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A RAND NOTE

Flexible Interactive Technologies for Multi-Person Tasks: Current Problems and Future Prospects

Tora K. Bikson, J. D. Eveland,
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December 1988

40 Years 1948-1988

RAND

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FLEXIBLE INTERACTIVE TECHNOLOGIES FOR MULTI-PERSON TASKS: CURRENT PROBLEMS AND FUTURE PROSPECTS

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INTRODUCTION

Whether organizations are moving to network their personal computers, decentralize their mainframe environments, or build group-level computing structures, they share at least one major concern: to provide flexible interactive technology to support and augment multi-person work. This chapter reviews cross-sectional, case study and pilot research carried out by RAND's Institute for Research on Interactive Systems, which explores the deployment of current information technology in diverse user groups.

The successful integration of new technology into information-intensive work demonstrates the socio-technical properties of work groups; that is, group members are interdependent not only on one another but also on the technology, and technical and organizational issues are closely interrelated. The more advanced the information-handling tools provided to the group, the more critical it becomes to give equivalent and concurrent attention to the social processes through which these tools are deployed, and to seek a mutual adaptation rather than maximization of either the social or technical system in isolation.

Reprinted from *Technological Support For Work Group Collaboration*, Margrethe H. Olson (ed.), pp. 89 112. © 1989 by Lawrence Erlbaum Associates, Inc. Reprinted by permission.

Experiences in the organizations we studied indicate that even today's technologies can make multi-person information tasks more manageable, increase throughput, and permit more broadly-based and flexible work groups. However the same research suggests that realization of these benefits heavily depends on the resolution of social questions about collaboration—questions about group norms and values, equitable role structuring, and shared task management—that organizations introducing new technology are not usually prepared to address.

Advances in hardware, software, and communications expand the opportunities for collaboration. The rate of evolution in the technologies for collaborative work (for instance, hypertext-based systems for data management or joint authoring, communication systems for coordination of interactions or intelligent message handling, etc.) has probably outpaced our understanding of how such tools can be productively managed and used in organizational contexts. Taking advantage of such technologies will require some very new answers to some very old social questions.

UNDERSTANDING THE TERMS

Although the notion of work group collaboration is a familiar one, it is often presupposed rather than defined. For purposes of the research reviewed here, we found it helpful to rely on the generic concept of a "work unit" from traditional organizational research. Trist (1981) defines primary work units in the following way:

> These are the systems that carry out the set of activities involved in an identifiable and bounded subsystem of a whole organization, such as a line department.... They have a recognized purpose, which unifies the people and activities. (p. 10)

If this characterization is amended so that the work unit's activities are information intensive, it yields a reasonable starting definition of white-collar work groups, or collaborating groups of information workers.

We operationalized this definition to emphasize both the complexity and the organization of work units. That is, following Rousseau (1983), we targeted for study groups of four or more persons, representing at least two different status or occupation levels, whose activity is related by outputs or by work processes (Bikson & Eveland, 1986; Bikson & Gutek, 1983; Bikson, Gutek, & Mankin, 1987; Gutek, Bikson & Mankin, 1987; Talbert, Bikson, & Shapiro, 1983).

Work groups comprise multiple individuals acting as a bounded whole in order to get something done (cf. Dunham Johnson, McGonagill, Olson, & Weaver, 1986; Kraut, Galegher & Egido, 1986). So construed, they are inherently collaborative. This view concurs with Blomberg's (1986) in underscoring the cooperative aspect of most work activities. A group's work goal, in turn, will likely involve a number of multi-person tasks and task cycles; its activities are expected to persist over time and to survive membership changes. Finally, we emphasize missions; that is, what groups do, in accounting for cooperation. In the phrase "work group," 'work' and 'group' get equal stress (Akin & Hopelain, 1986).

From this standpoint, the goal of technological support for work group collaboration is to enhance its mission performance. This interpretation accords with accepted definitions of tools as means for extending the capability of individuals, work groups, or organizations (Tornatzky 1983). For information work, the tools are flexible, computer-based information and communication technologies that aid the completion of multi-person tasks.

More specifically, the research summarized here focuses on interactive systems that can support multiple functions and are appropriate for use by all work group members. (This is not to claim that every function of the system is appropriate for all members, but only that some subset is appropriate for each of them.) This conceptualization of work group technology remains quite broad and is satisfied by widely varied configurations of hardware, software, and communications media. Candidate systems might range from personal computers communicating via the manual transfer of floppy disks to supermicros on broadband networks.

The systems we observed fall somewhere between these extremes, although they tend to be "lagging-edge" technologies rather than the leading-edge variety. Nonetheless we suspect there is much that is generic about group work and methods for augmenting it. If so, examining experiences with today's tools can prove helpful in understanding problems and prospects for supporting group collaboration with advanced technologies.

RESEARCH BACKGROUND

Since 1982, we at RAND have undertaken a number of studies of interactive systems in organizational settings. All rely on the common definition of the technology and the work group outlined above. However, they intentionally incorporate diverse research methods. Projects on which this discussion draws most heavily include:

- two extensive reviews of the literature (Bikson & Eveland, 1986; Bikson, Gutek, & Mankin, 1981)
- a large-scale cross-sectional study of 55 work groups in private sector organizations (Bikson, 1987; Bikson & Gutek, 1983; Bikson, Gutek, & Mankin, 1987)
- case studies of multiple work groups in single organizations (Bikson, Stasz, & Mankin, 1985; Stasz, Bikson, & Shapiro, 1986);

- two field intervention projects: a pilot electronic mail project to design, implement and track a message-handling system (Eveland & Bikson, 1987) and a long-term experiment comparing electronic and conventional interaction media for support of two otherwise identical task groups (Eveland & Bikson, 1988).

Although each research effort addresses project-specific hypotheses, they share some guiding propositions. For example, the projects all assume that the work group is the critical unit of analysis. They look secondarily at the overall organizational context in which the groups are embedded, at how targeted groups interact with other groups, and at individual differences. Almost never do they examine entire occupational strata (e.g., all managers, all professionals) because these are "groups" only in a statistical sense and do not reflect the organization of work.

The projects further suppose that any interactive technologies introduced into work settings will be, following Kling and Scacchi (1982), more like webs than discrete entities. This tenet leads to a technical focus not on highly specific electronic tools but on the broader interactive environment of which the tools are a part. That environment, we believe, should be modeled generically as an information-communication system. For example, its major components can be regarded as "messages" (chunks of content, which may be composed from text, numbers, images, graphics, and so on, and which may be operated on with content-appropriate electronic tools); "senders" (who compose and transmit the messages); and "receivers" (either another individual(s) or the same individual at another time). If the basic mission of white collar work is generation, transformation, or transmission of information, then this model of the technology web would seem to suit it fairly well (Talbert, Bikson & Shapiro, 1984).

What happens when a web of interactive technology is integrated into information work? The result, we believe, is a sociotechnical system in the traditional sense: Work groups become "directly dependent on their material means and resources for their output" (Trist, 1981; cf. Bikson & Eveland, 1986; Johnson & Rice, 1987; Pava, 1985; Taylor, 1987). That is, individuals become interdependent not only on one another but also on the technology for accomplishing their mission. Although the avenues for collaborative work and the means for managing it are multiplied, new sources of variance are also introduced by the technology that pre-existing social structures are usually ill-prepared to handle.

Finally, we expected to observe the mutual adaptation of social and technical systems. That is, flexible interactive systems are modified and extended to fit the user context even as the work group is changing to take advantage of the technology (Bikson & Eveland, 1986). However, there is no straightforward way to measure the success of this process. For research purposes, we regarded technologies as well-incorporated into work groups on the basis of how widely they were used, how satisfied the users were, and how they affected the performance of group missions (Bikson, 1987; Bikson, Gutek, & Mankin, 1987).

The following review of findings from this program of research that bear on the question of technological support for work group collaboration. In general, the discussion relies on the large cross-sectional study cited earlier, complementing it with information gathered in the case studies and field experiments.[1]

WORK GROUPS

First, we learned that while the work group is a productive unit of analysis, groups differ significantly from one another. Similarly, group work should not be treated as a unitary phenomenon since what holds true of some types of groups does not apply to others.

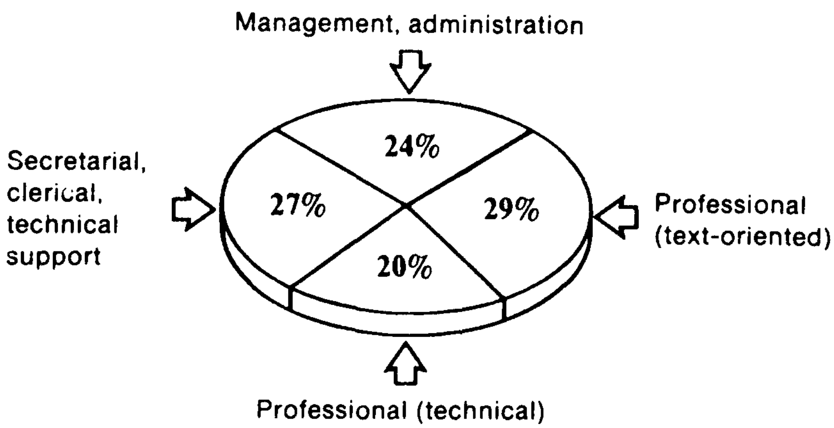

Figure 5.1.

1 Supported by a grant from the National Science Foundation, the study explored how well conceptions of technological innovation from previous research could inform and explain successful implementation of computer-based procedures in diverse white-collar settings. Over 500 white-collar employees, representing 55 work groups in 26 different manufacturing and service organizations, participated in the project. Data were obtained from employee surveys, managerial interviews, archival records, and observation. The research is reported in detail in (Bikson, Gutek, & Mankin, 1987) and summarized in (Bikson, 1987). For convenience, this research is often cited as the "cross-sectional" study throughout the chapter.

Given our definition of work group, it seemed most appropriate to classify groups according to their mission within the broader organization. As Figure 5.1 illustrates, our cross-sectional study of 55 white collar work groups generated four distinct functional types, each type accounting for 20 to 29 percent of the employee sample (Bikson, Gutek, & Mankin, 1987; Gutek, Sasse, & Bikson, 1986).

Management/administration: Groups in this category have decision-making, planning, policy-setting, and oversight responsibilities. Examples in our research include corporate strategic planning offices, fiscal controllers' offices, personnel departments.

Professional (text-oriented): We distinguished two types of groups that carry out professional functions. The "text-oriented" groups were so designated because their products tend to be conveyed with textual information. Legal offices, public relations offices, marketing departments, and the like, fall into this category.

Professional (technical): In contrast, these groups tend to produce specifications, designs, formulas, models. In our study, this category included electronic design departments, internal research and development departments, manufacturing quality assurance departments, etc.

Secretarial, clerical, and technical support: Groups of this type provide support services. Examples are reservations and bookings offices, inventory control, and payroll offices.

While we initially based these categories on what work groups do, we found the four types to be associated with a number of other differences.

For example, we observed substantial differences in size and internal structure. Although the average group size overall was 10, upper management/administration groups tended to have fewer members and support groups, more members. Interestingly, both these group types were significantly more centralized than either type of professional group in the cross-sectional study (Bikson & Gutek, 1983), a finding that reappeared in network analyses of communication data in our study of electronic mail patterns (Eveland & Bikson, 1987). In contrast to previous hypotheses about size and centralization (e.g., Crowston, Malone, & Lin, 1986), these data suggest that internal structure is more influenced by group type than by size. However, within professional groups we were able to show that the smaller the membership, the more centralized its communications (Eveland & Bikson, 1987).

Perhaps more important, we learned there are characteristic sets of information handling activities distinctive of each type of group. Not surprisingly, text-oriented professional groups do a great deal of writing, editing, and rewriting; their technical peers, by contrast, take the lead in computation and database maintenance. Upper level management and administration groups develop forms and distribute information, while support groups fill in forms and process records. The activity sets delineated in Figure 5.2 were obtained by factor analysis of task check lists and provide empirical support for the initial mission-based classification of work groups (Bikson, 1987; Bikson & Gutek, 1983).

On the other hand, the same checklists revealed many commonalities across the sample regardless of group membership. As Table 1 shows, while writing original material is most prevalent in text-oriented professional groups, two-thirds of the employees in our cross-sectional sample (N=531) write from time to time as a regular part of their job. Similarly, while top management spends a higher proportion of time in verbal communication than other groups do, almost everyone reports verbal communication to be a non-negligible part of their work. And over half of all employees have some sort of information files to maintain.

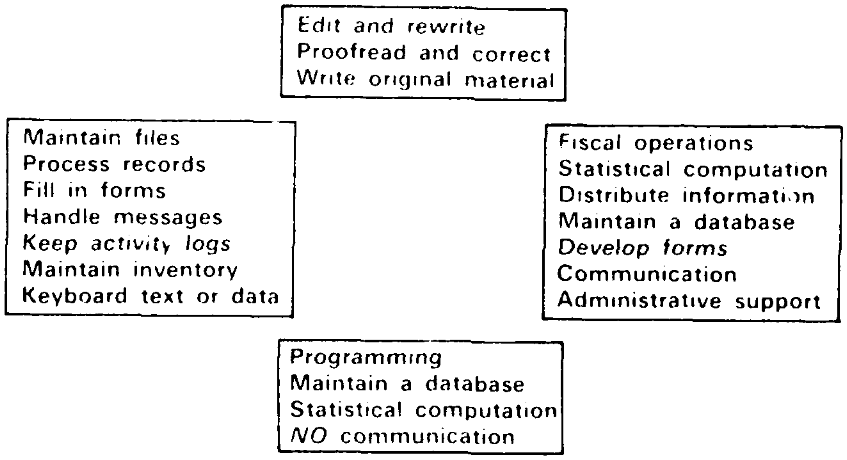

Figure 5.2. Information work that distinguished groups

From this empirical look at work groups and the activities their missions subsume, it seemed our view of the supporting technology might be an apt one: a highly generic information-communication environment in which more specialized tools are embedded as needed to carry out particular group tasks.

TECHNOLOGIES

When we examined interactive systems supporting group work, we found technologies, with an emphasis on the plural. The cross-sectional study established considerable variety in electronic tools in use; even within work units, "the tech

Most common tasks	Percent who do each
• Communicate verbally	96%
• Write original material	66%
• Proofread and correct	63%
• Edit and rewrite	57%
• Maintain files	57%
• Handle messages	49%
• Fill in forms	48%
• Distribute information	47%

TABLE 1
Very general information work

nology" tends to be a loose-bundled and changing collection of hardware, software, I/O devices, and communications capabilities supplied from multiple vendors (Bikson, Gutek, & Mankin, 1987). Our data corroborate the conclusion drawn by Kraut, Galegher and Egido (1986): There is no single technology that adequately supports the collaborative process; groups rather need and make use of a "rich palette" of computer-based tools, typically involving more than one vendor's products. We add that often they do so in spite of rather than because of technology planning processes. In fact, our case studies (e.g., Stasz, Bikson, & Shapiro, 1985) suggest that even when organizational policies dictate use of a single vendor or uniform product line, work groups will generally find a way to incorporate diversity.

Hardware

To search for patterns within this diversity of equipment, we did a principal components analysis of hardware characteristics in the cross-sectional study (Gutek, Sasse, & Bikson, 1986). For this purpose, we relied on 10 archival variables: date of acquisition of current configuration, type of processing unit, availability of local communications, number of vendors involved, nature of vendor support, and who formally owned or controlled the computer system.

This principal components analysis generated four different patterns or factors that together accounted for about 75 percent of the variance in observed equipment configurations. (It should be noted that the four factors do not stand for mutually exclusive categories; rather they represent general patterns that work groups may reflect more or less closely. For instance, a work group's equipment may very closely resemble configuration 1 and also bear some resemblance to con-

2.) The four configurations are described below in order of the proportion of common hardware variation they explain.

Configuration 1: This configuration consists of micro- or mini-based systems that are owned by the organization but may be controlled by a department other than the user group's department. The system is heavily dependent on vendor support.

Configuration 2: The second configuration is typified by mini-based systems and local communications. Many vendors are involved, and equipment is likely to be rented or leased. However the system is not likely to depend heavily on vendor support.

Configuration 3: A third configuration comprises microcomputers from multiple vendors controlled by the user group; this group also has primary responsibility for their support.

Configuration 4: The last configuration, least common in our sample, is characterized by older mainframe-based systems, usually acquired before 1981. These systems are owned and supported by the organization.

We found, not surprisingly, that the four equipment patterns are not evenly distributed among work group types (Gutek, Sasse, & Bikson, 1986). For example, while vendor-supported microcomputer or minicomputer systems (Configuration 1) can be found in all work group types, they most strongly characterize the text-oriented professional groups in our research. On the other hand, technical professional groups have greatest access to multi-vendor minicomputer systems that they themselves support (Configuration 2). While this configuration is also found with some frequency among nontechnical professional groups, it is associated with significantly higher job satisfaction in the technical groups (Gutek, Sasse, & Bikson, 1986).

Support groups frequently fall heir to the oldest systems, often mainframe systems that were not initially intended to support interactive use (Configuration 4). These groups also have the most uniform equipment. Upper management and administration groups, in contrast to other group types in our sample, are not uniquely associated with any particular equipment configuration. Among all arrangements, micro-based systems (configuration 3) are most evenly represented across group types.

Finally, we examined a wide range of outcome measures in relation to equipment characteristics to determine whether any hardware properties are significantly associated with successful work group support, either generally or within work group type. We found only weak and unsystematic relationships between particular hardware characteristics (whether taken separately or bundled into configurations) and outcome measures. The one exception is access. Not having a workstation of one's own is strongly and negatively associated with system use, user satisfaction, and work group performance across group types and equipment configurations (Bikson, 1987).

Software

Because different tasks can be performed on the same hardware and the same tasks on different hardware, how well work groups are supported by their technologies is likely to be more a function of software properties than equipment characteristics. On the other hand, software arrangements are even more diverse and difficult to characterize. In the cross-sectional study, for instance, less than 20 percent of the work groups used only unmodified off-the-shelf packages. The others had modified their software environment to varying degrees, and a majority of groups (74 percent) made use of one or more applications programs written specifically to meet their needs (e.g., capital asset tracking, avionics simulation).

Faced with such an array, we sought higher order characterizations of the software in use on the basis of our conceptual framework. Given the emphasis on mission performance by work groups, we looked first to the functions that electronic tools were being used to support. These data were obtained during initial site selection. In subsequent site visits we collected more information about the software in use, asking group members to evaluate it along a number of dimensions (Bikson, Gutek, & Mankin, 1987).

We learned that functional diversity of software applications by itself can discriminate work group types. The number of basic computer-assisted tasks reported per group ranged from 1 to 8. Support groups dominated the low end of this dimension, performing significantly fewer different functions than other types of groups. Management/administration groups, by contrast, have computer support for the largest number of different tasks. In this respect, then, technology webs come to resemble task arrays; that is, quite independently of computer technology, job variety discriminates work group types in the same way (Bikson & Gutek, 1983).

Whether users performed many or few computer-assisted tasks, we found some generic software properties to be systematically associated with positive work group outcomes. Most significant among them are the following (Bikson, 1987):

Functionality, or the extent to which applications software is appropriate for assisting users' particular job functions, is a strong predictor of success. This variable is a summary measure derived from user evaluations of specific system features. Upper management/administration groups judge their software to be substantially better on the functionality dimension than other groups; support groups give their systems notably negative ratings.

Interaction support, or whether users have what they need to interact effectively with their software applications, also significantly influences work group outcomes. Another summary variable, it represents not only type of dialog with the computer but also quality of the user manual. Interaction features also generate between-group differences, with technical professionals evaluating their systems most negatively on this dimension.

Customization, or extent of modification of software to conform to work group tasks, is a third generic dimension associated with positive results. In the sample we studied, customization was sometimes provided by a system integrator or by a systems department external to the work group. In other cases, work groups themselves had the capability to develop or modify applications (using high level programming languages, application generators, user-definable keys, user-determined profiles, and the like). Interestingly, we found that professional groups (whether technical or text-oriented) are most likely to be provided with options for modifying the way their systems behave. Both upper management/administration and low level support groups are typically denied this flexibility, relying on external sources for software modifications. In any case, collaborative work is better supported by software that is adapted or adaptable to the group's tasks (as the mutual-adaptation thesis, cited above, led us to expect).

If levels of functionality, interaction support and customization affect how well a set of computer-based tools assists a work group, what can be said about the tools themselves? As indicated earlier, when groups enrolled in the cross-sectional study, we got a list of major functions served by the computer for each. We also asked work group managers to rank them in importance; the results are displayed in Table 2.

Most important	Percent of groups
Very generic applications	42%
Very specific applications	40%
Communication, coordination	18%

TABLE 2
Major work group functions for computer support

First-ranked functions for computer support across group types are either highly general (e.g., writing and editing, statistics, document preparation for 42 percent of groups) or extremely domain-specific (e.g., acquisitions decision support, product requirements analysis, customer profile development in another 40 percent). Contrary to the electronic web we had envisioned, internal coordination and communication functions (e.g., electronic mail, calendaring and scheduling, project status tracking) were rarely mentioned as important applications of the technology (Bikson, Gutek, & Mankin, 1987). Nonetheless, 44 percent of the groups used their computer system for internal messaging and 57 percent, for external mail. These data suggested, alternatively, that specific tools may be easier to see than the web in which they are embedded. In any event, we used the smaller field research projects to take a closer look at computer-based communication in collaborative work.

COMMUNICATION

A frequent question is whether electronic media can overcome physical and social barriers to enable collaboration among individuals who otherwise would not be able to work together (e.g., Feldman, 1987). We have given special attention to electronic communication in two field intervention research efforts: a pilot project to provide an electronic mail system serving the needs of RAND's nontechnical employees (see also Eveland & Bikson, 1987)[2]; and a field experiment comparing the activities of non-colocated task groups with and without electronic communication capability (see also Eveland & Bikson, 1988).[3]

2 RANDMAIL is a message-handling system designed to be coherent with and to enhance existing organizational communication processes at RAND. For 18 months after its introduction, message header data (to, from, and cc notes plus date /time) were captured on two Unix-based minicomputer host machines. The 69,000 message headers logged represented 800 individual sender and/or receiver nodes. Nodes were linked with organizational characteristics (e.g., department, occupation, office location) to help interpret results generated by network analyses. This research, supported by an internal grant from The RAND Corporation, is reported in Eveland and Bikson, 1987). For convenience, we have referred to it throughout this chapter as the RANDMAIL study.

3 A grant from The John and Mary R. Markle Foundation is currently supporting a field experiment to examine the utility of computer-based communication for establishing or maintaining links between retirees and those nearing retirement. Retirees and employees were recruited (N=80) from a large organization and randomly assigned in equal numbers to "electronic" and "standard" task groups, each preparing a white paper on issues in the transition to retirement. Meetings, telephone calls, postage, and the like, are supported for both groups. In addition, electronic group members are provided with networked personal computers, electronic mail, and other software. Structured interview and survey data are collected from all participants at several times during the year-long task period. Findings will be available in RAND reports and other publications (T.K. Bikson, Rand Corporation, Principal Investigator).

A tentative answer to the question, based on preliminary findings, is "yes" when the barriers are physical and "no" (or at least "not necessarily") when the barriers are social. As others have noted (e.g., Rice, 1984), computer-based communication media, even the narrow-band sort we have studied, are not simple substitutes for other channels but rather provide new avenues for the technical augmentation of work group interaction. Their effectiveness for overcoming social distance, however, has yet to be established. The creation of new collaborations that span such distances, we believe, is probably a long-term phenomenon at best.

Space Constraints

As part of the RAND pilot project, we logged message headers for the first 18 months of the system's availability. These data included the time of day that a message was sent and office locations of the individuals involved. To explore questions about spatial distance, we constructed a 9-level ordinal-distance index representing how far apart the communicating persons are in terms of difficulty in making physical contact (for example, a '9' stands for interactions between the Washington and Santa Monica offices). Figure 5.3 presents the percent of messages sent as a function of the distance between sender and receiver nodes ("adjusted" figures correct for the number of people in a physical location).

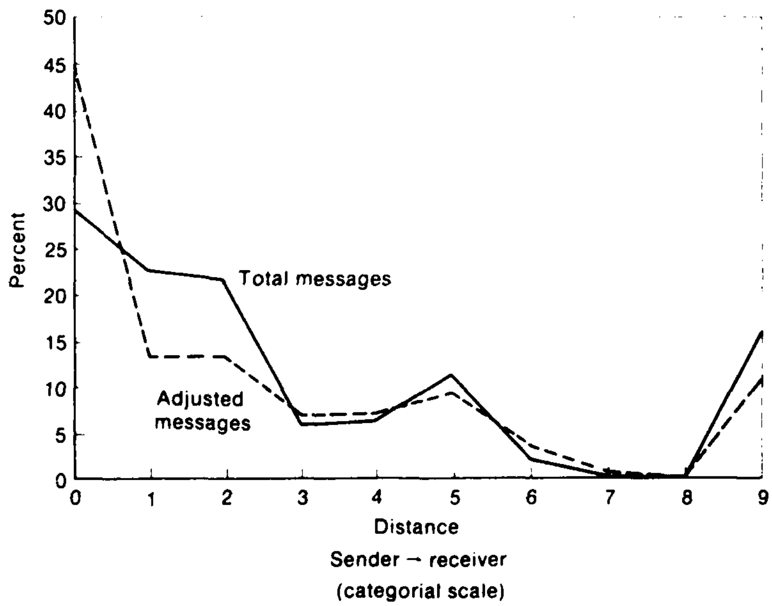

Figure 5.3. Space constraints and messaging.

As Figure 5.3 shows, we did not find that people use electronic messaging disproportionately to contact people who are spatially out of reach. On the contrary, except for interactions between the East and West coast, spatial distance was negatively associated with electronic interaction. On average, people sent about 45 percent of their messages to others in their immediate physical vicinity (Eveland & Bikson, 1987). We interpret this to mean that electronic links primarily enhance existing interaction patterns at RAND rather than creating new ones. Borrowing Orr's (1986) phrase, we seem to find "electronic hallways," but they appear in the main to parallel the spatial ones.

Time Constraints

On the other hand, the data suggest that the temporal barriers overcome by messaging are more important than is sometimes realized. In Figure 5.4, message sending is shown as a function of time of day using Pacific Standard Time. At RAND, asynchronous communication capability is, as expected, used to overcome the three-hour barrier between between the East and West coast offices.

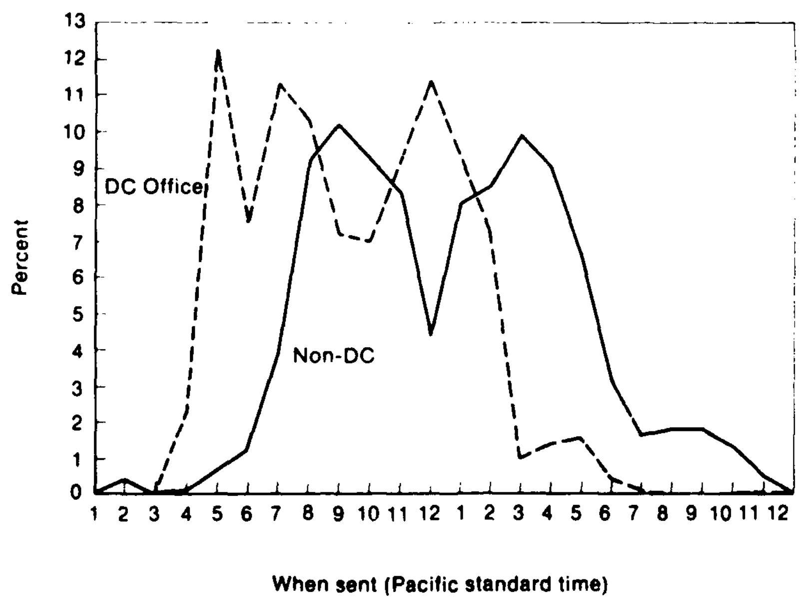

Figure 5.4. Time constraints and messaging

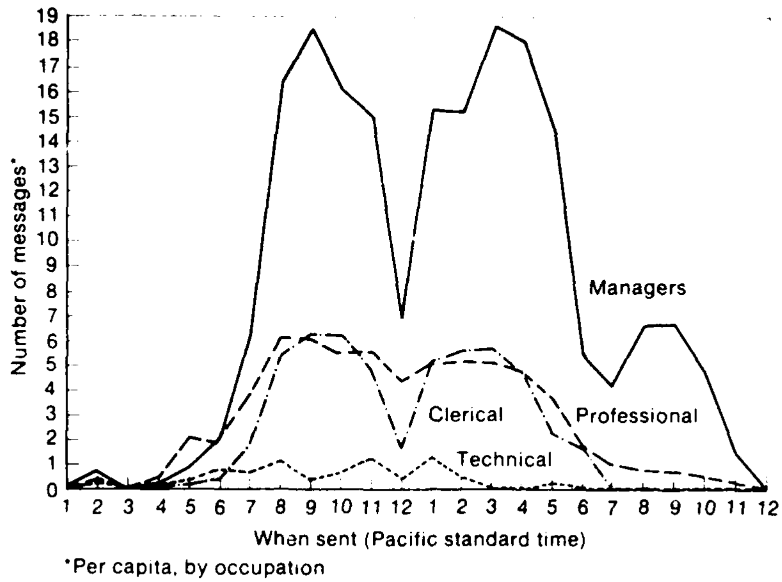

Figure 5.5. Time constraints and messaging

Even more striking, however, is the asynchronous coordination of communication displayed in Figure 5.5, where message sending times are broken down by occupational category. Different individuals within a work group appear to distribute their interactions over the work day according to occupational demands, personal preferences, and other factors. Overcoming time constraints on communication with individuals in the next office as well as in the next time zone probably deserves greater emphasis in understanding support for collaborative work (Eveland & Bikson, 1987).

Professional Groups

Organizationally, RAND is structured as a matrix with scientific responsibility partitioned between "departments" and "programs." Departments (e.g., Political Science, Information Science) are disciplinary in orientation and oversee hiring, promotion, etc.; they channel secretarial services and handle peer review for all research products. Programs (e.g., Labor and Population, Health) have a domain focus; they are charged with bringing in research funds, and they organize and oversee projects in their topic area, often involving researchers from multiple disciplines. The RANDMAIL project, for instance, drew on information scientists and behavioral scientists. Every researcher at RAND, then, participates in at least two groups. We examined patterns of communication within and between these professional groups to see how they influenced interaction and what the effect of electronic mail might be. Given our mission-oriented definition of work units, we would expect programs (which concern themselves with the production of research) to have a stronger impact than departments, in spite of what is often said about the difficulty of communicating across disciplinary lines.

A sociometric analysis of message data (Eveland & Bikson, 1987) revealed that members of different research departments, in spite of being geographically separated within RAND, regularly engage in interdisciplinary interaction. Examining the proportion of all messages sent to addressees in the same or a different department (see Figure 5.6) makes it clear that, except for messages from support staff, a sizeable majority of communications span RAND's departments. When we assessed these data longitudinally, we found evidence that department-based communication clusters became more open over the 18-month study period.

A sharply contrasting pattern is presented by Figure 5.7, which shows the proportion of all messages sent to addresses in the same or a different program of research. Sociometric analyses indicated that research programs generate communication clusters that are widely separated from one another; there is substantial intraprogram interaction, low interprogram interaction, and no evidence that electronic messaging increases the permeability of these clusters over time (Eveland & Bikson, 1987).

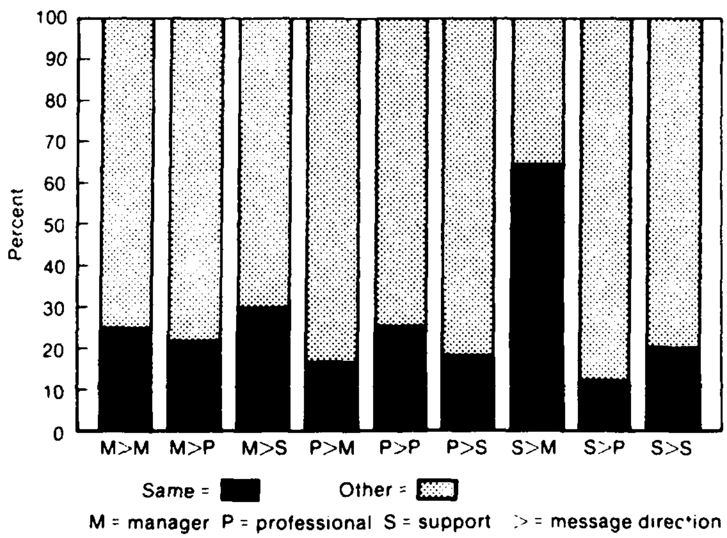

Figure 5.6. Individual message exchange: same or other department

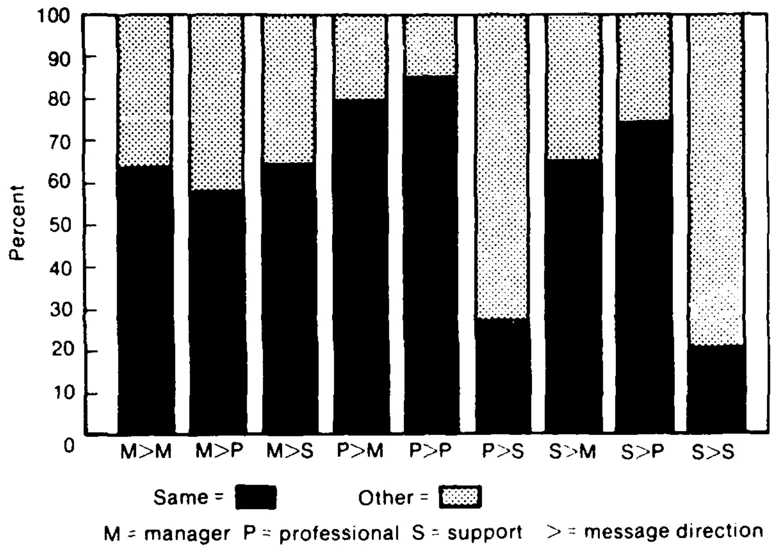

Figure 5.7. Individual message exchange: same or other program

Looking at communication among research programs by source of funding reinforces this finding. At RAND some programs (e.g., Soviet Studies, Project AIR FORCE) are chiefly supported by defense funds while others (e.g., Labor and Population, Health) receive their funds from domestic sources. When RANDMAIL interactions are examined by source of program support, it is clear that very few electronic communications span this funding boundary. This is so in spite of the fact that by disciplinary home and by type of research project, professionals engaged in Soviet Studies and Labor and Population work, for instance, may have more in common than either has with Air Force or medical research.

These analyses suggest, then, that electronic messaging is readily exploited to support ongoing collaborative work; but it does not necessarily promote the formation of new work collaborations, at least in the short term. Although electronic links can enable new collaborations as they arise for other purposes, the ability of information technology per se to stimulate new organizational interactions is still not evident.

All Groups

Like other organizations, RAND has not only professional groups but also management/administration groups (e.g., President's office, Finances, Personnel) and support groups (e.g., Telephone office, Library, Computer Services). The preceeding discussion focused on professional research groups because these collaborations permit multiple memberships and are more susceptible to change over time (and, thus, more capable of showing potential effects of new communication media). It is worth asking how, if at all, new media influence communication between different group types.

To address this question we analysed message network data twice, once using department-based professional groups and once using program-based professional groups (Eveland & Bikson, 1987). The results were virtually identical (see Figure 5.8 for a sociometric map of communicative distance between all RAND departments, distinguished by group type). These analyses indicate that, however defined, professional groups at RAND are relatively close to one another in the context of the total communication space; upper management/administration groups are also relatively close to one another; and there is very little communication between professional groups and management/administration groups. Support groups tend to be at the periphery of the communication space, not interacting with one another or with other types of groups. This pattern is a robust one unaffected by the introduction of electronic communication capabilities, a finding that may come as no surprise to students of industrial and organizational relations.

From this more focused pilot project as well as the cross-sectional study, there is evidence that electronic communication systems become embedded in the infrastructure of work and augment multi-person tasks, as sociotechnical theory suggests. Electronic mail is more a general information / communication vehicle than a substitute channel (e.g., for when the person is hard to reach physically or by telephone). Interactive linkages between work messages, work media, and workers make constraints of both time and space more manageable.

In consequence, such systems probably expand the potential for participation in multiple groups, allowing for collaborative work across a broader base of potential members. We find evidence for this conclusion in the increased interactions, within RAND, between disciplines. We also observed increased lateral interaction in our case study sites, even when it was specifically against organizational policy at the time; the organization's rules had to be altered in response (Stasz & Bikson, 1986).

A last bit of evidence comes from the field experiment now in progress (see footnote 3 and Eveland & Bikson, 1988). Two task forces, one conventionally supported and the other supported with electronic communications, were given the same general charge. Both groups of 40 members began by dividing this mission into subtasks for work by smaller groups. The conventional group spent considerable time arriving at a felicitous assignment of individuals to subgroups. In the electronic task force, in contrast, this did not arise as an issue. It was assumed that, given electronic means for overcoming the logistics of time and space for multi-person activity, members could work on as many subtasks as interested them. No one in the conventional task force affiliated with more than one subgroup, while

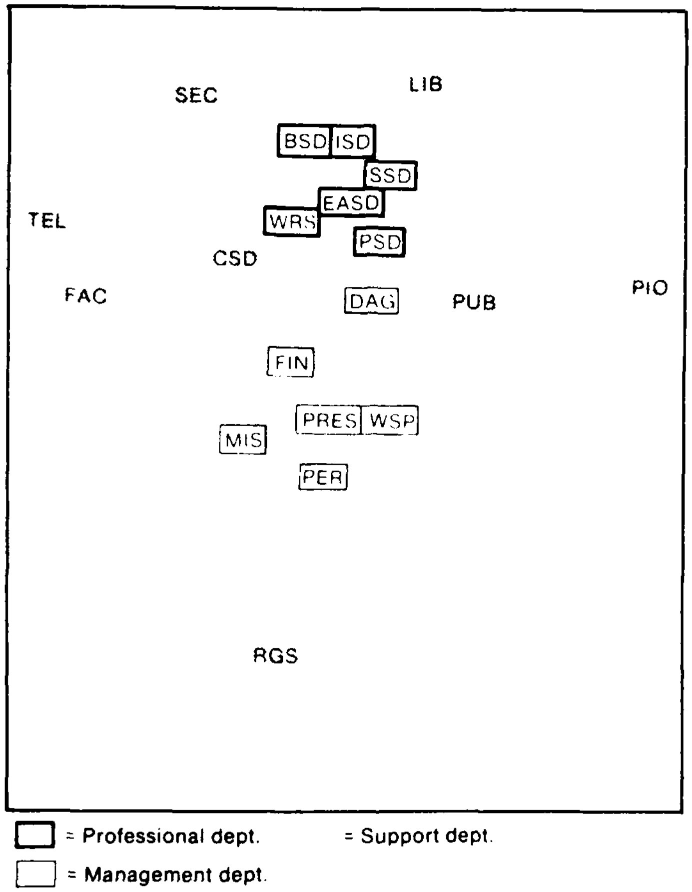

Figure 5.8. Sociogram: interactions among all groups

most participants in the electronic task force belong to two or more. At the end of the year-long work period, we will learn how these alternative arrangements fare; at this point, however, we can only conclude that availability of electronic communication media affects people's expectations as they enter collaborative work.

Interactive information-communication systems may expand the number of groups in which an individual can participate; viewed from the other side, they can expand the number of potential collaborators on which multi-person tasks may draw. But we do not see evidence that these media overcome traditional social barriers as well as they overcome space/time constraints. Rather, they seem to supplement existing preferences, opportunities, and methods for interaction.

HUMANWARE

Here humanware refers to the competence and skills to which work group members must have access in order to adapt to the collection of electronic tools that supports their collaboration. As explained earlier, as interactive systems become part of the infrastructure of white collar groups, the sociotechnical properties of their work grow in complexity and salience. We have reviewed some of the ways technologies conform to work groups. It is now appropriate to look briefly at the other side of mutual adaptation; that is, how groups change their work styles and acquire the knowledge resources to take advantage of interactive tools.

In a sociotechnical system, as we have noted, individuals become interdependent not only on one another but also on the technology. How, from the human side, is this managed? In the cross-sectional research project, we inquired of all individuals within computer-supported work groups whether or not their use of the system was voluntary. Not surprisingly, the response largely depends on the type of group. Support groups had the lowest positive response (58 percent said it was voluntary) whereas technical professionals had the highest rate of voluntary use (88 percent).

These differences, to be sure, reflect a group's organizational status and the nature of the tasks it performs as well as the desires of users. It is open to question, however, how much voluntariness will be tolerated when a work group is converting its procedures to new technologies. Interviews with work group managers produced ambivalent responses. On the one hand, managers want the transition to be voluntary; on the other hand, they make it clear that workers who are unwilling to learn to use the new tools may not be able to remain in the group.

In the RANDMAIL project we sought to develop a system useful to people who are not regular computer users. For instance, headers rely on normal names and preserve most of the regular internal memoranda conventions. We also sought to make it serve those who are not computer users at all. The database has hardcopy addresses for all employees who do not use electronic mail; when such individuals appear in a "To:" or "Cc:" line, the message is automatically printed and sent in the next internal mail distribution. Overall the new system has been a success. However, our data suggest that within the first few weeks, new electronic mail users seem to divide into frequent and infrequent users (Eveland & Bikson, 1987). Figure 5.9 displays early messaging behavior for all individuals who began using electronic mail during the 18-month logging period; that is, regardless of the calendar date at which an individual user came on line, Figure 5.9 reflects all new users' first 9 months. Over time, those in the heavier use category show gradually increasing reliance on RANDMAIL. The others (the light users in Figure 5.9) show no change, remaining minimal users throughout the study period. We do not know how the hardcopy population used mail. Anecdotal data suggest, however, that

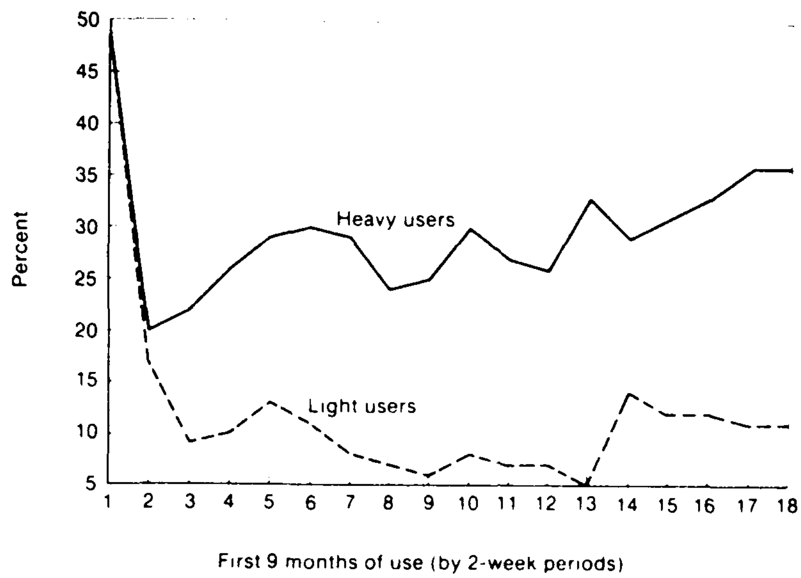

Figure 5.9. Individual differences and messages

these individuals are not easily integrated into a group that relies on electronic media for shared work.

The question of how to provide long-term learning support in work groups and secure needed technical assistance remains (Bikson & Gutek, 1984; Bikson, Stasz, & Mankin, 1985). As mentioned earlier, some work groups, notably technical professional groups, handle initial and advanced learning as well as system support largely on their own (Gutek, Sasse, & Bikson, 1986). For most groups, this way of coping with the humanware problem is not an option. They rely instead on either external centralized support or the emergence of local expertise, usually a combination of both.

Data collected in our cross-sectional study confirm the well established belief that, whenever possible, individuals prefer to consult a within-group "expert" (Bikson & Gutek, 1983, 1984; cf. Blomberg, 1986). We learned in interviews that an important advantage of local experts is that they know a great deal about the task in addition to the tool. The most often mentioned disadvantages, according to local experts themselves, are that the technical assistance they provide is not recognized and supported by management (Bikson, Stasz, & Mankin, 1985). Moreover, work groups cannot all count on having a self-selected expert.

On the other hand, most of the work groups we studied (72 percent of those in the cross-sectional sample) had access to a technical department formally authorized to provide training or technical assistance. Such departments were the first-choice knowledge resource for only about a fourth of the users (see Table 3).

SOURCE	PERCENT OF USERS
Another user who happens to be very proficient	46%
A technical expert outside the group	27%
The manager of the group	11%
Printed documentation	8%
On-line help	5%
Other	1%

TABLE 3
Where do you most frequently turn for technical assistance?

It's not the organization's problem:	36.1%
It's the organization's problem in the short run:	30.5%
There is a continuing role for the organization in this area:	33.4%

TABLE 4
What is the organization's responsibility in the area of employee adaptation to technological change?

Reasons for not drawing on this resource, explored in our case studies, include: "They tell you what to do—they don't teach you how to solve the problem"; "They don't understand the business;" "You can't talk to them." Such difficulties are not surprising in view of the fact that work groups with different task orientations generally do not communicate with one another (cf. Figure 5.8).

Better approaches to the humanware issue need to be developed if work groups are to more fully exploit the capabilities of interactive information and communication systems. Innovative examples are, in fact, available (e.g., Johnson, 1986) and others could doubtless be devised. Organizations, however, seem to be undecided about what role, if any, they should play in facilitating the adaptation of work groups to ongoing technological change. When we posed this question to managers of the work groups participating in our cross-sectional study, about a third replied that it was up to individual employees to keep their skills marketable and another third thought there might be a one-shot role for the organization bringing its employees into the computer age. Only the remaining third believed organizations would have a continuing responsibility to help develop the humanware to keep pace with advancing tools (See Table 4).

CONCLUSION

Flexible interactive technologies clearly have the capability to support and enhance collaborative work. Our research provides considerable evidence that they make multi-person information tasks more manageable and enable increases in group output as well as throughput. Most conclusions, however, are conditioned by the type of group or nature of its tasks, factors that need to be taken into account in research on collaborative work.

It is worth recalling the results of the last half century of small group research about what makes collaboration work (McGrath, 1984; McGrath & Altman, 1966):

- High skill, high ability in group members
- Good group training, considerable group experience
- Autonomy, participative decisionmaking, cooperative work conditions
- Mutual liking; group members value one another's task and social attributes, hold one another in esteem, accord themselves high status
- High level of intragroup communication

Our efforts to analyze computer-supported collaborative work do not invalidate these conclusions. Rather, by increasing the complexity of organized work and speeding up the pace of group interaction, the use of advanced information technology generates a need for creative attention to the social variables that affect multi-person tasks.

The research reported here substantiates the view that interactive information and communication media help overcome barriers of space and, even more importantly, barriers of time, especially among those engaged in common tasks. That is, these tools permit reconciling individual scheduling needs with group goals. In this way, electronic messaging can become a general mode of working rather than a substitute medium to be used in case other avenues for interaction are inconvenient.

We believe, in addition, that these technology webs permit more broadly based, reconfigurable, and overlapping collaborations. In particular, interactive message systems appear to decrease communication barriers between lateral groups in an organization and to promote shared activities. They seem to facilitate communication across disciplines and to support multiple group memberships, which typically pose as serious time-conflict problems as they do distance or telephone-tag problems. In sum, new computer-based technologies allow people to collaborate with increasing numbers of individuals like those with whom they already work.

However, they do not necessarily help overcome traditional social and organizational barriers to group interaction, such as differences in status, values, and missions. These pose formidable obstacles that are more likely to be alleviated by changes in social structure and management policy than by technological advance. Although new technology may serve to destabilize existing organizational patterns and allow for the emergence of alternative organizational designs, it does not by itself ensure the existence of such designs or mandate any particular set of social choices.

New technologies for collaborative tasks, in short, are neither simply the servants nor simply the masters of organizational design. Rather, they make it ever more critical for the organizations that use them to develop creative strategies for evaluating and balancing social and technical capabilities. Successful new modes of work group collaboration will require more social and managerial innovation than has been evidenced to date.