for use by the firm.

There is no differentiation of technical employees along lines of authority in the technical division. In our sample, the technical employees were all at level 1 in the authority structure but were distributed at four levels of expertise. On average, the technical employee sample had as much seniority as the administrative employee sample. Level 2 managers in technical departments had twice the span of control ($\bar{X} = 7.0$) as did level 2 managers in administrative departments ($\bar{X} = 3.1$). Although this is a sample of one organization, the flatter structure in the technical division fits with Barley's (1994) argument that technical workers are likely to be organized in a more horizontal structure than are administrative workers.

Technologies. We studied the use of telephone, voice mail, and email.² All employees in the firm have access to telephone connections with other employees. The telephone system is connected with a voice mail system that provides both voice answering and voice messaging (see Rice and Danowski 1993). Voice answering, much like using an answering machine, refers to situations in which calls are forwarded to the voice mail system because the caller does not answer. Employees use voice messaging when they dial directly into the voice mail system intending to leave a message for one or more people.

Employees have access to email through a computer network. Like voice mail, email allows employees to send one or more messages to others. Whereas voice messages are limited to several minutes,³ email messages can be any length. Recipients can read messages, save messages, edit them, delete them, forward them to other people, or reply to the sender. Additionally,

email offers the option of printing the text, combining it with other computer mail or placing it in a computerized filing system.

Voice mail and email are well established in this firm. Voice mail and email were introduced approximately six and seven years, respectively, before this study. Respondents indicated on our survey that they check for voice mail messages 6.8 times a day on average and check their email messages 4.2 times a day on average. Eight respondents said they do not check their email at least once a day; two of the eight employees rarely, if ever, use their email account. Although both voice mail and email are widely available, addressing on the email system is more difficult than calling someone's voice mail. Whereas email requires the sender to know the entire path of the email address (including the system the recipients are using), a telephone number is all that is required to deliver a voice mail message. Even so, subjects' ratings of the ease of use of their voice mail and email systems were not significantly different ($t[1, 87] = 1.64, p < 0.11$) nor were ratings of email significantly different between technical and administrative employees ($t[1, 77.4] = 0.21, p < 0.84$). In contrast, ratings of the ease of use of voice mail differed significantly ($t[1, 53.3] = 2.45, p < 0.02$) with administrators finding voice mail easier to use.

Sample

The sample consisted of 88 employees, 33 technical employees and 55 administrative employees. We obtained access to these employees through the vice president of each division who permitted us to approach their department heads. All three departments in the administrative division agreed to participate. Four of the five technical departments contacted in the technical division agreed to participate. (The technical department that declined to participate cited a major project with a tight deadline.) The selection of participants within each department was left to the department head (level 3) based on our request for a sample of level 2 managers with supervisory responsibility for at least two subordinates also included in the study. Level 2 managers then selected their subordinates. We requested departments heads to treat the study as voluntary, although we offered feedback on the organization's use of communication technology. Five of the 27 level 2 managers declined to participate or were scheduled to be on vacation. Since level 2 managers recruited their subordinates, we have no information about individuals at level 1 who might have declined. We told every employee who agreed to participate in

the study that the study was voluntary and that all individual data would be kept confidential. All employees in the study completed all phases of data collection.

Procedure

We gathered data through a brief survey, a 48-hour (two day) diary of all communication (see Conrath et al., 1983, Conrath 1973, Ross 1989) using any technology, and a post-diary interview. On day 1, we met with the respondents from each department. We explained the study and the diary procedure and distributed the brief survey to obtain self-reports of typical communication patterns, such as how often respondents accessed their email and voice mail. The meeting and survey were intended primarily to build commitment to the study. Respondents in this study were not asked to indicate their type of job, hierarchical level, seniority, or expertise and were not told the hypotheses. Job, hierarchical level, seniority, and other demographic information was gathered from personnel records.

On days 2 and 3, respondents completed the diary. They used booklets of forms for logging communication over two days. Separate booklets were provided for communications at and away from the respondent's desk. Respondents were instructed to record each of the email, voice mail, facsimile and telephone communications they sent and received during the next two days, including hours spent away from the office. For each communication, respondents were to indicate the technology used, the name of the sender or caller (or "me"), the name of the receiver (or "me"), and whether the communication was a reply to a previous communication. Space was provided for respondents to record the content of the communication and comments, and they were encouraged to make notes so that they would remember their communication when we interviewed them. Respondents were asked to record personal communication during work hours, but to note "private" if they wished to withhold the name of the other person(s) in the communication. (Few did so.)

To determine whether there were systematic biases in recorded communication, we attempted to match sent communications with those logged as received by other respondents in the study. Our matching procedure resulted in 166 "matched" communications of the 217 that we determined were matchable (e.g., sent by a person in the study on the same day and during office hours), a 76.5% response rate of confirmed communication by senders and receivers. By comparing "matched" and "unmatched" communication on our

variables, we can estimate the bias of senders in recording their communication. The chi-square tests indicated there was only one marginally significant difference. That is, senders appear to have slightly underreported lateral communication ($\chi^2 = 2.8$ $p < 0.10$). A Mantel-Haenszel test of the 3-way interaction between matched versus unmatched communication, technical versus administrative employee, and lateral versus vertical communication suggests that technical employees tended to underreport their lateral communication ($\chi^2 = 19.9$ $p < 0.001$). This bias works against our hypothesis (H1).

On day 4, we interviewed each respondent privately. During the interview, we asked the respondent questions about each communication he or she had logged. We asked the respondent to clarify notations on the diaries, especially the names of others with whom the respondent had interacted. We also obtained measures of the importance and urgency of each communication, in order to check on potential bias in the recording of communications.

Variables

We used the corporation's formal designation of each employee to determine his or her level in the authority structure and classification in this study as technical or administrative. Supervising managers in both the technical and the administrative departments are classified as administrative. In the technical division, there were 33 technical employees, all designated as level 1, and 18 administrative employees, 5 at level 3, 11 at level 2, and 2 at level 1. In the administrative division, there were 37 participants (none of whom were technical), 3 at level 3, 9 at level 2, and 25 at level 1.

A categorical variable, communication direction, was defined as whether a communication was directed from a respondent upwardly, to another employee at a higher level in the authority structure, downwardly, to another employee at a lower level in the authority structure, or laterally, to someone at the same level.

A second categorical variable, cross-cutting the communication direction variable, was communication distance. Communication distance was defined as whether a communication was directed from a respondent to another respondent in the same chain of command, out of the chain but in the same department, or out of the department. A communication was coded as "in the chain" when the communication partner was the sender's boss or subordinate, or was someone at the same level who reported to the same boss.

We did not code any communication as "hierarchical" or "diagonal" as others have done (e.g., Randolph

and Finch 1977, Wickesberg 1968, Wilson 1992) because these terms have been used differently in different studies, and because such coding confounds direction and distance, two orthogonal dimensions of communication that we have proposed have different importance to administrative and technical employees. However for comparing our data to those of others, we consider "hierarchical" communication to be essentially equivalent to vertical communication within the chain of command. Diagonal communication is equivalent to vertical communication outside the chain of command or the department.

All communications sent or initiated by a respondent were coded as telephone, voice mail, email, or facsimile. However we did not use facsimile communication in our analyses because there were very few such communications.

Analysis

Our analyses were performed on 848 dyadic communications sent by the respondents. To avoid double counting of communications we did not evaluate communications received by respondents. We also did not include group communication (messages to multiple addressees) because clear classification of communication direction and distance is required to test our hypotheses. Frequently group communications could not be coded for direction or distance because they were sent to recipients at multiple authority levels or in multiple departments. A chi-square test showed no difference between administrative and technical employees in the amount of group communication they initiated ($\chi^2 = 0.21$, $p < 0.65$). Only 3.5% of communications contained more than one addressee. Of the group communications, 46.6% were by email, 42.1% on voice mail, and 10.5% were conference calls using the telephone. Administrators and technical employees did not differ statistically in their use of technology for group communication ($\chi^2 = 1.53$, $p < 0.57$).

To test our predictions, we ran a series of logistic regressions. In all of the analyses, we included four individual attributes as control variables: gender, minority, seniority, and total communication (all sent and received communication using technology). Ideally, a dummy variable for each individual would be used as a control to eliminate the correlation among communications caused by multiple events per respondent. But such a strategy would have prevented us from testing the effects of type of work and level in the authority structure, which are key to our predictions. Therefore, we used the control variables to approximate individual attributes.

We conducted all the analyses in pairs, first comparing technical employees to all administrators, and then comparing technical employees to administrators at level 1 only. In this organization, technical employees have the same official authority level as level 1 administrators, although they do not supervise other employees. Hence, in this respect at least, technical employees are more comparable to administrators at level 1 than to all administrators.

To test predictions about communication direction, we combined upward and downward communication, and compared this vertical communication with lateral communication. To test predictions about communication distance, we made two orthogonal comparisons. First, we compared all communication inside the chain of command with all communication outside the chain of command. Then we examined only communication outside the chain of command. Within this category, we compared communication in the department (but outside the chain of command) with communication outside the department.

Results

Sample Characteristics

Table 1, which gives descriptive data on the sample, indicates that technical and administrative employees in the sample were similar demographically. About half of each group was female, about one-quarter was minority, and each group had about the same 15 plus years of experience with the firm. Goodness-of-fit tests (and *t*-tests, for continuous data) were calculated to compare the sample with the organization's population. These tests indicate that the seniority and gender of the sample and population were not significantly different. The proportions of 3rd level managers and minorities in the sample are overrepresented and underrepresented, respectively. This difference mainly reflects our purposeful oversampling of managers at higher levels (who tend not to be minority). Administrators' total communication using technology (initiated and received) averaged 27.7 communications each day whereas technical employees' total communication by these technologies averaged only 20 communications each day ($t[1, 84.7] = 2.73$, $p < 0.01$). This difference is consistent with the observations many others have made of managers' high frequency of communication (Sproull 1984).

Of the 1,025 sent, dyadic communications using telephone, voice mail, or email, 848 could be identified by the addressee's type of work and relationship with the

Table 1 Sample and Population Characteristics

Group	Percent Female	Percent Minority	Mean Firm Experience in Years	Percent Level 1	Percent Level 2	Percent Level 3
Technical Sample (<i>n</i> = 33)	51.5	24.8	15.5	100	NA	NA
Administrative Sample (<i>n</i> = 55)	47.3	22.2	15.8	49.1	36.4	14.5
Total Sample (<i>n</i> = 88)	51.1	23.9	15.7	68.2	22.7	9.1
Firm Population	47.3	32.7	14.7	76.1	19.9	3.2
Sample Versus Population						
<i>p</i> -value	0.45	0.01	0.15	0.08	0.50	0.01

respondent in the authority and departmental structure. The data analyses were performed on these 848 communications.

Communication Direction and Distance

Figure 1 summarizes the distribution of communication within and across organizational structure by technical employees, by all administrative employees, and by administrators at level 1. Table 2 shows the mean number of communications across organizational structure for each group. We hypothesized that technical employees, as compared with administrative employees, would use technology to have proportionately more lateral communication as compared with vertical communication (H1). Table 3 presents a series of logit analyses addressing this hypothesis. The analyses in the upper half of the table examine the likelihood that lateral communication will be initiated by a technical employee rather than an administrative employee. Model 1a indicates that a lateral communication is more likely to be initiated by a technical employee than by an administrator. Model 1b, comparing technical employees with administrators at level 1, shows the same result. These results support H1. Models 2a, 2b, 3a, and 3b introduce the variable, out of chain communication, in order to test the generality of the lateral effect for technical employees and to explore contacts involving weak ties. Comparing technical employees with all administrators in model 2a suggests there is no difference for communication outside the chain of command between the two groups, but comparing technical employees with level 1 administrators (2b) suggests the level 1 administrators communicate more outside the chain of command. Models 3a and 3b show that the main effect for lateral communication of tech-

nical employees remains even with the out of chain variable included.

The analyses in the lower half of Table 3 examine only communication outside the chain of command. These analyses test the likelihood that when employees communicate outside the chain of command, lateral rather than vertical communication is more likely to be sent by a technical employee (H1). In models 4a and 4b, there is a significant main effect such that a lateral communication (outside the chain) is more likely to be initiated by a technical employee, which supports the hypothesis. In models 5a and 5b, there are no significant differences between technical employees and administrators in their degree of extradepartmental communication. In model 6a and 6b, the main and interaction effects on this reduced set (out of chain communication only) suggest that extradepartmental communication is more likely to be initiated by an administrator at level 1 than by a technical employee. Extradepartmental lateral communication is more likely to be initiated by a technical employee whereas extradepartmental communication that is vertical (that is, diagonal communication) is more likely to be initiated by a level 1 administrative employee.

Barley (1994) has suggested that both the nature of technical work and the horizontal organization of technical workers leads to their collaborative behavior. But, do technical employees communicate laterally because they must consult and collaborate with other people on technical projects or do they communicate laterally because management happens to place them in teams where they are surrounded by others at the same level of authority? Proximity effects are known to be strongly predictive of communication (e.g., Allen 1977, Kraut et al. 1990). Next to proximity, demographic and orga-

Figure 1 Percentage of Communication by Direction and Distance for Technical Employees, Administrators, and Level 1 Administrators

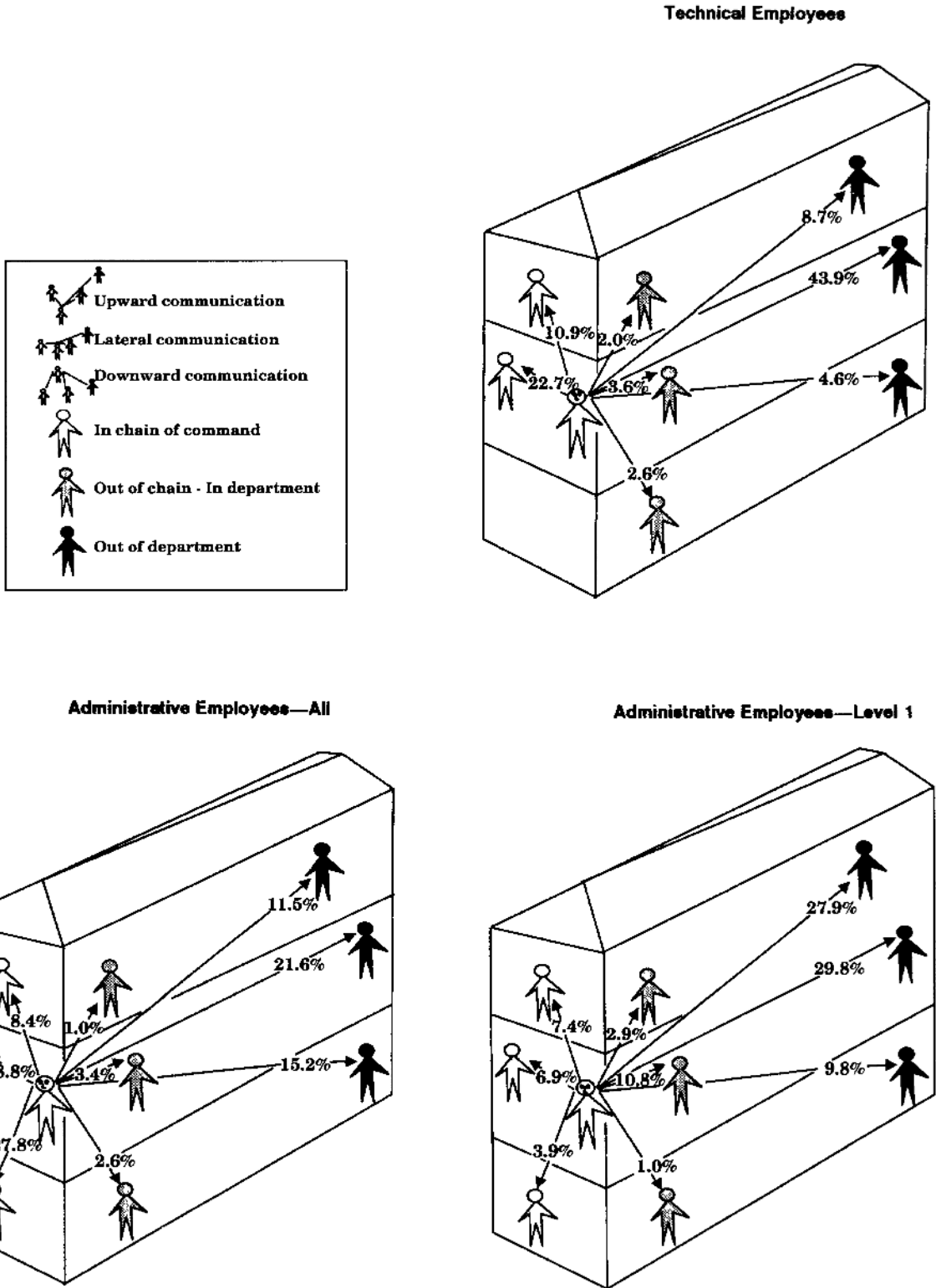


Table 2 Percentage Distribution and Mean Number of Communications Using Technology Sent During Two Days by Technical and Administrative Employees

Technical Employees—Level 1 (n = 33 employees)

Communication Direction	Technology	Communication Distance					
		Within the Chain of Command (n = 67)		Within Dept., Outside the Chain (n = 16)		Outside the Dept (n = 111)	
		%	Mean	%	Mean	%	Mean
Lateral (n = 138 communications)	Telephone	12.9	0.76	2.6	0.15	39.2	2.30
	Voice Mail	1.0	0.06	0.5	0.03	2.6	0.15
	Email	9.8	0.58	0.5	0.03	2.1	0.12
	All Technology	22.7	1.49	3.6	0.21	43.9	2.57
Upward (n = 42 communications)	Telephone	5.2	0.30	0.5	0.03	4.1	0.24
	Voice Mail	2.1	0.12	0.5	0.03	1.0	0.06
	Email	3.6	0.21	1.0	0.06	3.6	0.21
	All Technology	10.9	0.63	2.0	0.12	8.7	0.51
Downward (n = 14 communications)	Telephone	0.0	0.00	2.1	0.12	4.1	0.24
	Voice Mail	0.0	0.00	0.5	0.03	0.0	0.00
	Email	0.0	0.00	0.0	0.00	0.5	0.03
	All Technology	0.0	0.00	2.6	0.15	4.6	0.27

Administrative Employees—All Levels (n = 55 employees)

Communication Direction	Technology	Communication Distance					
		Within the Chain of Command (n = 293)		Within Dept., Outside the Chain (n = 45)		Outside the Dept (n = 314)	
		%	Mean	%	Mean	%	Mean
Lateral (n = 219 communications)	Telephone	4.5	0.53	1.7	0.20	16.0	1.89
	Voice Mail	3.5	0.38	0.5	0.05	4.0	0.47
	Email	1.1	0.13	1.2	0.14	1.6	0.18
	All Technology	8.1	1.04	3.4	0.39	21.6	2.54
Upward (n = 136 communications)	Telephone	2.6	0.31	0.5	0.05	8.1	0.96
	Voice Mail	4.3	0.51	0.3	0.04	3.1	0.36
	Email	1.5	0.18	0.2	0.02	0.3	0.04
	All Technology	8.4	1.00	1.0	0.11	11.5	1.36
Downward (n = 297 communications)	Telephone	11.4	1.34	1.8	0.22	10.6	1.25
	Voice Mail	8.9	1.05	0.5	0.05	3.8	0.45
	Email	7.5	0.89	0.3	0.04	0.8	0.09
	All Technology	27.8	3.28	2.6	0.31	15.2	1.79

Administrative Employees—Level 1 Only (n = 27 employees)

Communication Direction	Technology	Communication Distance					
		Within the Chain of Command (n = 37)		Within Dept., Outside the Chain (n = 30)		Outside the Dept. (n = 138)	
		%	Mean	%	Mean	%	Mean
Lateral (n = 97 communications)	Telephone	4.4	0.33	5.4	0.41	25.4	1.91
	Voice Mail	1.5	0.11	1.5	0.11	2.9	0.22
	Email	1.0	0.07	3.9	0.30	1.5	0.11
	All Technology	6.9	0.52	10.8	0.82	29.8	2.24
Upward (n = 78 communications)	Telephone	1.5	0.11	1.5	0.11	22.0	1.67
	Voice Mail	4.4	0.33	1.0	0.07	5.4	0.41
	Email	1.5	0.11	0.5	0.04	0.5	0.04
	All Technology	7.4	0.55	3.0	0.22	27.9	2.12
Downward (n = 30 communications)	Telephone	3.9	0.30	1.0	0.07	8.8	0.67
	Voice Mail	0.0	0.00	0.0	0.00	0.5	0.04
	Email	0.0	0.00	0.0	0.00	0.5	0.04
	All Technology	3.9	0.30	1.0	0.07	9.8	0.75

Table 3 Logistic Regressions Predicting Communication from Technical Employees as Compared with Administrative Employees

All Communications						
	Technical vs Admin.	Tech vs Lvl 1 Admin.	Technical vs Admin	Tech vs Lvl. 1 Admin	Technical vs. Admin.	Tech vs. Lvl 1 Adm
	Model 1a (n = 848)	Model 1b (n = 400)	Model 2a (n = 1018)	Model 2b (n = 522)	Model 3a (n = 846)	Model 3b (n = 400)
Variables	coef (se)	coef (se)	coef (se)	coef.(se)	coef (se)	coef (se)
Intercept		**	*		**	**
Control Variables						
Gender (male = 1)	-.28(0.20)	.02(0.29)	-.16(0.17)	.21(0.19)	-.26(0.20)	.13(0.24)
Minority	-.57*(0.24)	-.51(0.27)	-.51*(0.26)	-.71**(0.23)	-.55*(0.24)	-.51(0.28)
High Seniority (> 20 yrs)	-1.86**(0.28)	-1.91**(0.32)	-1.57**(0.23)	-1.31**(0.27)	-1.85**(0.28)	-1.98**(0.33)
Total Communications	< .01*(0.00)	< .01(0.00)	< .01**(0.00)	< .01(0.00)	< .01(0.00)	< .01(0.00)
Lateral Communication	1.58**(0.19)	1.23**(0.23)			2.04**(0.32)	1.36**(0.46)
Out of Chain			.28(0.17)	-1.02**(0.24)	.44(0.30)	-1.00**(0.38)
Lateral X Out of Chain					-.75(0.40)	-.11(0.53)
Chi-Square	164.61	70.41	104.37	56.87	166.48	83.98
df	5	5	5	5	7	7
p	< .01	< .01	< .01	< .01	< .01	< .01

Communications Only Out of the Chain of Command

	Technical vs Admin	Tech vs Lvl 1 Admin	Technical vs Admin	Tech vs Lvl 1 Admin.	Technical vs Admin	Tech vs Lvl 1 Admin.
	Model 4a (n = 488)	Model 4b (n = 296)	Model 5a (n = 657)	Model 5b (n = 418)	Model 6a (n = 488)	Model 6b (n = 296)
Variables	coef.(se)	coef (se)	coef.(se)	coef.(se)	coef.(se)	coef (se)
Intercept		**		**	**	**
Control Variables						
Gender (male = 1)	-.48*(0.24)	-.17(0.28)	-.21(0.19)	.08(0.21)	-.47(0.24)	-.07(0.28)
Minority	-.62*(0.30)	-.58(0.33)	-.56*(0.24)	-.80**(0.26)	-.58(0.30)	-.52(0.34)
High Seniority (> 20 yrs)	-2.14**(0.38)	-2.27**(0.42)	-1.60**(0.28)	-1.33**(0.31)	-2.11**(0.38)	-2.20**(0.43)
Total Communications	< .01(0.00)	< .01*(0.00)	< .01(0.00)	< .01(0.00)	< .01(0.00)	.01(0.00)
Lateral Communication	1.33**(0.24)	1.31**(0.28)			.44(0.65)	-.72(0.75)
Out of Department			-.06(0.32)	-.06(0.36)	-.84(0.47)	-1.56*(0.61)
Lateral X Out of Department					1.05(0.70)	2.33**(0.80)
Chi-Square	86.05	61.01	60.12	34.81	87.65	69.83
df	5	5	5	5	7	7
p	< .01	< .01	< .01	< .01	< .01	< .01

*p < 0.05

**p < 0.01

nizational similarity (Wagner et al. 1984, Zenger and Lawrence 1989) and a history of interaction (Krackhardt 1992) strongly influence communication. If people talk with others who are nearby and similar, then the lateral communication of technical employees might be explained simply by the number of other employees in the proximate peer group.

In order to evaluate the possibility that differences in the organization of employees predicts their communication differences, we conducted an additional analysis. We compared the number of people that technical and administrative employees worked with at different levels in their chain of command with the number of people they contacted. The results of this analysis suggest a strong association between the number of potential connections and the number of actual connections. For instance, technical employees had an average of 8.9 other employees at the same level as them who reported to the same boss and 1.0 possible vertical connections (their boss). Administrative employees at level 1 (the same level as the technical employees) had an average of only 4.2 other level 1 employees who reported to the same boss, less than half as many, but 2.8 vertical connections (nearly 3 times more). Technical people had more potential lateral contacts and administrators had more potential vertical contacts, reflecting the more horizontal structure of the technical division and technical workers.

According to a goodness-of-fit test, technical employees' and administrators' communication behavior did not vary significantly from the structure of the organization ($\chi^2 = 0.02$, $p < 0.11$ and $\chi^2 = 0.64$, $p < 0.60$, respectively). Technical employees exercised 1.6 (17.5%) of their potential lateral links and 0.6 (56%) of their potential vertical links in the chain of command, whereas administrators exercised 2.0 (44.8%) of their potential lateral links and 2.1 (38.3%) of their potential vertical links in the chain of command. These data suggest that the lateral communication of technical workers we observed may be explained in part by the way technical employees are organized. If technical employees in the firm are organized in teams at one level of the authority structure, and if people talk with co-workers, the structure has essentially institutionalized a lateral communication bias.

A similar argument also applies to the bias toward lateral communication of technical workers out of the chain of command and extradepartmentally. In a company with 40,000 employees, as this company employs, anyone has numerous potential connections both lateral and vertical. However, if the organization of tech-

nical workers is more horizontal throughout the firm than is the organization of administrative workers, then there are legions of technical people at level 1 available for communication. A chi-square test examining administrative versus technical senders by administrative versus technical receivers ($\chi^2 = 139.2$, $p < 0.01$) indicates that, in fact, technical employees as compared to administrative employees in our sample interact proportionally more with technical recipients than with administrative recipients. Demographic and organizational similarity would tend to produce at least the appearance of lateral communication by technical workers, since they are all given the level 1 designation. A logit analysis predicting whether or not a communicator outside the department is technical (using the same structure as in Table 3) indicates that technical employees communicate more laterally outside the department than do administrators (coeff. = 1.50 [0.27], $p < 0.01$). In short, organizational structure can account for some communication differences between technical and administrative employees.

Use of Communication Technology

Technical and administrative employees' mean use of telephone within and across structure, and the percentage distributions of use of telephone, are shown in Table 2. Table 4 presents all of the logit analyses pertaining to technical and administrative employees' use of telephone as compared with asynchronous technology (email and voice mail).

Model 1a and 1b show analyses of the likelihood that a telephone call will be initiated by a technical employee rather than an administrative employee, or a level 1 administrative employee, respectively. We predicted that technical employees would use the telephone more (H2). The main effect is not significant. We also hypothesized that when employees engaged in lateral as compared with vertical communication, they would use the telephone rather than asynchronous technology (H4). Models 2a and 2b show the increased likelihood of a telephone call being made for lateral rather than vertical communication, although the effect is not significant in model 2b comparing level 1 administrators with technical employees. Outside the chain of command, in Models 4a and 4b, the pattern is the same. Hence there is some support for the hypothesis. We also predicted that when employees engaged in communication outside the chain, and outside the department, they would use the telephone rather than asynchronous technology (H5). Models 2a and 2b give strong support to this hypothesis, as do models 4a and 4b. Models 3a and 3b and 5a and 5b include interac-

Table 4 Logistic Regressions Predicting Use of Telephone as Compared with All Asynchronous

Variables	Tech and Admin		Tech and Admin Lvl 1		Tech and Admin		Tech and Admin Lvl 1		Tech and Admin		Tech and Admin Lvl 1		Tech and Admin		Tech and Admin Lvl 1		Out of Chain Only			
	Model 1a	Model 1b	Model 2a	Model 2b	Model 3a	Model 3b	Model 4a	Model 4b	Model 5a	Model 5b	Model 1a	Model 1b	Model 2a	Model 2b	Model 3a	Model 3b	Model 4a	Model 4b		
	(n = 1020)	(n = 523)	(n = 846)	(n = 407)	(n = 846)	(n = 407)	(n = 486)	(n = 295)	(n = 486)	(n = 295)	(n = 486)	(n = 295)	(n = 486)	(n = 295)	(n = 486)	(n = 295)	(n = 486)	(n = 295)	(n = 486)	(n = 295)
Intercept																				
Control Variables																				
Gender (male = 1)	0.18(0.15)	0.25(0.22)	0.11(0.17)	-0.03(0.25)	0.11(0.17)	-0.04(0.26)	0.26(0.24)	0.20(0.33)	0.30(0.24)	0.29(0.33)										
Minority	-0.05(0.17)	-0.26(0.25)	0.07(0.20)	-0.03(0.29)	0.13(0.20)	0.04(0.29)	0.40(0.30)	0.26(0.37)	0.52(0.30)	0.28(0.38)										
High Seniority (> 20 yrs)	-6.1***(0.16)	-39(0.26)	-54(0.17)	-24(0.29)	-47***(0.17)	-22(0.32)	-56*(0.24)	-23(0.39)	-37(0.26)	-10(0.43)										
Total Communications	< 0.1*(0.00)	< 0.1*(0.00)	< 0.1(0.00)	< 0.1(0.00)	< 0.1(0.00)	< 0.1(0.00)	< 0.1(0.00)	< 0.1(0.00)	< 0.1(0.00)	< 0.1(0.00)										
Technical Employee	0.30(0.17)	-47(0.22)			0.14(0.47)	0.05(0.62)			-46(0.81)	-35(1.00)										
Technical Recipient																				
Lateral Communication			0.44***(0.16)	0.42(0.24)	0.44(0.30)	0.55(0.71)	0.42*(0.21)	-0.55(0.31)	0.71(0.64)	-0.58(0.88)										
Out of Chain			1.12***(0.15)	1.27***(0.25)	1.22***(0.21)	1.52***(0.51)														
Out of Department					-12(0.61)	-37(0.88)			0.71*(0.29)	1.29***(0.37)										
Lateral X Technical Empl					-35(0.38)	-1.08(0.76)														
Lateral X Out of Chain																				
Lateral X Out of Department																				
Technical Empl X																				
Out of Chain																				
Technical Empl X																				
Out of Dept																				
Lateral X Technical X																				
Out of Chain																				
Lateral X Technical X																				
Out of Dept																				
Chi-Square	37.73	12.91	97.74	35.65	104.19	41.55	20.27	21.18	30.10	29.07										
df	5	5	6	6	11	11	6	6	11	11										
p	< 0.01	0.03	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01										

*p < .05
**p < .01

Table 5 Logistic Regressions Predicting Use of Email as Compared to Voice Mail

Variables	All Employees	Level 1 Only
	Model 1a (n = 364)	Model 1b (n = 122)
	coef (se)	coef (se)
Intercept	**	
Control Variables		
Gender (male = 1)	- .17(0.26)	0.63(0.45)
Minority	0.05(0.31)	-.87(0.51)
High Seniority (> 20 yrs)	0.51(0.28)	1.37*(0.58)
Total Communications	< .01(0.00)	-.01(0.00)
Technical Employee	1.94**(0.34)	1.99**(0.48)
Chi-Square	37.73	30.21
df	5	5
p	< .01	< .01

*p < .05
**p < .01

tion effects which show a significant effect for technical employees to use the telephone for lateral extradepartmental communication.

The data on the mean use of email and voice mail by technical and administrative employees are described in Table 2. Logit analyses of the use of email as compared with voice mail by employees who used asynchronous technology are summarized in Table 5.

We hypothesized that when employees used asynchronous communication technology, technical employees would use email rather than voice mail proportionately more than administrative employees would (H3). The results shown in models 1a and 1b support this hypothesis.

We argued that administrators ought to use voice mail more than technical employees do. They do. Administrators used voice mail for 29% of their total communication and administrators at level 1 used voice mail for 17% of their communication whereas technical employees only used voice mail for 8% of their overall communication. The difference in these percentages (between administrators and technical employees and between level 1 administrators and technical employees) were highly significant. We hypothesized that administrative employees at higher levels in the authority structure, and administrators communicating vertically, would use asynchronous communication rather than telephone, and voice mail rather than email (H6). To evaluate this hypothesis, we examined only the communication of administrators (Table 6). Model 1a examines the use of telephone by administrators at level 3 in comparison to the use of the telephone by administrators at lower levels. Consistent with the hypothesis, the negative coefficient in the main effect for level 3 shows that the higher level administrators do use asynchronous communication technology more than those at lower levels. Model 2a shows that administrators use asynchronous technology for vertical communication.

Table 6 Logistic Regressions Predicting Use of Telephone Compared with Asynchronous and Predicting Use of Email Compared with Voice Mail for Administrators Only

Variables	Predicting Telephone		Predicting Email	
	Model 1a (n = 780)	Model 2a (n = 654)	Model 3a (n = 300)	Model 4a (n = 280)
	coef.(se)	coef (se)	coef (se)	coef (se)
Intercept	*	**	**	**
Control Variables				
Gender (male = 1)	0.29(0.18)	0.17(0.19)	27(0.32)	-.30(0.31)
Minority	-.16(0.20)	-.05(0.22)	0.22(0.35)	0.15(0.36)
High Seniority (> 20 yrs)	0.61**(0.17)	-.57**(0.19)	0.27(0.31)	0.52(0.31)
Total Communications	< .01(0.00)	< .01(0.00)	< .01(0.00)	< .01(0.00)
Hierarchical Level 3	-.62**(0.20)		-1.55**(0.34)	
Lateral Communication		0.51**(0.11)		< .01(0.29)
Chi-Square	43.02	29.42	27.61	4.79
df	5	5	5	5
p	< .01	< .01	< .01	< .45

*p < .05
**p < .01

Model 3a in Table 6 tests the hypothesis that high level administrators use voice mail over email (H6). The hypothesis is supported. Model 4a tests the hypothesis that administrators communicating vertically use voice mail rather than email (also H6). This effect is not significant, mainly because administrators use voice mail extensively for both vertical and lateral communication.

Discussion

Hierarchy and informal networks have always existed side by side. In the past, researchers and managers emphasized the structural and operational significance of the former (Hall 1986). Informal networks were viewed as emergent ad hoc linkages formed because of physical proximity (e.g., Allen 1977, Monge et al. 1985, Kraut et al. 1988), a history of prior personal relationships (Krackhardt 1992), and demographic similarity (Wagner et al. 1984, Zenger and Lawrence 1989). When informal networks were seen as "the grapevine"—unplanned, personal, and casual—neither managers nor researchers viewed them as integral to formal organization or crucial to accomplishing work (see Katz and Kahn 1978, p. 449). Today, a more deliberate "network organization" is in the offing (Nohria and Eccles 1992). Major business and technical forces are changing the nature of work, and firms are spending substantial sums on reorganization, redefinition of the role of manager, and support for technology so that lateral and diagonal ties operate efficiently and effectively (Barley 1994, Powell 1990). Our findings are consistent with Barley's (1994) idea that increasing technization of work implies an emphasis on horizontal structure and collaborative, lateral flows of communication for technical employees. Our findings also are consistent with research on network organization (Powell 1990) and technical teams (e.g., Allen 1977) and scientific collaboration (Kraut et al. 1990), which document extensive lateral and diagonal connections. Our work and that of others suggests that much of this communication is systematic and highly correlated with formal organization, not "informal" in the lay use of the term.

In our study, only 30% of employees' communication using technology was traditionally hierarchical: vertical and inside the chain of command. Of the rest, 42% was lateral and 28% was diagonal. In some respects, but not others, our data resemble patterns from the pre-computer era. Wickesberg (1968) observed remarkably similar distributions as well as differences between technical and administrative employees in much

the same direction as ours, though not as large. In Wickesberg's study, 30% of managers' total communication was lateral and 37% was diagonal; in our study 34% of managers' total communication was lateral and 30% was diagonal. In Wickesberg's study, 45% of professional and technical employees' total communication was lateral and 32% was diagonal; in our study 70% of technical employees' total communication was lateral and 18% was diagonal. Wickesberg's conclusion seems appropriate to our study too, that managers and non-managers alike seek contributors to their task effectiveness and "move wherever in the organization information, advice, counsel, and expertise may be found" (p. 267).

Our study seems to differ from earlier studies in highlighting the very large use of technology for extradepartmental communication. Both technical employees and level 1 administrators' most frequent communication using technology was lateral and extradepartmental. But the next most frequent communication by level 1 administrators was extradepartmental and diagonal whereas for technical workers it was lateral communication within the work group. Hence level 1 administrators used technology for extradepartmental communication even more than technical employees did, but the source of this difference was administrators' high frequency of diagonal communication. This finding provides some support for our argument, based on weak-tie theories (Burt 1983, Granovetter 1982, Lin 1982), that administrators seek resources unavailable locally by contacting superiors in other departments. If so, we would expect junior administrative employees to initiate extradepartmental communication upwardly because those at higher levels in other departments presumably have more resources not offered by their own superiors. Our data do show such a bias: At the first level of management, 28% of administrators' communication was upwardly diagonal whereas only 11% was downwardly diagonal, to other people's subordinates.

Our data also differ from those of others in showing some significant differences in the ways administrators and technical employees cross different boundaries to do their work. We argued that horizontally-structured technical employees operating within teams and specialties across departments may particularly engage in lateral communication. Our finding of 71% lateral ties among technical employees is 25% higher than Wickesberg's pre-1970 employees, and also has precedence in a recent study by Wilson (1992) of technical military teams (including team managers). He found that employees in these teams reported having 63%

lateral and 20% diagonal ties for "help or technical advice concerning work-related problems" (p. 134).

We derived hypotheses about the preferences of technical and administrative workers for different communication technologies based on analyses of the attributes of technology vis à vis the nature of employees' work and the way work is organized. We argued that communication technologies can be ranked by how well they suit collaboration, particularly the intense exchange of information required for planning and technical exchange. From an analysis of the attributes of telephone, voice mail and email we predicted that crossing organizational boundaries in communication, and communication by technical workers, would be associated with the use of the telephone, and secondarily, with the use of email. We found that lateral and out-of-chain communication was disproportionately by telephone for all employees, not just technical employees. This finding gives support to Nohria and Eccles' (1992) argument that when people connect to weak ties (i.e., cross organizational boundaries), they must exchange social as well as substantive information. Accordingly the superiority of the telephone over current asynchronous technologies for conveying both social information and content might outweigh the sheer convenience of asynchronous technology when people cross organizational boundaries. This balance of comfort and convenience would be expected to shift the use of technology towards asynchronous modes as people communicated with others further away and across time zones.

We found, as predicted, that when technical workers used asynchronous technology, they used email rather than voice mail. This finding is consistent with our argument that email is more effective than voice mail for conveying and discussing complex information. Overall, administrators were much more likely to communicate, and to use voice mail. This finding is consistent with our argument that voice mail technology would be attractive to administrators both because it is efficient and it conveys social information about the sender such as his or her status, accessibility, and dominance.

This study has a number of important limitations to both internal and external validity. For example, though we know that 50% of communication was extradepartmental, how important, consultative, or interesting is this communication? Suppose people are just ordering out for pizza? The logs of communication in this study do not contain sufficient information to allow analysis of the content of communication sent by employees. The only data that address this problem come from post-diary interviews in which we asked people to rate

the importance of each communication on a scale of 1 to 10 (10 = most important), and to tell us whether or not the communication was urgent. Logit analyses predicting important communication (scores of 8, 9, or 10) indicate that administrative employees as compared with technical employees perceived more of the communication they sent to be important. Technical employees as compared with administrators indicated that more of their lateral and out-of-chain communications were important. However there were no main effects or interactions for lateral, out-of-chain, or extradepartmental communication, suggesting that using technology to cross boundaries does not mean just talking about pizza.

In this study, we were not able to collect data on employees' face-to-face communication, hence we lack baseline statistics on overall communication of technical and administrative employees. Insofar as comparisons are possible, the similarity of our data to those of earlier studies (e.g., Wickesberg 1968) suggests that measuring face-to-face communication would not have changed our main conclusions. The logic of our argument is that telephone is much like one-to-one face-to-face communication, but is done at a distance. Hence we would have predicted that, as compared with administrative employees, more of technical employees' communication would be face-to-face (though in absolute terms the administrative employees would communicate more in all venues). We also would have predicted lateral, as compared with vertical communication would be face-to-face. These hypotheses could be addressed in future research.

Ours is a case study of communication within the headquarters of one large organization in which communication partners have equal access to all three technologies. An assumption that clearly does not hold in many worldwide organizations. The corporate culture seems to promote communication within and across structure. The organization is also distinctive in having a highly observable status hierarchy reflecting the authority structure. For example, workplaces at each level of the authority structure are standardized at different levels of comfort and privacy. Just below the managerial level, people work in cubicles without doors; level 1 and 2 managers work in slightly larger cubicles; a level 3 manager has an office with windows looking out at the cubicles; a level 4 manager has a larger office with better furniture, and so forth. Despite these signs of traditional hierarchy and bureaucracy, posters promoting teamwork and cooperation are placed throughout the organization, implying some institutionalization of the idea of network organization.

The firm we studied also is distinctive in that it is a telecommunications company, and views communication technology both as a critical corporate resource and as a product. In their day-to-day work, our respondents rarely dealt directly with the products of the company. Still, the firm sells communication services and its culture would seem to encourage employees to use this technology more frequently than employees might in other firms. Culture pressure and incentives will influence people's perceptions of technology and the work they do, hence how they use the technology (Fulk et al. 1990).

In future research on the use of technology to cross boundaries, the limitations of this study should be addressed by comparing face-to-face communication with communication using technology and comparing organizations of different types. One intriguing finding of our study that future research could address is that over 50% of all communication in the study was extradepartmental. Does this imply that technology can aid and abet extradepartmental communication? It might. On average, departments in the study were 0.8 floors and 1.2 wings (about 120 yards) distant from each other. (We think this underestimates overall distance between departments in the organization because we sampled only employees located at the headquarters office.) Previous research on the effects of proximity have shown that if people work in nonadjacent offices, communication drops precipitously (e.g., Monge and Kirste 1980). Allen (1977) found that contact between engineers in a research laboratory dropped to near zero at separations of 30 meters. Kraut et al. (1990) reported that communications per month dropped from over 60 for people in adjacent offices to 30 for people on the same floor, to less than 20 for people on different floors in the same building. Previously, investigators have argued that technology does not change this proximity effect (Mayer 1977, Allen 1986, Eveland and Bikson 1987). In this study, half of the communication using technology was extradepartmental, a distribution that does not fit the proximity model from other research. Hence we venture that both old and new communication technology used in the firm we studied does reduce the impact of proximity and encourage extradepartmental communication.

In the history of organizational studies, communication across boundaries used to be taken far less seriously than hierarchical communication. Texts warned managers to constrain informal communication, which though good for morale, could undercut managerial

control and disrupt smooth organizational functioning (e.g., Katz and Kahn 1978). Today, it is no longer appropriate to consider communication across boundaries as primarily social and of limited usefulness (see Ancona and Caldwell 1992). Technological change and task demands increasingly require that organizations be structured to support lateral and diagonal communication. Organizations must invest in communication technology infrastructure and the development and enforcement of policies that systematically encourage informal communication. (For example, organizations should not inhibit the use of electronic communication by allowing managers to monitor private conversations.) Recently, organizational and network theorists have extended investigations of the interplay between organizational structure and informal communication. In this research, informal structure is seen as filling important gaps in formal structure (e.g., Burt 1992, pp. 148-149). Theorists also have explored the relationship between organizational structure and communication technology (e.g., Poole and DeSanctis 1992). As researchers continue to interweave and extend these two lines of research, we will better understand communication that crosses boundaries, and how systematic changes in the use of technology for this communication changes people's work and the functioning of the organization.

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Endnotes

¹Although almost all organizations have a hierarchy, they do not all operate in the same manner. For instance, the locus of control need not be centralized at the top of the hierarchy. In a strong horizontal structure, the division of labor is structured along lines of expertise (such as technical specialty or profession—the accounting department, the chemical engineering department, the systems analysis department, and so forth). Doing so tends to lend greater autonomy to members of these departments as well as greater responsibility for coordinating across departments to solve problems and develop products (Raelin, 1986).

²Facsimile machines are available to all employees in a central location no more than 150 feet from any person's desk. Only 11 of the employees sent communications used facsimile.

³Limits on voice mail minute length arbitrarily limit the exchange of large amounts of content and are not fundamental to the technology.

References

- Abbott, A. (1991), "The Future of Professions: Occupation and Expertise in the Age of Organization," in P. S. Tolbert and S. R. Barley (Eds.), *Research in the Sociology of Organizations*, 8, Greenwich, CT: JAI Press, pp. 17-42.
- Adams, J. S. (1976), "The Structure and Dynamics of Behavior in Organizational Boundary Roles," in M. D. Dunnette (Ed.), *Handbook of Industrial and Organizational Psychology*, Chicago, IL: Rand-McNally, pp. 1175-1199.
- Aldrich, H. (1979), *Organizations and Environments*, Englewood Cliffs, NJ: Prentice-Hall.
- Allen, T. J. (1977), *Managing the Flow of Technology*. Cambridge, MA: MIT Press.
- ____ (1986), "Organizational Structure, Information Technology, and R & D Productivity," *IEEE Transactions on Engineering Management*, 33, 212-214.
- Ancona, D. G. and D. F. Caldwell (1992), "Bridging the Boundary: External Activity and Performance in Organizational Teams," *Administrative Science Quarterly*, 37, 634-665.
- Barley, S. (1994), "The Turn to a Horizontal Division of Labor: On the Occupationalization of Firms and the Technization of Work," National Center for the Educational Quality of the Workforce, University of Pennsylvania, available from author
- Barry, B. and T. S. Bateman (1992), "Perceptions of Influence in Managerial Dyads: The Role of Hierarchy, Media, and Tactics," *Human Relations*, 45, 6, 555-574.
- Bizot, E., N. Smith and T. Hill (1991), "Use of Electronic Mail in a Research and Development Organization," in J. Morell and M. Fleischer (Eds.), *Advances in the Implementation and Impact of Computer Systems*, Vol. 1. Greenwich, CT: JAI Press, pp. 65-92.
- Brooks, F. P. (1987), "No Silver Bullet: Essence and Accidents of Software Engineering," *IEEE Computer Society*, 20, April, 10-18.
- Burt, R. S. (1980), "Models of Network Structure," *Annual Review of Sociology*, 6, Palo Alto, CA: Annual Reviews, pp. 79-141.
- ____ (1983), "Range," in R. S. Burt and M. J. Minor (Eds.), *Applied Network Analysis*, Beverly Hills, CA: Sage, 176-194
- ____ (1992), *Structural Holes: The Social Structure of Competition*, Cambridge, MA: Harvard University Press.
- Business Week* (1993), "The Horizontal Corporation," December 20, 76-81.
- Casson, M. (1994), "Why are Firms Hierarchical?" *Journal of the Economics of Business*, 1, 47-76.
- Conrath, D. W. (1973), "Communication Patterns, Organizational Structure, and Man: Some Relationships," *Human Factors*, 15, 459-470.
- ____, C. A. Higgins and R. J. McClean (1983), "A Comparison of the Reliability of Questionnaire Versus Diary Data," *Social Networks*, 5, 315-322.
- Curtis, B., H. Krasner and N. Iscoe (1988), "A Field Study of the Software Design Process for Large Systems," *Communications of the ACM*, 31, 1268-1287.
- Cyert, R. M. and J. G. March (1963), *Behavioral Theory of the Firm*, Englewood Cliffs, NJ: Prentice-Hall
- Daft, R. L. and R. H. Lengel (1984), "Information Richness: A New Approach to Managerial Behavior and Organization Design," in B. Straw and L. L. Cummings (Eds.), *Research in Organizational Behavior*, Vol 6, Greenwich CT: JAI Press, pp. 191-233.
- ____ and ____ (1986), "Organizational Information Requirements, Media Richness and Structural Design," *Management Science*, 32, 554-571.
- ____, ____ and L. K. Trevino (1987), "Message Equivocality, Media Selection, and Manager Performance: Implications for Information Systems," *MIS Quarterly*, 11, 355-366.
- Downs, A. (1967), *Inside Bureaucracy*. Boston, MA: Little, Brown and Company.
- Drucker, P. F. (1988). "The Coming of the New Organization," *Harvard Business Review*, Jan/Feb, 45-53.
- Dubin, R. and S. Spray (1964), "Executive Behavior and Interaction," *Industrial Relations*, 3, 99-108.
- Eveland, J. D. and T. K. Bikson (1987), "Evolving Electronic Communication Networks: An Empirical Assessment," *Office: Technology and People*, 3, 103-128.
- Feldman, M. S. (1987), "Electronic Mail and Weak Ties in Organizations," *Office: Technology and People*, 3, 83-101
- Ferguson, N. (1977). "Simultaneous Speech, Interruptions and Dominance," *British Journal of Social and Clinical Psychology*, 16, 295-302.
- Finholt, T., L. Sproull and S. Kiesler (1990), "Communication and Performance in Ad Hoc Task Groups," in R. Kraut, J. Galegher, and C. Egido (Eds.), *Intellectual Teamwork: Social and Technological Foundations of Cooperative Work*, Hillsdale, NJ: Erlbaum Associates, pp. 291-325.
- Fish, R. S., R. E. Kraut, R. W. Root and R. E. Rice (1993), "Video as a Technology for Informal Communication," *Communications of the ACM*, 36, 48-61.
- Fulk, J., J. Schmitz and C. W. Steinfield (1990), "A Social Influence Model of Technology Use," in J. Fulk and C. W. Steinfield (Eds.), *Organizations and Communication Technology*, Newbury Park, CA: Sage Publications, 117-140.
- Galbraith, J. R. (1973). *Designing Complex Organizations*, Reading, MA: Addison-Wesley.
- Granovetter, M. (1982), "The Strength of Weak Ties: A Network Theory Revisited," in P. Marsden and N. Lin (Eds.), *Social Structure and Network Analysis*, New York: John Wiley and Sons, 105-130.
- Hall, R. H. (1986), *Dimensions of Work*, Beverly Hills, CA: Sage Publications.
- Hannaway, J. (1985), "Managerial Behavior, Uncertainty, and Hierarchy: A Prelude to a Synthesis," *Human Relations*, 38, 1085-1100
- Hedlund, G. (1986). "The Hypermodern MNC: A Heterarchy?" *Human Resource Management*, Spring, 9-35.
- Heydebrand, W. V. (1989). "New Organizational Forms," *Work and Occupations*, 16, 323-357
- Jones, E. E. (1964), *Ingratiation*, New York: Appleton, Century, Crofts
- Katz, D. and R. L. Kahn (1978), *The Social Psychology of Organizations*, 2nd ed., New York: John Wiley & Sons.

- Kiesler, A. (1989), "Organizational, Institutional, and Societal Evolution: Medieval Craft Guilds and the Genesis of Formal Organizations," *Administrative Science Quarterly*, 34, 540-564.
- Kiesler, S. and L. Sproull (1982), "Managerial Response to Changing Environments: Perspectives on Problem Sensing from Social Cognition," *Administrative Science Quarterly*, 27, 548-570.
- Kipnis, D., S. M. Schmidt and I. Wilkinson (1980), "Intraorganizational Influence Tactics: Explorations in Getting One's Way," *Journal of Applied Psychology*, 65, 440-452.
- Krachenberg, A. R., J. W. Hencke, Jr., and T. F. Lyons (1993), "The Isolation of Upper Management," *Business Horizons*, July/August, 41-47.
- Krackhardt, D. (1992), "The Strength of Strong Ties: The Importance of Philos In Organizations," in N. Nohria and R. Eccles (Eds.), *Organizations and Networks: Structure, Form, and Action*, Boston, MA: Harvard Business School Press, 216-239.
- Kraut, R. E., J. Galegher, and C. Egido (1988), "Relationships and Tasks in Scientific Collaboration," *Human-Computer Interaction*, 3, 31-58.
- _____, _____, R. Fish and B. Chalfonte (1992), "Requirements and Media Choice in Collaborative Writing," *Human-Computer Interaction*, 7, 375-407.
- Kraut, R. E. and L. A. Streeter (1990), "Satisfying the Need to Know: Interpersonal Information Access," *Human Computer Interaction*, *Interact '90*, in D. Diaper (Ed.), Cambridge, England, 909-915.
- Kraut, R. J., C. Egido and J. Galegher (1990), "Patterns of Contact and Communication in Scientific Research Collaborations," in J. Galegher, R. E. Kraut and C. Egido (Eds.), *Intellectual Teamwork: Social and Technological Foundations of Cooperative Work*, Hillsdale, NJ: Lawrence Erlbaum, pp. 149-172.
- Lave, J. (1988), "Situating Learning in Communities of Practice," in L. B. Resnick, J. M. Levine and S. D. Teasley (Eds.), *Perspectives on Socially Shared Cognition*, Washington, D.C.: American Psychological Association, pp. 63-84.
- Lin, N. (1982), "Social Resources and Instrumental Action," in P. Marsden and N. Lin (Eds.), *Social Structure and Network Analysis*, Beverly Hills, CA: Sage.
- Malone, T. W. and J. F. Rockart (1991), "Computers, Networks, and the Corporation," *Scientific American*, 263, 128-137.
- March, J. and H. Simon (1958), *Organizations*, New York: Wiley.
- Markus, M. L. (1990), "Toward a 'Critical Mass' Theory of Interactive Media," in J. Fulk and C. W. Steinfield (Eds.), *Organizations and Communication Technology*, Newbury Park, CA: Sage Publications, 194-218.
- Markus, M. L. (1994), "Electronic Mail as the Medium of Managerial Choice," *Organizational Science*, 5, 502-527.
- Mayer, M. (1977), "The Telephone and the Uses of Time," in I. Pool (Ed.), *The Social Impact of the Telephone*, Cambridge, MA: MIT Press.
- Meltzer, L., W. N. Morris and D. P. Hayes (1971), "Interruption Outcomes and Vocal Amplitude: Explorations in Social Psychophysics," *Journal of Personality and Social Psychology*, 18, 392-402.
- Miles, R. E. and C. C. Snow (1986), "Network Organizations: New Concepts for New Forms," *California Management Review*, 28, 62-73.
- Mintzberg, H. (1973), *The Nature of Managerial Work*, New York: Harper & Row.
- Monge, R. R. and K. K. Kirste (1980), "Measuring Proximity in Human Organizations," *Social Psychology Quarterly*, 43, 110-115.
- _____, L. W. Rothman, E. H. Eisenberg, K. L. Miller and K. K. Kirste (1985), "The Dynamics of Organizational Proximity," *Management Science*, 31, 1129-1141.
- Nickerson, R. S. (1992), *Looking Ahead: Human Factors Challenges in a Changing World*, Hillsdale, NJ: Lawrence Erlbaum Associates.
- Nohria, N. and R. Eccles (1992), "Face-to-Face: Making Network Organizations Work," in N. Nohria and R. G. Eccles (Eds.), *Networks and Organizations: Structure, Form, and Action*, Boston, MA: Harvard Business School Press, 288-908.
- Ouchi, W. G. (1980), "Markets, Bureaucracies, and Clans," *Administrative Science Quarterly*, 25, 129-140.
- Papa, W. H. and M. J. Papa (1992), "Communication Network Patterns and the Reinvention of New Technology," *Journal of Business Communication*, 29, 41-61.
- Pelz, D. C. and F. M. Andrews (1966), *Scientists in Organizations: Productive Climates for Research and Development*, New York: Wiley.
- Perrow, C. (1967), "A Framework for the Comparative Analysis of Organizations," *American Sociological Review*, 32, 194-208.
- Poole, M. S. and G. DeSanctis (1992), "Microlevel Structuration in Computer-supported Group Decision Making," *Human Communication Research*, 19, 1, 5-49.
- Powell, W. W. (1990), "Neither Market nor Hierarchy: Network Forms of Organization," *Research in Organizational Behavior*, 12, 295-336.
- Putnam, L. L. and R. L. Sorenson (1982), "Equivocal Messages in Organizations," *Human-Communication Research*, 8, 2, 114-132.
- Quinn, J. B. (1992), *Intelligent Enterprise*, New York: Free Press.
- Raelin, J. A. (1986), *The Clash of Cultures: Managers Managing Professionals*, Boston, MA: Harvard Business School Press.
- Randolph, A. W. and F. E. Finch (1977), "The Relationship Between Organization Technology and the Direction and Frequency Dimensions of Task Communication," *Human Relations*, 30, 1131-1145.
- Reid, A. (1977), "Comparing Telephone with Face-to-Face Contact," in I. Desola Pool (Ed.), *The Social Impact of the Telephone*, Cambridge, MA: MIT Press, pp. 386-415.
- Reinsch, N. L. and R. W. Beswick (1990), "Voice Mail Versus Conventional Channels: A Cost Minimization Analysis of Individuals' Preferences," *Academy of Management Journal*, 33, 801-816.
- Rice, R. E. (1992), "Task Analyzability, Use of New Media, and Effectiveness," *Organization Science*, 3, 475-500.
- _____, (1993), "Media Appropriateness: Using Social Presence Theory to Compare Traditional and New Organizational Media," *Human Communication Research*, 19, 451-484.

- _____ and C. Aydin (1991), "Attitudes Towards New Organizational Technology: Network Proximity as a Mechanism for Social Information Processing," *Administrative Science Quarterly*, 36, 219-244.
- _____ and D. Case (1983), "Electronic Message Systems in the University: A Description of Use and Utility," *Journal of Communications*, 33, 131-152.
- _____ and J. A. Danowski (1993), "Is It Really Just Like a Fancy Answering Machine? Comparing Semantic Networks of Different Types of Voice Mail Users," *Journal of Business Communication*, 30, 369-397.
- _____, D. Hughes and G. Love (1989), "Usage and Outcomes of Electronic Messaging at an R & D Organization: Situational Constraints, Job Level, and Media Awareness," *Office: Technology and People*, 5, 141-161.
- _____ and D. E. Shook (1990), "Voice Messaging, Coordination, and Communication," in J. Galegher, R. E. Kraut and C. Egido (Eds.), *Intellectual Teamwork: Social and Technological Foundations of Cooperative Work*, Hillsdale, NJ: Lawrence Erlbaum, pp. 327-350.
- Ross, M. (1989), "Relation of Implicit Theories to the Construction of Personal Histories," *Psychological Review*, 96, 341-357.
- Short, J., E. Williams and B. Christie (1976), *The Social Psychology of Telecommunications*, London, UK: John Wiley & Sons.
- Siegel, J., V. Dubrovsky, S. Kiesler, and T. W. McGuire (1986), "Group Processes in Computer-mediated Communication," *Organizational Behavior and Human Decision Processes*, 37, 157-187.
- Simon, H. A. (1962), "The Architecture of Complexity," *Proceedings of the American Philosophical Society*, 106, 467-487.
- Sproull, L. and S. Kiesler (1986), "Reducing Social Context Cues: Electronic Mail in Organizational Communication," *Management Science*, 32, 1492-1512.
- _____ and _____ (1991), *Connections: New Ways of Working in the Networked Organization*, Cambridge, MA: MIT Press.
- Sproull, L. S. (1984), "The Nature of Managerial Attention," in P. Larkey and L. Sproull (Eds.), *Advances in Information Processing in Organizations, I*, Greenwich, CT: JAI Press, 9-27.
- Steuer, J. (1992), "Defining Virtual Reality: Dimensions Determining Telepresence," *Journal of Communication*, 42, 73-93.
- Straus, S. G. and J. E. McGrath (1994), "Does the Medium Matter? The Interaction of Task Type and Technology on Group Performance and Member Reactions," *Journal of Applied Psychology*, 79, 87-97.
- Thompson, J. D. (1967), *Organizations in Action: Social Sciences Bases of Administrative Theory*, New York: McGraw-Hill.
- Thorelli, H. B. (1986), "Networks: Between Markets and Hierarchies," *Strategic Management Journal*, 7, 37-51.
- Travis, P. (1990, January 22), "Why the AT & T Network Crashed," *Telephony*, 218, 11.
- Trevino, L. K., R. Lengel and R. L. Daft (1987), "Media Symbolism, Media Richness, and Media Choice in Organizations: A Symbolic Interactionist Perspective," *Communication Research*, 14, 5, 553-574.
- Tushman, M. L. (1977), "Special Boundary Roles in the Innovation Process," *Administrative Science Quarterly*, 22, 587-605.
- Wagner, W. G., J. Pfeffer and C. A. O'Reilly (1984), "Organizational Demography and Turnover in Top-management Groups," *Administrative Science Quarterly*, 29, 74-92.
- Walton, R. E. (1989), *Up and Running: Integrating Information Technology and the Organization*. Boston, MA: Harvard Business School Press.
- Watson, K. M. (1982), "An Analysis of Communication Patterns: A Method for Discriminating Leader and Subordinate Roles," *Academy of Management Journal*, 25, 1, 107-120.
- Weeks, G. D. and A. Chapanis (1976), "Cooperative vs. Conflictive Problem Solving in Three Telecommunications Modes," *Perceptual and Motor Skills*, 42, 879-917.
- Whitely, W. (1984), "An Exploratory Study of Managers' Reactions to Properties of Verbal Communication," *Personnel Psychology*, 38, 41-53.
- Wickesberg, A. K. (1968), "Communication Networks in the Business Organization Structure," *Academy of Management Journal*, 3, 253-262.
- Wilson, D. O. (1992), "Diagonal Communication Links within Organizations," *The Journal of Business Communication*, 29, 129-143.
- Yates, J. (1989), *Control through Communication: The Rise of System in American Management*, Baltimore, MD: Johns Hopkins University Press.
- Yukl, G. and C. M. Falbe (1990), "Influence Tactics and Objectives in Upward, Downward, and Lateral Influence Attempts," *Journal of Applied Psychology*, 75, 132-140.
- Zenger, T. R. and B. S. Lawrence (1989), "Organizational Demography: The Differential Effects of Age and Tenure Distributions on Technical Communication," *Academy of Management Journal*, 32, 353-376.
- Zmud, R. W., M. R. Lind and F. W. Young (1990), "An Attribute Space for Organizational Communication Channels," *Information Systems Research*, 1, 440-457.

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