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Group Decision Making and Communication Technology

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Advances in computing and telecommunications technology are changing how people can meet and make group decisions. Technological changes help people cross physical, social, and psychological boundaries, and have secondary effects on group behavior and decision making. Experiments show that, compared with a face-to-face meeting, a computer-mediated discussion leads to delays; more explicit and outspoken advocacy; "flaming;" more equal participation among group members; and more extreme, unconventional, or risky decisions. Technological and social psychological variables that cause these effects in laboratory groups do not scale at equal rates. Technological change in organizational group decision making can lead to outcomes not seen in the laboratory, which makes it essential to do field research. Three phenomena observed in field studies are redistributions of work time, relative advantages in participation for peripheral workers, and increases in complexity of group organization. Experimental and field studies on these technology effects are useful not just as an "impact statement" for those considering technological change; this research also can put a new light on basic processes in which we have always had an interest.

People in organizations spend much time in meetings and group decision making; managers spend most of their time in this way (Mintzberg, 1973; Sproull, 1983).[1] Much about meetings is predictable. For instance, members' participation typically is unequal. Member status predicts who will dominate. Managers speak more than subordinates; men speak more than women; the person at the head of the table speaks more than others. People are polite, considerate, and avoid controversy. If a decision is necessary, people converge on it, discarding options through discussion. People prefer options that have obvious popularity. Often we can predict the decision just by knowing who dominates the discussion. Five decades

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[1] The research described in this article is discussed in detail by Sproull and Kiesler (1991).

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of research on group behavior, much of it documented in this journal, have addressed why and how group decision making is predictable (McGrath, 1984).

Advances in computer and telecommunications technology are changing how people can meet and how they make decisions in groups. People can "talk" as a group outside the meeting room, at once or asynchronously, whether the group has 2 or 200 or 2000 members, whether they work in the same building or across the world. Not just the physical aspects of meetings change with this technology. The dynamics of group decision making differ from those of face-to-face meetings. This article is about how people behave in decision-making meetings conducted through a new communications technology termed "electronic communication." The most common form of electronic communication is computer-based electronic mail used on a network, with various programs for group interaction such as distribution lists, bulletin boards, and conferences.[2] First we provide a simple framework for thinking about communication technology and group decision making. Next we compare behavior in electronic meetings with the behavior of the same people in face-to-face meetings. The standard of comparison is face-to-face meetings, not because they are always preferable to other forums but because they are ubiquitous. We discuss some limitations to using these experimental comparisons to evaluate technology effects. Finally, we offer suggestions for thinking about technology in research on decision making. One purpose of this article is to show that an examination of technology effects is valuable not just as an "impact statement" for those considering technological change; this research also can put a new light on basic processes in which we have always had an interest.

To set the stage for the discussion that follows, consider these two cases of electronic communication in organization decision making:

> In a software development team designing its next project, each member accepts an information-gathering assignment to complete within 2 weeks, the time of the next group meeting. Person A,

[2] We do not discuss video conferences, telephone conferences, facsimile, and other communication technologies that can be used for group decision making. Some of these are easier to use and more popular today than electronic mail. Yet these technologies typically lack the power of computers for storing, editing, and channeling information, and for creating and using databases. They create conditions more like face-to-face conversation than electronic communication does. They impose transaction costs that constrain group size, group memory, asynchronous conversation, and other potentially important aspects of group decision making. We study electronic communication, not because it is more or less efficient as a communication device, but because more can happen with it—it provides a larger scope for investigating basic group processes than many other technologies do.

while working on her assignment, thinks of a different approach that will be better than the one she was assigned. She sends a message via an electronic distribution list to the other members of her group explaining the change. Without this procedure, people would not hear about the change until the next meeting, when the work they had done might conflict with A's new idea (and vice versa). Because group members send and read electronic mail at their convenience, the technology allows them to learn about midcourse corrections between meetings. Also, group members are reminded that they are group members and that the work of the group is, or should be, proceeding (Eveland & Bikson, 1988; Finholt, Sproull, & Kiesler, 1990; Wasby, 1989).

The publication committee of a major journal in the geophysical sciences meets twice a year and communicates periodically via electronic mail. The committee decided at one face-to-face meeting to replace the chief editor, who was retiring his university professorship. Over the next few months, the committee used electronic mail to solicit nominations for the editorship. Via an electronic bulletin board on SCIENCEnet, which has about 3000 members, the committee described the kind of person it was seeking. The committee chair collected nominations and circulated comments within the committee electronically. Then he sent a voting form to the committee, upon which a clear preference emerged. Unexpectedly, the current editor, having seen the notice about his replacement on the electronic bulletin board, put a message on the same bulletin board. He announced that he did not want to retire his editorship and that he would like readers to nominate him. Immediately, several people sent electronic mail to the publication committee members, demanding to know why the committee was replacing the current editor. Public discussion on the bulletin board of the committee's procedures and decision ensued. Eventually the committee approved a new editorial structure, with two chief editors—including the previous one. According to committee members, without electronic mail the decision would have been faster but there would have been less opportunity for outsiders to react to the committee's initial decision, or to make new nominations or counterproposals. A new journal structure might have happened anyway, but with people less informed and with somewhat different terms.[3]

[3] For a description of SCIENCEnet and its role in one scientific community, see Hesse, Sproull, Kiesler, and Walsh (in press).

FIRST- AND SECOND-LEVEL EFFECTS

The cases above suggest that communication technology has effects at two levels. The first level of effects is the anticipated technical effects—the planned efficiency gains or productivity gains that justify an investment in new technology. In the software development team, saving time by informing the group of midcourse corrections is an example of a first-level effect. Conventional cost-displacement or value-added analysis often underlies the calculation of these gains. For instance a firm thinking about installing a voice mail system would estimate how much money could be saved by replacing telephone operators, receptionists, and secretaries with the new technology (cost-displacement analysis). Or, suppose it did not intend to fire people whose jobs could be replaced or reduced by the new technology; it would calculate what additional duties those people could do when they no longer had to answer the phone (value-added analysis).

Enormous difficulties plague such analyses. Also, the most important effects of a new technology may be not to let people do old things more efficiently, but to do new things that were impossible or infeasible with the old technology (Sproull & Kiesler, 1991, Chap. 1; Bell, 1973; Simon, 1987; Zuboff, 1988). Expanding the number of participants in decision making, as did the publication committee, is an example of one such change. We call such changes "second-level effects" because they are indirect—are caused by behavior that the technology makes feasible and by how people use those options. Some reasons for second-level effects of communication technologies are that the new technology leads people to pay attention to different things; that the technology leads people to have contact with different people; and that because of task changes using the technology, people depend on one another differently. Social roles, which codify patterns of attention and social interaction, can change. The automobile made possible social roles of auto mechanic, hot rodder, and Sunday driver. The computer led to hacker, user consultant, and MIS specialist. These changes do not alter human nature. People still care about their boss's evaluations, work for incentives, and respect peers' opinions. Yet changes in attention, social contact, and interdependencies can affect the relative impact of situations and processes, and change people's choices and distributions of outcomes among them.

The telephone exemplifies an earlier communication technology that had both first- and second-level effects. The telephone was sold originally as an efficient replacement for the telegraph and therefore as a tool for business. In 1878, Pittsburgh's first telephone directory had 12 pages; all the subscribers were businesses or businessmen. Telegraph companies

offering telephones for lease at $50 a year advertised, "The Telephone has ceased to be a novelty and has become a recognized instrument for business purposes" and emphasized to the business manager, "NO SKILL WHATEVER is required in the use of the instrument." Bell Telephone Company partners decided to prepare for the distant possibility that people would use the telephone for social purposes as well. By the late 1920s, the Bell System was emphasizing the social character of the telephone with claims such as "friends who are linked by telephone have good times" and "friendship's path often follows the trail of the telephone wire" (Fischer, 1985). Today, people use the telephone as much for social and personal reasons as for business, and the technology has had tremendous social and organizational impact (Aronson, 1971). The telephone reduced isolation and danger for rural families. City dwellers used it as a babysitter. It reinforced the social phenomenon of the teenage peer group. It led to new social and occupational roles: telephone operator, telemarketer, call girl. It helped the geographic expansion of organizations. People once wondered if the telephone would increase the authority of the boss inside the firm by allowing him to call subordinates at any hour of the day. Instead it gave employees a chance to call their supervisors and each other. The telephone probably democratized more workplaces than it bureaucratized.

The telephone had extensive and unanticipated effects in part because it extended social contacts, attention, and interdependencies beyond patterns determined by physical proximity. Reducing the constraints of physical proximity increased people's choice of interactions, whether with family members who had migrated from the farm to the city, or distant employees, or the boss. Second-level effects occurred because people's personal networks have a mutually causal, spiraling relationship with their information networks, with their close relationships, with the conformity they display, and with cultural change. This characterization suggests four points useful in thinking about the potential consequences of new technology. First, the full possibilities of a new technology are hard to foresee. The inventors and early adopters are likely to emphasize the planned uses and underestimate the second-level effects. Second, unanticipated consequences often have less to do with efficiency effects and more to do with changing social arrangements of interpersonal interactions, ideas about what is important, and procedures or norms guiding behavior. Third, these second-level effects often emerge somewhat slowly as people renegotiate changed patterns of behavior and thinking. Finally, second-level effects are not "caused" by technology operating autonomously on a passive organization or a society. Instead they are constructed by people as their design and use of technology interacts

with, shapes, and is shaped by the technological, social, and policy environment. Technology may have a significant role in these changes. As humans we decide our own cultural responses to technology, but an initial technological capability can influence the direction of second-level effects (Maruyama, 1963; Mason, 1970).

ELECTRONIC COMMUNICATION TECHNOLOGY

When computers first were introduced on a large scale in organizations in the decades following WWII, they primarily aided in the rapid processing of routine information, doing the work that clerks and accountants had done. The computer acted only on information that it "understood," i.e., codified, prestructured, and standardized data on which the computer could do computations. A person can interact with such a computer to find out, for example, how many seats remain on an airline flight—the computer "understands" how many seats remain unfilled. (See Rule & Attewell, 1989, for an analysis of how these systems affect organizations today.) Now, the marriage of computers and communication technology has made possible another kind of computer-supported information processing, one that helps communication among people. The two cases at the beginning of this article exemplify this technology. With it, the computer does not make computations on the information people use; it does not have to "understand" the information. Instead, it lets people exchange natural language text and make sense of the information.

Technologies to aid communication at a distance have existed since people first sent up smoke signals and wrote on papyrus. The new computer-based tools differ from older communication technologies—including telephone and facsimile—in that they contain programs for managing communication and data, such as distribution lists, bulletin boards, and editors. Programs and processing power minimize the effort of search and distribution and expand the choices of sources and seekers of information. They help overcome problems of group size by allowing people to talk with many people as easily as to a few (e.g., Kraut & Streeter, 1990; Sproull & Kiesler, 1986). Although people can use these tools for formal communication (such as for processing engineering change orders and taking vote counts), they mainly use them for informal communication. That is, people use their memories, not data records, as the primary information storage medium, and "talk" directly with one another to exchange information and make decisions.

Some behavioral implications of electronic group communication can be generated by thinking about what it does not do. One way to accomplish this is to contrast electronic communication with a typical face-to-

face meeting. McGrath and Hollingshead (1990) list characteristics of face-to-face interaction as follows (p. 35):

> In face-to-face interaction,
> - All members are linked in all modalities with 0 time lags.
> - One and only one person has the floor at any one time. Except for momentary silences, someone is always holding the floor.
> - Speakers exercise some control over who the next speaker will be, as well as when they can interrupt.
> - Group members share floor time unequally.
> - Speakers cannot pause too briefly or for too long a time (hence few interruptions, few silences).
> - Speakers signal transitions using multiple cues in different modalities or channels.
> - The audience for each act is all, but only, the set of participants present.
> - The set of potential next speakers is all, but only, the set of participants present.
> - There is no anonymity in face-to-face groups.
> - Group members expect each input to be logically or psychologically connected to preceding or anticipated inputs.

A group making a decision by electronic communication works in a different physical and social situation, where each of the above rules is absent or different. First, electronic communication helps people cross barriers of space and time so they can exchange information whatever their location and whenever they want to communicate. There is no built-in temporal sequence of discussion; people can talk at once, not at all, or in illogical order. Distribution lists, bulletin boards, and conferencing applications make communicating with many people nearly as easy as communicating with a few. Messages remain in computer memory, enabling group members to go backward in time, retrieve earlier decisions and conversations, and edit versions for future communications.

Electronic communication also helps people cross social and psychological barriers. Because communication is mainly by text, interaction lacks social context cues that are present in face-to-face settings and conversation. This deficit is important because people perceive the social order through static and dynamic social context cues. Static cues emanate from artifacts such as the chair at the head of a conference table, and people's appearance, such as their wearing business suits. Dynamic cues emanate from people's behavior, for instance, nodding approval, hesitating before replying, and frowning (e.g., Patterson, 1983). Once people perceive social context cues, they adjust their targets of communication, the tone and content of their communications, and their conformity to social norms. For instance, when social context cues emphasize status differences, then both speech and demeanor become more formal. Typically, when social context cues are strong, as when executives are face-to-face in a business discussion, peoples' behavior is other-focused, differentiated, controlled, and finely tuned to the situation. The absence of social context cues makes it hard for people to perceive and adapt to the social order-social structure and roles, and situational norms. For obedience to hierarchy to happen, for example, it is insufficient for people to hold different status positions; they must be aware that they do. When social context cues are weak, people feel distant from others and somewhat anonymous. These feelings tend to produced self-centered and unregulated behavior. People become somewhat less concerned about making a good appearance (Cottrell, Wack, Sekerak, & Rittle, 1968). Their behavior becomes more extreme, more impulsive, and less socially differentiated (Diener, Fraser, Beaman, & Kelem, 1976; Singer, Brush, & Lublin, 1965).

All communication technologies attenuate to at least some degree the social context cues available in face-to-face conversation. The telephone reduces dynamic and static cues by eliminating visual information about communicators. Letters and memoranda have even fewer cues, and therefore regulate interaction even less well than face-to-face or telephone communication does (see, for instance, Williams, 1977). In practice, we do not usually experience social chaos when using paper communication. There are sufficient social context cues generated by the kind of paper, forms of type, handwriting, headings, and so forth, to signal norms (Siegel, 1988). Nonetheless in experimental comparisons, paper questionnaires elicited more antisocial opinions and more personal revelations than face-to-face interviews did (Sudman & Bradburn, 1974). Written notes elicited more swings of opinion in groups than face-to-face discussions did (Festinger, 1950, p. 176).

Some investigators have hypothesized that electronic communication technologies attenuate social context cues even more than paper communication does (Short, Williams, & Christie, 1976; Hiltz & Turoff, 1978; Kiesler, Siegel, & McGuire, 1984). Dynamic cues disappear; static cues are few. In most networks, for example, when people send an electronic mail message, the only signs of position and personal attributes for senders and receivers are names and addresses, which may identify their organization but often not their subunits. Missing are indications of senders' and receivers' job title, social importance, level in their organization's hierarchy, departmental affiliation, race, age, and appearance. Some addressing programs do not use first names, so gender information may be missing as well. Also a situational definition is missing. When using electronic mail one does not expect or encounter reminders of the situation surrounding the communication, as one does using other communication technologies. Corporate policy memos on paper, for example,

look a certain way, are generated and read in certain settings but not in others, by some people and not by others, and concern certain topics but not others. People may possess information about norms from other sources, of course, but there are few cues in the computer interaction to remind people of that knowledge.

Evidence is accumulating from field surveys and experiments that computer-mediated communication, through its reduction of social context cues, can overcome social inhibitions, encourage communication across social or psychological boundaries, and deregulate group behavior. For instance, Sproull and Kiesler (1986) report enhanced self-absorption and uninhibited behavior in electronic mail messages of an organization. In other studies comparing paper and pencil responses with responses to an electronic mail questionnaire, the latter were more extreme, more revealing, and less socially desirable (Kiesler & Sproull, 1986; Sproull, 1986). Waterton and Duffy (1984) found that a computer-mediated interview generated significantly more reporting of alcohol use by men than did a paper-mediated interview. (Also, according to city sales figures, the former reports were more accurate than the latter.)

Research has not yet revealed which of several plausible psychological mechanisms deregulate behavior when social context cues are missing. Existing experimental evidence suggests that without nonverbal and paralinguistic reminders of the social context, peoples' attention turns away from others and so does their concern with being positively evaluated or with liking the other (Kiesler, Zubrow, Moses, & Geller, 1985). In her study of "Drugcorp" Zuboff (1988) quoted a respondent as saying, "DIALOG [the computer communication system] lets me talk to other people as peers. No one knows if I am an hourly worker or a vice president. All messages have an equal chance because they all look alike. The only thing that sets them apart is their content. If you are a hunchback, a paraplegic, a woman, a black, fat, old, have two hundred warts on your face, or never take a bath, you still have the same chance" (p. 371). Another possibility is that computer messages seem ephemeral and people simply forget that their communications will be read. Zuboff describes how employees in her study felt "psychologically secure" and could pour out their thoughts at the keyboard. She quotes one respondent, "When I discuss something on DIALOG, in the back of my mind I know somebody else is going to hear it, but it isn't as obvious as if we were all in one room. It's like I know the tape recorder is running, but I kind of block it out" (p. 370). Either process, reduced evaluation anxiety or reduced social attention, could account for the observations that people using computer-mediated communication as compared with other means of communication respond more openly and conform less to social norms and other people.

EXPERIMENTS ON COMPUTER-MEDIATED GROUP DECISION MAKING

Since the 1960s, technologists and policy makers have discussed remote "distributed" group decision making via computer network (e.g., Fischhoff & Johnson, 1990; Martino, 1972; Rohrbaugh & Wehr, 1978). Distributed decision making is said to make decision making more efficient and fair, and to "purify" interaction, removing "irrelevant" sources of bias such as personal charisma. In 1980, Jane Siegel and Sara Kiesler decided to see how a group used electronic communication in decision making. In our pilot study, three undergraduates sat in different rooms before computer terminals and used a computer conference program on our Carnegie Mellon University network for real-time discussion. The group had to reach consensus on several choice shift tasks (Stoner, 1961; Kogan & Wallach, 1967). While making these decisions by computer, the group shifted toward more extreme positions than they did when face-to-face. Also, the group became hostile internally and had enormous difficulty reaching consensus. While we were puzzling over these results, Allen Newell reported that computer scientists sometimes displayed similar behavior on the ARPANET (see also Emmett, 1982). Since this suggested that our pilot group was not unique, we decided to compare face-to-face and electronic decision making in groups more systematically. Below, we describe results from seven experiments on group decision making, listed in Table 1 (Dubrovsky, Kiesler, & Sethna, 1991; Huff & King, 1988; McGuire, Kiesler & Siegel, 1987; Dubrovsky, Kiesler, & McGuire, 1986; Weisband, in press). Also, we refer to related findings where the main focus was other than decision making (e.g., Kiesler *et al.*, 1985; Shah, 1990) and to some relevant field studies by us and others (e.g., Eveland & Bikson, 1988). At the outset, others anticipated our work early in the development of electronic communication technology (in particular, see Englebart, 1989; Hiltz & Turoff, 1978; Licklider & Vezza, 1978; Short *et al.*, 1976; Sinaiko, 1963; Vallee, Johansen, Lipinski, & Wilson, 1977).

General Method

As indicated in Table 1, our experimental groups have had two to four members. Our "laboratory" is a large office or conference room for the face-to-face condition; computer-mediated communication conditions require that each group member go to a different office in the same building. Typically there are two to three experimenters to ensure that subjects go to their proper place and follow the procedures properly. The small group sizes and their location in one building precluded our examining in these experiments an important technical capability of electronic communica-

TABLE 1
Experiments on Group Decision Making and Communication Technology

Study reference	Subjects	Expt. No.	Group size	Task	Independent variables[a]	Main dependent variables
Siegel *et al.*, 1986	Undergraduate and graduate students (CMU)	1	3	Choice shift	CC vs FF, anonymity	Time, discussion content, participation rates, choice shift
		2	3	Choice shift	Procedure control	Time, discussion content, participation rates, choice shift
		3	3	Choice shift	FF vs CC vs EM	Time, discussion content, participation rates, choice shift
McGuire *et al.*, 1987	Managers	1	3	Gain, loss risk choice	FF vs CC, gain and loss problems	Time, discussion content, participation rates, risk vs risk averse, advocacy
Dubrovsky *et al.*, 1991	Undergraduate and graduate students (Clarkson)	1	4	Choice shift	FF vs EM, status, expertise	Time, discussion content, participation rates, advocacy, status influence
Huff and King, 1988	Undergraduate and graduate students (Pitt, CMU)	1	2	Project choice	FF vs EM, status	Status influence, quality of project
Weisband, in press	Undergraduate and graduate students (CMU)	1	3	Choice shift	FF vs EM, preadvocacy discussion, selection of first advocate	Time, discussion content, participation rates, advocacy, influence of first advocate

[a] FF, face-to-face discussion; CC, real-time, synchronous computer conference; EM, electronic mail.

tion—its use for decision making in very large, geographically dispersed groups. This limitation is discussed later in this article.

We generally employed a repeated-measures design, with order of decision, decision task, and condition balanced separately. Doing so allowed us to control for comfort with computers, predilections to be outspoken, and other factors that might explain group behavioral differences; fortunately, we have not observed simple order effects. At the beginning of each experimental session, groups met together and with an experimenter. They were introduced to one another and received instructions for a study of decision making using different communication technologies. They then heard about the decision tasks, did a practice task individually, and then made individual choices for each experimental decision task. At that point, experimenters looked to see what sequence of communication condition and task the group had been assigned randomly. If appropriate, members were taken to separate rooms for electronic communication and instructed to reach consensus as a group on each task. Otherwise, for face-to-face conditions, the groups remained together until it was their turn to talk using electronic communication. When all the group decisions were done, the members made the choices again individually.

The raw data in these experiments include individual and group choices, questionnaire responses, and tape recordings and electronic transcripts of group discussions. We developed a reliable content coding scheme for group discussions (Siegel *et al.*, 1986). The basic unit of content analysis is each separable thought or remark that group members utter during the group discussion. Coders divide subjects' statements into these remarks and count them. They then code for types of remarks including socially inappropriate or "uninhibited" remarks (swearing, name-calling, threats, intimacies). The data from choices and content coding were used in group-level and, where appropriate, in individual-level analyses. As in previous research on groups, we compared individual pregroup and postgroup choices with group choice (e.g., Nagao, 1983). A new twist in this procedure was to compare choices advocated during group discussion, especially the choice of the first advocate, with group choice (see especially Weisband, in press). To evaluate the role of advocacy, we coded remarks that explicitly proposed or advocated a particular decision, e.g., "I think alternative No. 2 is the right one." Also at the group level, we evaluated participation by comparing groups' total number of remarks across conditions, and equality of participation within the group, usually using the Gini coefficient (Alker, 1965). Finally, some studies have been appropriate for analyses of decision schemes, in which case we have followed the procedures of Davis and his colleagues (e.g.,

Davis, Kerr, Atkin, Holt, & Meek, 1975; Kirchler & Davis, 1986; Laughlin & Early, 1982).

Time for Decision Making

Our comparisons only consider the time groups spend in actual discussion to reach consensus—either speaking and listening or reading and typing on a computer. (In other words, our measures of time in decision making exclude getting to meetings and other transaction costs, a critical feature that differentiates face-to-face and electronic discussion.) We find in our experiments that it takes approximately 4 times as long for a three-person group to make a decision in a real-time computer conference as face-to-face (e.g., Siegel *et al.*, 1986); it takes as much as 10 times as long in a four-person group that lacks time restrictions (Dubrovsky *et al.*, 1991). These delays seem to have three causes. First, the network may be slowed by high use; this problem has essentially disappeared in recent years. Second, despite simultaneous sending and receiving, it takes people longer to type and read than to talk and listen. Third, the lack of nonverbal "backchannel feedback" (Kraut, Lewis, & Swezey, 1982) in electronic discussions causes members to have trouble figuring out how others are taking their messages, how confident others are, and when the group is ready to come to final agreement.

Seemingly, it does not help to restrict the group's time when they make their decisions electronically. When they had a time limit, groups exchanged much less verbal information electronically than they did face-to-face—sometimes only half as much information. Because short deadlines reduced verbal information exchange, they just added to the problems in reaching mutual understanding and sympathy posed by diminished nonverbal information. The decisions made in experiments with limited-time electronic discussions were more extreme and polarized than decisions made in experiments with electronic discussions where groups took as much time as they wanted (e.g., Siegel *et al.*, 1986, vs Weisband, in press).

Participation

In a face-to-face meeting, only one person can talk at a time. Taking turns is unnecessary in electronic discussions. Thus for any given duration of time more people can "talk" in an electronic meeting than in a comparable face-to-face meeting. In a face-to-face meeting, talking time usually is not distributed equally across all participants. One person or a small clique usually dominates the discussion (Alker, 1965). In electronic discussions, participation is distributed more equally. For instance, when

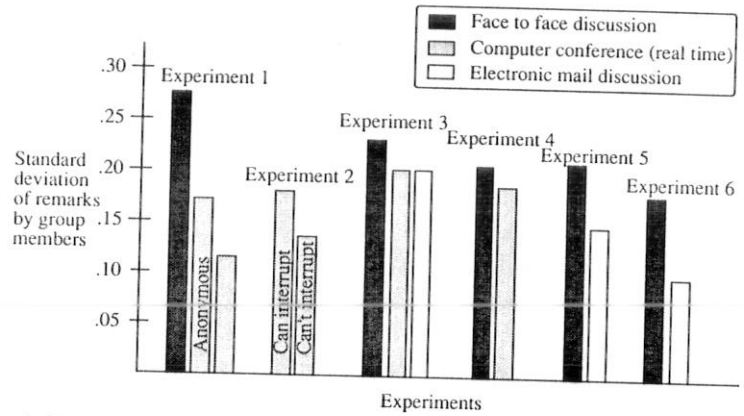

FIG. 1. Inequality of participation in group discussions. Data from Siegel, Dubrovsky, Kiesler, & McGuire, 1986 (Experiments 1–3); McGuire, Kiesler, & Siegel, 1987 (Experiment 4); Dubrovsky, Kiesler, & Sethna, 1991 (Experiment 5); Weisband, in press (Experiment 6).

three-person groups held discussions electronically, there was half as much inequality in participation as when they talked face-to-face. People tended to talk closer to one-third of the time in the electronic discussion. Figure 1 illustrates these differences in participation patterns across experiments.

In mixed status groups, higher status people talk more than lower status people. For instance, in face-to-face groups managers talk more than subordinates; men talk more than women. These behaviors hold even when the generally higher status (and more vocal) people are not more expert on the topic under consideration. Status imbalance has been documented in classrooms, hospitals, personnel interviews, performance appraisals, and decision-making meetings (Berkowitz & Bennis, 1961; Berger, Fisek, Norman, & Zelditch, 1977; Dubin & Spray, 1964; Holtgraves, 1986; Strodtbeck & Lipinski, 1985; Weiner & Goodenough, 1977). Because it is harder to "read" status cues in electronic messages than it is in other forms of communication, high status people do not dominate the discussion in electronic groups as much as they do in face-to-face groups. For instance when groups of executives met face-to-face, the men in the groups were five times more likely than the women to make the first decision proposal. When those same groups met via computer, the women made the first proposal as often as the men did (McGuire *et al.*, 1987). When pairs of graduate students and undergraduates met face-to-face to decide their joint project, the pairs were likely to choose the topic preferred by the graduate student. When equivalent pairs of students

discussed and decided electronically, they were equally likely to choose the topic initially preferred by the undergraduate (Huff & King, 1988).

We compared face-to-face discussion with discussion by electronic mail in groups with one MBA student and three college freshmen (Dubrovsky *et al.*, 1991). Everyone in the groups considered the MBA student to be higher in prestige and experience. This status imbalance influenced the face-to-face discussions, where the MBA student talked more than the freshmen. The MBA student also was more likely to take the initiative in advocating a position and influenced the actual group decision more. This domination occurred most strongly for career choice decisions about which the MBA student was more knowledgeable. It happened also, but less so, in decisions about the freshman year curriculum, about which the MBA student was no more expert than the freshmen. Electronically, status differences were smaller. The high status group member participated proportionately less and, as we show in Fig. 2, had less relative influence as a first advocate when the group communicated electronically. The principal reason for this decline in influence was that any member could advocate a position before hearing from others and many did so. In 38 of 48 electronic discussions, a high status member and one or more low status members advocated a position "first." This change in group behavior reduced but did not obliterate the impact of status differences on decision making.

Consensus Process

Consistently we have replicated our pilot study results: When groups make decisions using electronic communication, they have more difficulty reaching consensus than when they meet face-to-face. Perhaps in anticipation of this difficulty, group members use more explicit verbal statements of their positions and hold more votes. When they do disagree electronically, they engage in deeper conflict then they do face-to-face. Conventional behavior, such as politeness and acknowledgment of other peoples' views, decreases. The computer science community has dubbed rude, impulsive behavior and the expression of extreme views on networks "flaming." Flaming is more common in electronic communication than in other forums. In one of our experiments, groups made 102 "flaming" remarks in 24 electronic discussions whereas the same groups made only 12 such remarks in 24 face-to-face discussions (Dubrovsky *et al.*, 1991). At the extreme, anger in one electronic discussion escalated so much that participants had to be escorted individually out of the building. Flaming was more extreme when group members talked anonymously (Siegel *et al.*, 1986, Experiment 1).

If groups are relatively uninhibited or unregulated when they interact electronically, then perhaps they reach consensus less methodically than

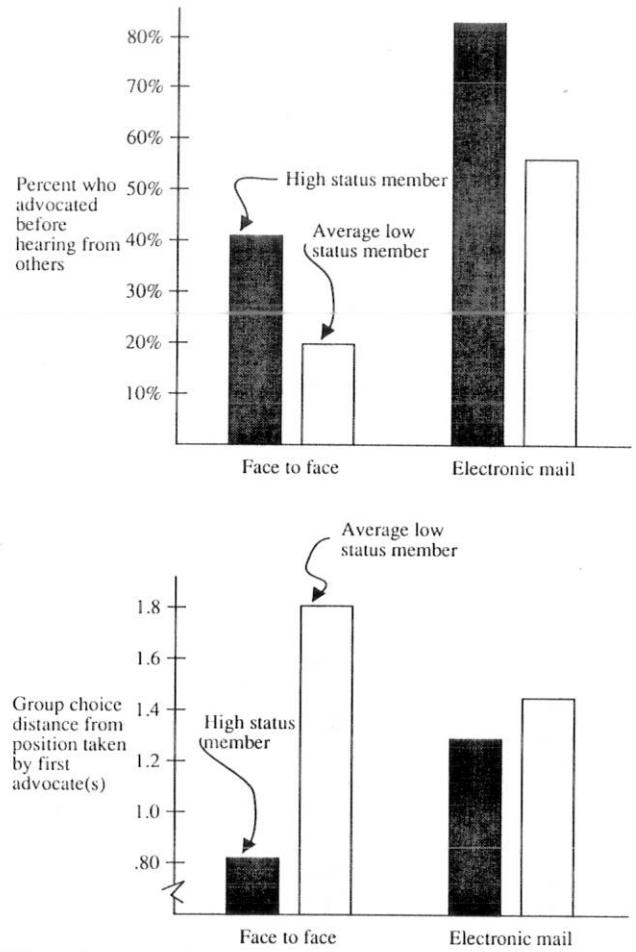

FIG. 2. Effects of status on first advocacy (top) and on the influence of advocacy on group choice (bottom; smaller distance indicates more influence). In face-to-face discussions, only one member could be a first advocate. In nearly all of the electronic mail discussions, more than one member was "first," that is, advocated a position without waiting for others. Adapted from Dubrovsky *et al.*, 1991.

face-to-face groups do. Suzanne Weisband (in press) found, in both electronic and face-to-face situations, if groups had an initial group discussion of their choice alternatives, they ultimately made a decision influenced heavily by the first person to advocate a solution. (When the first proposal was risky, the group decision tended to be risky; when the first proposal was conservative, the group decision tended to be conservative.) Still, the process of coming to consensus diverged in the two modes of communi-

cation. In the face-to-face discussions, people gradually conformed: the second person to speak up tended to agree with the first person, and the third person with the others. By the time the third person took a position, his or her stand tended to equal the final group choice. But, as shown in Fig. 3, the electronic mail discussions were different. The third person's first offer was just as far from the ultimate group decision as the first person's was. This divergence meant that the electronic groups then had to spend time trying to reconcile contradictory proposals. These data suggest that electronic communication may disrupt group process. One way groups might deal with this disruption is to use voting techniques or explicit decision rules rather than to talk things out. Otherwise, if electronic decision requires consensus, then an electronic group has to work harder to get consensus than a comparable face-to-face group does.

Decision Riskiness and Quality

We studied risk taking in an experiment with university administrators and corporate managers, who individually and in three-person groups, made multiattribute risk decisions about investments (McGuire *et al.*, 1987). These tasks have been used in many previous experiments (with individuals only) to study implications of prospect theory (Kahneman & Tversky, 1979; Payne, Laughhunn, & Crum, 1980; Tversky & Kahneman, 1981). For example, suppose you have a choice between a safe investment and one that is riskier but more attractive. Suppose the first will return $20,000 over 2 years, whereas the other investment has a 50%

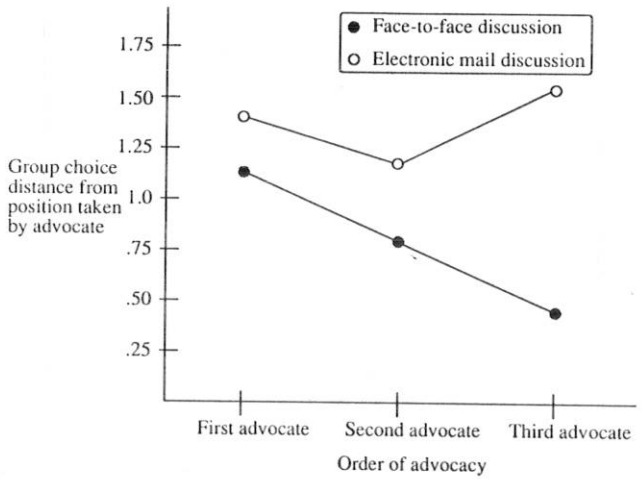

FIG. 3. Agreement during discussion: Distance between group choice and advocate's position (from Weisband, 1989).

chance of returning $40,000 and a 50% chance of returning nothing. Which would you choose? Most people avoid risk when one alternative is a sure gain; they choose the $20,000. (This option only seems safer; mathematically there is no difference between the two alternatives in the expected value over 2 years.) By contrast, when the choice is between a sure loss and a chance of losing nothing, people tend to be risky. For instance, when the choice is between surely losing $20,000 and an investment that has a 50% chance of losing nothing and a 50% chance of losing $40,000, most people will pick the second investment. They choose the riskier option (although, again, the expected values over 2 years of the options are mathematically equivalent).

In our experiments, groups that met face-to-face were risk averse for gain choices and risk seeking for loss choices, far more than they were as individuals. Our results in face-to-face groups therefore provided some support for prospect theory. They also provided some support for the theory of persuasive arguments (Vinokur & Burnstein, 1974); when groups met face-to-face they exchanged more arguments and elaborated on their positions more, which led to more shift toward prospect theory predictions. But decision making by computer did not result in the same outcomes. When the groups met using the computer to communicate, they were somewhat risk seeking in all circumstances. And the executives were just as confident of their decisions whether they made them through electronic communication or face-to-face. Finally, decision scheme analyses suggested that the process of coming to consensus was somewhat different in the two conditions. A striking result was that in the face-to-face discussion condition, a prospect theory "norm" (safety in gain situations and risk in loss situations) predicted decisions dramatically better than a prediscussion majority scheme. This was a result we predicted based on previous decision scheme research (e.g., Laughlin & Early, 1982). In the computer-mediated discussion condition, the prospect theory norm described the data less well than did majority rule, but majority rule did no better than a coin toss and worse than a risk-seeking rule.

We speculate that the basis of the risk-taking differences we observed was the reduced social information exchanged electronically. Lacking the opportunity to share full information, group members may have become less sensitive to implicit social pressure and accountability. Simultaneously, they were more likely to express extreme, unconventional, or risky viewpoints due to reduced social attention or evaluation anxiety. Together these behaviors could lead to somewhat risky or unconventional choices. The choice process would be described by first or majority advocacy during discussion, rather than majority pregroup preferences of individuals. Some indirect evidence on one aspect of this hypothesis was gathered recently by Shah (1990). In his experiment on face-to-face ver-

sus computer-mediated bargaining, first offers in the computer-mediated sessions were more extreme than those in the face-to-face sessions, and probably as the result, joint outcomes (which require going beyond obvious solutions) were less good in the former than in the latter.

Because the decision tasks we have used are not appropriate for quality measures, we have not studied decision quality across tasks explicitly, something that should be done in future research. But something can be said toward understanding decision quality in electronic groups. Because decision making is less constrained by the influence of social norms, electronic groups may make more unconventional decisions than when the same people interact in person. It makes sense for a group to ignore norms or social structure when the norm is incorrect or when the structure puts influence in the wrong hands. In the experiment with MBA students and freshmen, we used two tasks, one where the high status person was not especially knowledgeable. Yet the high status person dominated face-to-face discussions even when the lower status members had more knowledge. This domination faded when the group made its decision electronically. So perhaps when groups face a conflict between expertise and high position (or social norms), then electronic discussion will lead to better quality decisions. We have no direct evidence of this, but in one study (Huff & King, 1988) graduate student–undergraduate pairs that discussed and chose their joint semester project using electronic mail were less influenced by the status of the graduate student and ultimately produced better projects than pairs who made the choice in a face-to-face meeting.

SCALING UP

Using laboratory experiments, we test assumptions empirically in a way that we cannot do through natural experience alone. We would like to deduce from laboratory findings what will happen with real groups in organizations with real technology. We are at some disadvantage here in that experimental groups never duplicate groups in organizations. Many people think about this issue in terms of variables "left out." For instance, researchers usually construct experimental groups using members unaccustomed to working together. With experience, routines, and social norms, established groups may overcome, or create, problems in decision making very differently than experimental groups do. Organizational practices, structures, and technology also can have an impact on group dynamics.

A more difficult problem in using experimental results arises when group process, procedures, technology, and other factors do not scale at the same rate; then, multivariate effects change, causing a phenomenon in the large to look very different from how it looks in the small. Ship

designers encounter this problem when they try to deduce the behavior of a full-size ship from model tests. Two important factors in a ship's drag are waves made by the ship's prow and turbulence under the ship. Because wave effects and turbulence depend on fine details of the hull shape, designers cannot rely on mathematical calculations alone. Instead, they build scale models and tow them in water, measuring their drag. Although the model gives an estimate of drag, there is no way to measure how much of the model's drag is accounted for by turbulence and how much by making waves. To make matters worse, the two factors do not scale in the same way. The turbulence under the ship depends on the surface area and the speed to the 1.825 power, but the wave drag is a much more complex function of speed and ship size. Since the two effects are confounded in the model drag and scale differently, scaling up from model tests is very hard. The ship in its full glory may act very differently than did the model, particularly if the model is small relative to the ship. Ship models and towing tanks are surprisingly large for that reason.

Although in experiments we manipulate situations in an attempt to separate variables, we are never entirely successful. Group processes and technology effects in laboratory group decision making are confounded. Moreover, because they are very different, we suspect that they scale differently to organizational reality. Variables that seem trivial (perhaps because of low variance) in the laboratory may loom much larger in an organization. If so, we may see the same phenomena differently in the two settings. Field research does much more than just add variables. A principal reason we must do field research is that it helps discover how variables scale. One phenomenon we have observed to change markedly from laboratory to field is how groups spend their time. In our laboratory experiments, it takes a group longer to make decisions electronically than face-to-face. Yet the reverse seems to be true in certain organizational groups that use electronic mail. This may happen because of substitution effects that we cannot see in the laboratory, where scheduling, agendas, and so forth, are done by the experimenter, not by the subjects. In software development teams we studied over several months, teams that used electronic mail more spent less time in face-to-face meetings, on the phone, and writing paper memos than groups that used electronic mail less (Finholt *et al.*, 1990). The teams used electronic communication for scheduling and coordination and to make simple decisions. Total communication was the same in all teams. From this, we conclude that electronic communication need not change the total time it takes groups in organizations to work together or make decisions. Instead people may redistribute how they spend their time.

The participation-equality phenomenon discussed earlier also can look somewhat different in organizational groups. In laboratory settings, group

size is established, so participation changes involve only a redistribution among those in the group, not changes due to new or lost members. In organizations, outsiders sometimes participate in group decisions or even join groups late (e.g., sometimes managers add committee members to coopt outside groups). Electronic communication seems to both allow and inspire such participation. People already at the center of the organization may be affected little by this because they are already connected with others. But "peripheral" employees—people working on shift, in branch offices, and at the bottom of the hierarchy—may gain new opportunities to initiate connections and join groups. There are potentially many people and groups accessible via the network, and because of reduced social context cues, peripheral people should feel somewhat uninhibited about "meeting" new people electronically. If management policies permit or encourage such interactions, these employees can increase both their membership in groups and their social connections to groups. These interactions can increase information flow between the periphery and the center of the organization and among peripheral workers. In short, while increasing connections through electronic communication could benefit everyone in principle, peripheral employees are likely to see a relatively greater benefit than are central employees (Hesse, Sproull, Kiesler, & Walsh, in press; Huff, Sproull & Kiesler, 1989). We think both passive and active connections (receiving information and sending it) can be beneficial to such employees. Passive connections offer the opportunity not only to learn from other employees but also to discover similarities they share with people who have different jobs and work in different places. Active connections give people a new opportunity to "have a say" both in their work group and to the boss. Active participation contributes to feelings of commitment (Eveland & Bikson, 1988; Huff *et al.*, 1989).

Another phenomenon that seems different in the laboratory and in organizational groups is group differentiation. Electronic organizational groups can be much larger, more complex, and more fluid structurally than their face-to-face counterparts (Finholt & Sproull, 1990). In some scientific communities, such as high energy experimental physics, 200- and 300-person groups collaborate remotely on large joint projects. Eveland and Bikson (1988) studied a utility firm that created two large task forces to prepare reports on preretirement practices and policies. Both task forces had 1 year to produce their reports. Both were composed of senior employees and retired employees. One task force was given computers and electronic mail to use in its work; the other talked only in person and by phone. Although both task forces created subcommittees, the task force with electronic communication created more of them. Both task forces assigned members to subcommittees: the task force without electronic communication assigned each person to only one subcommittee; the task force with electronic communication had people on more than one subcommittee. Not only were there more subcommittees in the task force with electronic communication, but also they had more complex organization in an overlapping matrix structure. The task force added new subcommittees during the course of its work. Indeed the group decided to continue meeting even after the official 1-year life span of the committee had ended. Electronic communication helped the structure of the one task force to grow and change as its task evolved.

The software development teams mentioned above also used electronic communication to create subgroup structures. Via one-to-one mail, project managers and chief programmers created two-person crisis management groups that kept on top of the ever-changing project requirements and personnel shifts. Via all-group distribution lists, project managers and chief programmers kept all other team members informed of changes. In this fashion electronic communication technology helped the teams create in-groups without out-groups.

APPROPRIATENESS OF ELECTRONIC DECISION MAKING

For any decision situation, managers have, in principle, three choices: no meeting, an electronic discussion, or a face-to-face meeting. Sometimes no meeting at all is the right choice. Sometimes it is better to create an electronic group when, because of distance, time zones, or organizational or social differences, one would otherwise have no group at all. It also might be appropriate to create an electronic group when an existing group has too little opportunity for face-to-face interaction. Electronic communication can be used to extend this interaction. Electronic communication can prevent dispersed groups from delegating too many decisions to the chairperson or to another group. Delegation can be efficient, but if done merely for convenience, the group may not be using its resources effectively. For decisions like allocating finances or making technical judgments, taking a vote is often better than relying on one person because averaging across people reduces error (Einhorn, Hogarth, & Klempner, 1977; Laughlin & Ellis, 1986; Vroom & Yetton, 1973). If there is chance for discussion before the vote, group members also might like the outcome more and feel more responsible for it. The time saved by delegating decisions and not meeting at all may not be worth the disgruntled people who feel disenfranchised.

Given the choice to convene a group, electronic meetings sometimes can be more appropriate than face-to-face ones. The face-to-face meeting may be dominated by loud talkers or by people who have less knowledge than they have prestige. Group problem solving often falls short due to the influence of extraneous social differences. A person with a good so-

lution must convince others to adopt it. Doing so can be difficult in face-to-face meetings if the person with the correct answer has low status. Face-to-face groups do not always ratify an obvious correct answer when one member proposes it (e.g., Laughlin, 1980; Maier & Solem, 1952). Even correct proposals must be endorsed by more than one person for the group as a whole to come to recognize their correctness. Such groups could benefit from the remoteness and reduced social information in electronic communication. An electronic meeting also can be used as a "pre-meeting meeting" to gather information and solicit opinions before a decision to be made face-to-face. People also can stay in touch after a face-to-face decision through electronic communication, thus attaining simultaneous linking and buffering of members who are working independently.

Face-to-face decision making probably is best when a decision requires complex thinking and subtle multiparty negotiations, and when problems are ill-defined. Some decisions must be ratified symbolically. Face-to-face meeting permits members to engage in ritual in a way no mediated communication can. Since it is public and enhances perceptions of full participation, face-to-face decision making also is probably best for generating commitment to a course of action. Thus a project team may hold many face-to-face meetings early in its life to define the issues, secure commitment to the team's goals, and decompose the task into parts. The individual members publicly agree to work on the parts by themselves. Yet even under these conditions, electronic communication may be useful in the future as a way to augment conventional face-to-face meetings with computer support in the meeting room (DeSanctis & Gallupe, 1987; Greif, 1988).

We do not know yet how policies and technology designs will change to adapt electronic communication to particular decision tasks. For instance, some kinds of groups require human mediation or they never get anything done. People who worked on the Common LISP project using the ARPANET report that they relied on one designated moderator to keep order and to hold votes when people could not reach consensus. The moderator also called several face-to-face meetings when "theological conflict" was impossible to resolve electronically. (Many fewer people could participate in the face-to-face meetings, however.) Some have tried to automate the moderator role. One commercial email program asks group members to label their messages according to their purpose, for example, "Request" when they want to ask a favor, and "Promise" when they want to satisfy a request. The program is supposed to help manage the group by keeping track of messages and generating reminders when it is time for requests to be met or when promises fall due. But most people do not use these facilities because they do not want to make their

intentions and strategies explicit. Unfortunately most information technology designs, formal policy analyses, and even social science studies emphasize the instrumental, task-oriented dimension of information exchange and ignore its strategic and symbolic dimensions (for discussions of this point, see, for example, Burns, 1989; Electronic Publishing, 1990; Fleming, Darley, Hilton, & Kojetin, 1990; March & Sproull, 1990; National Research Council, 1989; Pfeffer, 1978).

CONCLUSION

Human beings in groups confront many constraints from the physical and social order. Physical order arises from natural limitations and opportunities of space and time; humans devise artifacts and technologies that change the physical order. Social order arises from a shared social reality—a human construction of group structures and habitual interactions. Technology can stimulate change in the social order of groups and thus have a second-level effect on group behavior and decision making. As science policy makers, managers, and software developers begin to "put groups on-line" to streamline their operations, research can show whether patterns of membership, interaction, and group outcomes vary significantly from those of traditional groups. Research on technology effects also speaks to behavioral and social science if it illuminates fundamental group and decision-making processes.

One way illumination may happen is through advances in computer technology that create novel environments for group interaction and new kinds of interaction within those environments. Electronic mail, teleconferencing, hypertext systems, and so forth, have created contexts with some unique properties that did not exist previously. For instance, the development of natural language databases on networks permits distributed discretionary information sharing in "virtual" groups—those that exist only electronically. We are beginning to see information-sharing behaviors that public goods theories do not explain (cf. Constant, Sproull, & Kiesler, 1990; Kraut & Streeter, 1990; Thorn & Connolly, 1987). We are even more likely to observe quantitative changes in old but rare phenomena. That is, technology can make commonplace phenomena that rarely exist without the technology. For example, collaborative learning in classrooms (and more game-like competition) may become common (see Schofield, Evans-Rhodes, & Huber, 1990). Technology also provides new conceptual models for thinking about groups and organizations. Concepts of group collaboration, organizational learning, and distributed intelligence, for instance, may be clarified and informed by studies of the operation of computer systems. Finally, technology is giving us new research tools for the study of classical problems in communication, rep-

resentation, instruction, interaction analysis, and the like (see, for instance, Lepper & Chabay, 1988).

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