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ABSTRACT

This publication contains six essays responding to the following themes: information as a resource to be shared; whether and how new technologies are causing change in the nature and definition of information; and how changes are affecting the fields of education, economics, sociology, technology, business, and world affairs. Following the foreword (Paul J. Myer), examples of the range of information available to everyone are reviewed in an introduction to the essays (Nicholas Johnson). The value of information is discussed in "The Role of Technology in an Information Age" (Stephen H. Haeckel and Richard L. Nolan). "The Economics of Information" (Roger G. Noll) provides a readable introduction to the subject for noneconomists. "Competing with Information" (Blake Ives and Sirkka L. Jarvenpaa) provides a theoretical base and a case study for conclusions about the nature of information for business, predicting information and expertise will supplant physical goods as the basis of developed nations' economies. "The Promise of a New World Information Order" (Peter F. Cowhey and M. Margaret McKeown) addresses issues such as the utility of the content of global communications. "Technology, Information, and Social Behavior" (Sara B. Kiesler and Pamela Hinds) suggests that it may be as important to study people as information technology itself. "Network Literacy in an Electronic Society" (Charles R. McClure) describes the educational implications of the changing nature of information. (KRN)

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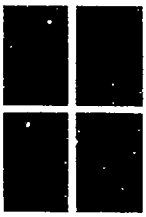

THE KNOWLEDGE ECONOMY

The Nature of Information in the 21st Century

1993–1994

Annual Review of the
Institute for Information Studies

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The Institute for Information Studies was established in 1987 by Northern Telecom in association with The Aspen Institute, a prestigious international center for the study of the humanities and public policy alternatives. IIS programs recognize the increasingly significant role and responsibility of senior executives in leveraging the information assets, as well as formulating the strategic direction of the enterprise. Through discussions and workshops on vision and change within an organization, the program focuses on the importance of information communication in business, and addresses the impact of business principles on the individual, community, and society.

CONTENTS

TECHNOLOGY, INFORMATION, AND SOCIAL BEHAVIOR

Sara B. Kiesler
Pamela Hinds

Department of Social and Decision Sciences
Carnegie-Mellon University

Hi, all,

I am sure I'm not the first to ask this question but I can find no help in Quest [on-line data base of previous questions and replies] so I'm asking the world [the company] to see if I can get any answers.

I have a number of 2311's [computer terminals] (50+) installed at ABC Co. and many of them are starting to get too dim even at the max brightness setting. Is there any way to increase the brightness on these monitors or is the solution a replacement?

Any info would be greatly appreciated.

Regards, Nadia

E-mail memo to 9,000 employees. She received seven replies in four days from people in three countries.

As social scientists exploring how the nature of information is changing, we come to questions of how information is traded and used, who controls information, and the impact of information on those who do and do not have access to it. Even so-called scientific facts and technical procedures are embedded in the social context, depend on social behavior, and in turn influence social behavior. Thus in the e-mail message quoted above, the technical answer to the employee's question

depends on (and influences) her behavior (asking strangers for help), on others' behavior (how they trade know-how to learn from one another about "max brightness," and why they give information away to someone they don't know), and on the culture of the organization (that does or does not promote good citizenship). Asking these questions surfaces larger issues of the organization of work, the distribution of power and control, privacy, and the mobilization of resources. In this article, we draw from empirical research on computer networking to discuss how new information technologies change the social aspects of information, and how these changes in turn affect behavior and the relationships among groups and individuals.

SOCIAL ASPECTS OF INFORMATION

From ancient times, new technologies have increased the durability and portability of information. When information is durable and portable, ideas in one person's head can live and travel beyond that one person. The portability of information changes the distribution of information: who knows what. The distribution of information is important because people learn from others, particularly when they do not have recourse to direct observation or to objective measures such as yardsticks and weights. What people believe is real constitutes their social reality. Does understanding of how disease spreads reside just in doctors and faith healers or does a community learn about disease by watching TV? People cannot see germs, so medical disease is a social reality created or influenced by television.

The distribution of information also influences the credibility of information, its further spread, its impact on social behavior. When most of the community believes that germs cause disease, germs are both less arcane and more sacred. Knowing about germs sends villagers to seek Western medicine and incidentally exposes them to urban values.

The durability and portability of information affects not only the distribution of information but also the distribution of social relationships—who knows whom—and the form and quality of these social relationships. For instance, the sender of the e-mail message quoted above sent that message to hundreds of strangers. Each of those who replied also made copies of their replies available in a computer archive

to everyone else in the firm. Now employees have more in common with one another and can draw on that information in the future. More generally, computer-based communication technology seems to increase the number of weak social ties and to reinforce existing strong social ties. There is historical precedent for this effect of communication technology. For instance, the telegraph made it possible for officials in Washington to make frequent contact with their ambassadors in foreign countries. The significance of this change was not simply that Washington could obtain foreign news quickly, but that Washington could keep tabs on its envoys. Through the exchange of reports, the capitol exerted greater authority over ambassadors' behavior.

The distribution of relationships affects future information exchange, since people seeking information tend first to share news with, and seek out, those whom they know. Further, when people get to know one another across lines of time, geography, and group, an influx of new opportunities and ideas crosses social boundaries. These opportunities and ideas can increase individuals' mobility and their groups' innovativeness. On the other hand, as in the case of ambassadors, greater access to others can be used to control others or even to mobilize against them. It is easier to monitor others or spy on them with satellites and radio receivers and telephones than without them.

Talk about information technology and resulting social change pervades professional and scientific discourse and the popular media. Frequently *computers* and *revolution* appear in the same sentence. Some have forecast widespread unemployment and the impoverishment of social life; others have promised a world in which everyone is a well-paid, well-educated "information worker." That information technology can lead to social change is largely undisputed. Historic and antecdotal evidence suggests that using technology as a means of organizing, protecting, manipulating, and distributing information leads to, or at least can be used in the service of, changes in social relationships in organizations and in society. But in actuality, information technology has not caused a revolution in society nor has it altered human nature. Its social effects are far more subtle and are still evolving. There is much dispute about the true role of information technology in social stability and change, and scholars have different conceptual frameworks for thinking about technological change. Below we offer one framework for doing so.

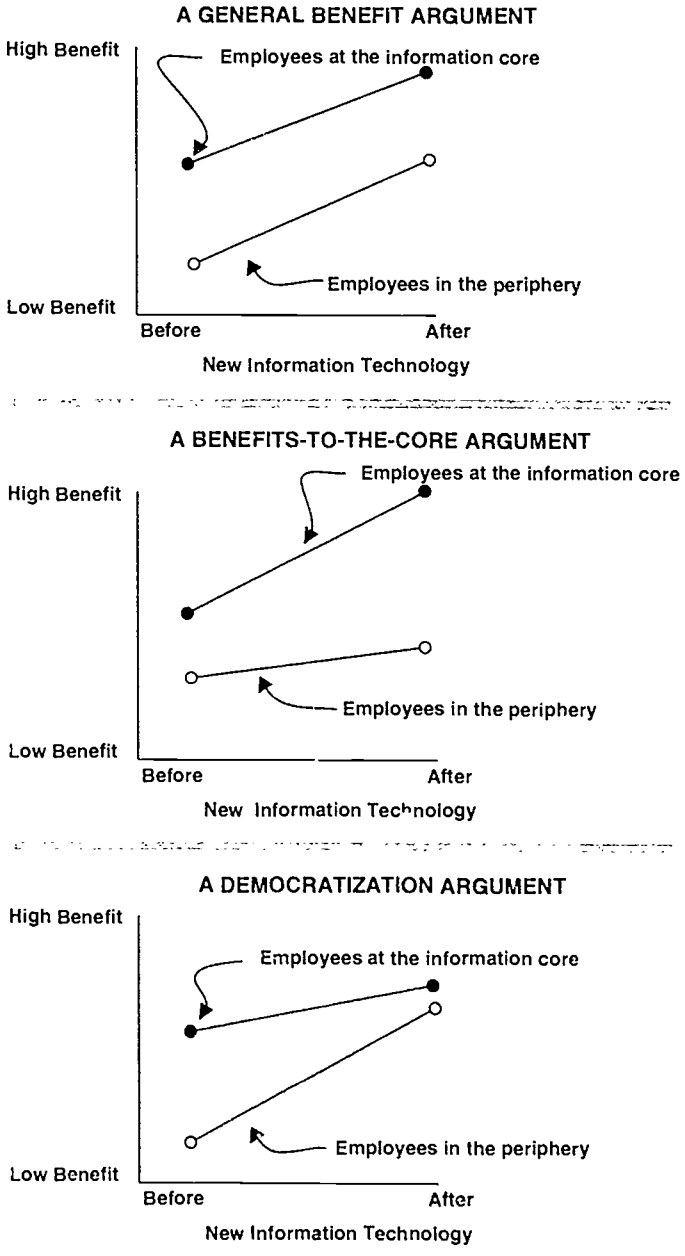
FRAMEWORK FOR THINKING ABOUT INFORMATION TECHNOLOGY IMPACT

Our framework for thinking about information technology and social change separates two kinds of change. The first kind of change is a general effect, fairly immediate, on organizations or society. This general change could take many directions. One direction is a positive one, where technology leads to increases for everyone in productivity, efficiency, reduction of energy usage, effectiveness, or quality of life. Another is a negative one, where technology leads to bad effects such as pollution or crowding or war. We are going to assume here that the net effect of technology is a generally positive one, and consider a second kind of change. This second kind of change is a differential effect on different social groups. This effect is frequently hard to predict and measure but also can be ultimately just as important as the second kind of change. For example, although the telephone was intended as a business tool, it became even more important in personal usage and had far-reaching effects not only on organizational forms such as the branch office, but also on rural life, on families, on teenagers, and on parents.

Many scholars are concerned with the differential impact of information technology in society. Who really benefits the most? Who is the "loser?" At least three arguments are made. The first says there is no important differential effect of technology, that only the first kind of change is important. In Figure 1, we can see this argument modeled in the "General Benefit" graph. A second argument is that the elite of society or those at the technical or administrative core of organizations invariably benefit from technology much more than the have-nots, than marginal members of groups, or than people at the periphery of organizations. A third argument is just the reverse: that have-nots, marginal group members, and employees on the periphery of organizations, or distant from their technical and administrative core, really benefit most from new technology. This is the democratizing argument for technology.

Figure 1 shows how the three arguments predict general and differential benefits and losses from new information technology in large organizations. In these graphs we oversimplify greatly by dividing the organizational world into two groups. One group consists of those at the authority, technical, and information "cores" of the organization,

Figure 1 The Differential Impact of Information Technology in Society



such as those who have high managerial status, or those who are technically experienced, or those who are located in the technical center of the organization. The other group consists of those who are more "peripheral" by virtue of their lesser access to information and influence, such as those in branch offices far from the technical core. By peripheral we do not mean unimportant. For instance, peripheral employees may be sales people at the interface between the organization and its customers. They are essential but we call them peripheral because of their poorer access to information and to others. We also simplify by depicting the graphs in a form respresenting a generally positive effect although our discussion considers examples of less beneficial outcomes.

Within the framework of our analysis, different arguments can be made as to how those at the core and those at the periphery of organizations are influenced by new information technology. The general-benefit and general-loss arguments are that that each group benefits about the same degree from new technology. For example, technologies like central air conditioning blow cool air on everyone in a building from the president on the top floor right down to the mail room clerk in the basement. All benefit. Somewhat the same argument could be made for many inexpensive entertainment technologies, such as the Walkman radio and videotaped movies. Although we can take such an overall positive posture toward information technology, an overall negative posture is also possible. For instance, we can argue that air conditioning is harmful to all because it emits toxins and fluorocarbons. Because air conditioning generally reaches all people equally, there is no reason to believe that those in the core suffer any more or less than the people at the periphery.

The benefits-to-the-core argument is that those who already have access to information and power also control new technology, and typically use technology in their own interest to gain further benefit. The Egyptian scribes kept the distribution of papyrus and writing implements to themselves. In the 19th century, governments did in fact use the telegraph to tighten control over their ambassadors to foreign countries. In the 20th century, business developed and adapted paperwork technology—memoranda, filing systems, typewriters—toward greater control of work and employees. Memoranda and reports reinforced a hierarchical system of authority. Today managers in big companies buy tech-

nologies for the benefit of management and hardly would be expected to invest in those that would undermine their control.

Another version of the benefits-to-the-core argument is based on the observation that competency multiplies. Those who are at the technical core of the organizations are usually the most skilled and knowledgeable members of the organization, and are the ones who have the most exposure to new generations of technology and gain most from them and from new ideas and knowledge. One example of such an effect in the larger society is seen in the relative impact of the television show *Sesame Street:* Children of wealthy, educated parents learn more from *Sesame Street* than do children of poor, uneducated parents. Whereas both groups learn (benefit) from *Sesame Street,* the gap between rich and poor increases. When the overall impact of technology is negative, the core might lose least. Hence, suppose technology increases information overload, the speed of work, and psychological stress on workers. By virtue of their ability to buffer themselves from stress with secretaries, faster computers that automate routine tasks, two-martini lunches, and so forth, those at the core, one could argue, suffer less the ill effects of technology.

The democratization argument is that information technologies, often unintendedly, equalize groups by giving peripheral employees (or citizens) increased access to resources, information, and influence that those at the core already have. Hence the invention of the tractor, refrigeration, and electrification of the farm made it possible for more people of moderate income to eat fruits and vegetables in the winter, somewhat narrowing the gap between rich and non-rich. This argument is a motivating philosophy and political argument for nonprofit organizations and government investments in new communication and computer technology. The basic argument is that new technology—computers in the schools, medical technologies, public television, and the National Research and Education Network (NREN)—will provide to peripheral groups (the technically ignorant, the poor, the young, the old) and organizations (high schools, community agencies, small businesses), information resources that previously were enjoyed mainly by elite individuals and organizations.

The democratization argument suggests that the negative impact of information technology might be less severe for those at the periphery, hence narrowing the gap between the core and the periphery despite the

overall negative impact of technology. For example, suppose information technology reduces employees' or citizens' privacy and their exposure to public ridicule. Because those at the core have more transactions and are more visible to others, they probably experience a greater loss of privacy than those at the periphery. (When Michael Jackson or Bill Clinton gets a strange haircut or befriends someone, television and cable TV ensure the country knows about it instantly.)

The arguments described above have stimulated much research on new information technology. We next review some of this research.

EVIDENCE ON THE SOCIAL IMPACT OF INFORMATION TECHNOLOGY

The earliest literature about computer-based information technology was largely speculative, for there were few computer information systems to study in the 1950s and early 1960s. Writers took established theories of organizations as rationalistic bureaucracies or as economic task systems dominated by a legitimate managerial hierarchy and deduced from these images how computing should change the firm or the society. These early reflections on the effects of information technology often polarized around extreme versions of general change arguments described above. They had utopian or Orwellian visions of organizational change, both visions assuming the changes would be unidirectional and uniform—the same for all organizations, for all kinds of computerized information systems, and for all groups. Over the years, researchers have collected evidence to test these notions. Here we review some of that evidence in three areas: changes in skill requirements on the job, shifts in control and influence, and structural changes in organizations.

Skill Requirements

General-benefit theorists have argued that information technology will absorb the most routine of manual tasks, leaving all jobs rich in higher-order and cognitive skills. An intense debate has existed between them and the benefits-to-the-core school that views workplace technologies as instruments for subordinating workers by replacing skilled craft-like jobs with narrow deskilled jobs. Subsequent empirical re-

search on information technology in diverse workplaces has revealed flaws in both of these arguments. First, the impact of computing on skills, although widespread, has varied. Changes in clerks' work look very different from changes in professionals' or managers' work. In some cases, as in libraries that put in cataloging and search systems, the same kinds of people were either deskilled or upskilled: Some librarians became computer information professionals and some administrative clerks. Almost identical computer systems applied to similar clerical work forces have affected work in dramatically different ways in different companies.

This research has led to a thorough reworking of theories of information technology and skill change. Skill changes, although triggered by the adoption of a technology, less reflect the technology itself than they are outcomes of setting up and putting in technology, and of the structure of the workplace and work groups into which the technology is deployed.

Control and Influence

Many stories about extensive benefit from computer networking for both peripheral and core employees have come from the computer industry. There, even novice computer professionals have high value to firms, which treat them well. These employees have enjoyed perquisites including free and extensive access to computers and networks. In these situations, everyone from the top echelon to the bottom of the organization generally benefits somewhat equally from the technology.

Other firms use technology to reinforce control. A 1990 study by Rule and Brantley showed how supervisors at a burglar alarm company used new computer-based data from alarms to check whether field inspectors assigned to machines had given them their periodic manual servicing. Computerized analyses of sales were another common vehicle for increased control by managers. One employee said of a firm that fabricated steel parts and entered every order into the computer:

> The President gets a copy of every order and the order lists the profit margin and dollar profit for every order. Before computers, he simply got the dollar total made on the order (and he got it much later). Now, he is much tougher on the sales people when he sees a low margin. Since he often sees this before the

> bill has gone out, he will often change the price. He usually gets the customer to pay that price. Before computers, by the time he saw the dollar profit on each order, the invoice had probably gone out already. He didn't want to issue an additional bill because the customer wouldn't pay it. Also, since he only saw total dollar profit, he might think an order that made $1,000 was a good order without realizing that the profit margin was only 3 percent. Now, he sees both dollar and percentage and this leads to keeping better tabs on the sales and salesmen.

The benefits-to-the-core school also can point to evidence on the role of hierarchy in networks and electronic communication technology. Hinds and Kiesler (1993) recently did an analysis of employees in seven departments of a large telecommunications firm. Newer electronic communication technology (voice mail and e-mail) was used more by those at higher levels of authority, and was used for hierarchical communications more than for communications among peers. And across departments, those whose respondents engaged in more communication up and down the hierachy also were the departments making greater use of new electronic communication technology.

When researchers look at interdepartmental or interorganizational communications, however, they find evidence of democratization. An experiment illustrating democratization effects was conducted by Tora Bikson and J. D. Eveland at Rand in 1988. They formed two task forces in a large utility firm, each assigned to analyze employee retirement issues and produce a report. Each task force had 40 members, half who had recently retired from the company and half who still worked but were eligible for retirement. The primary difference between the two groups was that Rand provided one group with networked computer terminals and software. Both task forces created subcommittees, but the networked task force created more of them. Also, unlike the task force without electronic communication, the networked task force assigned people to more than one subcommittee. The networked task force also organized its subcommittees more complexly in an overlapping matrix structure. That task force added new subcommittees during its work. It also decided to continue meeting even after its official one-year life span had ended. Finally, retired people who were members of the networked task force were much more influential, headed more subgroups, and

became closer to other members of the task force than retired people who were members of the task force that was not networked.

Research shows that computer networks can be a participatory vehicle for peripheral employees. Senior managers and key professionals usually have good connections and are "in the know" in their organizations and professional communities. Employees who are less central by virtue of geographic location, job requirements, or personal attributes have generally had fewer opportunities to make contact with others. Reducing the impediments to communication across both physical and social distance is therefore likely to affect the influence peripheral employees have, and their feelings of connection, more than that of central employees. In the Hinds and Kiesler study, electronic mail provided a vehicle for lower-level employees in the firm to be in contact with those at higher levels. In another study, Huff, Sproull, and Kiesler found that employees who used electronic mail extensively reported more commitment to their jobs and coworkers than employees who did not use the network much. But this correlation was much stronger for shift workers who, because of their jobs, had fewer opportunities to see their coworkers than regular day workers did.

As many firms diversify and become global, many employees become peripheral geographically. Despite the global nature of their firm, these employees will mainly lead local lives at work. They will spend most of their time in one physical location—the office and its immediate environs. They will talk mostly to people like themselves—their immediate coworkers, clients, or customers. They will participate in a few workplace groups—their primary work group, perhaps a committee or task force, and possibly an informal friendship group. New information technology, however, is encouraging employees in some dispersed firms to become much more cosmopolitan. Using computer networks, these employees transcend their local environs and communicate easily with people around the world. They "talk" with distant employees, customers, and suppliers, many of whom they have never met in person, as easily as they talk with someone in the next office. They participate in groups discussing company policy, new product design, hiring plans, or last night's ballgame without ever physically meeting with the other group members.

Research conducted in laboratory experiments suggests that electronic "discussions" are likely to be more egalitarian than those held

face-to-face in the same organizations. One reason for this phenomenon is that networking technology allows for conversation absent social-context cues and reminders, and therefore people are less constrained in what they say and who they talk with. Due to the openness of responses on networks, organizations are finding that many group activities are being done at long distance on computer networks people did not think would be possible. These range from group discussions of sex to health counseling to training new employees to huge electronic project groups. But just as an electronic message is not merely a fast letter or a transcribed conversation, an electronic group is not just a traditional group whose members use computers. For example, electronic groups tend to be much, much larger than nonelectronic groups created for similar purposes.

Reviewing the research on control and influence in organizations suggests that the impact of new information technology depends greatly on the policies of managment and design of the technologies. Management can use information technology to increase control and influence from the top down. In cases where managers have invested in networks but encouraged employees to use them creatively to increase their productivity or in cases such as the Internet, which grew exponentially without much social control, influence and control seem to have been increased more democratically.

Structural Changes

Benefits-to-the-core theorists have long predicted that new information technologies would reinforce existing social structures. They argue that, historically, elites have aggrandized whatever instrumentalities of social control are provided by new technologies, and suppressed or hobbled those consequences of the technologies working against their interests. On an opposing side are general-benefits and democratization theorists who argue that prevailing organizational structures are artifacts of existing limits to information, cognition, and control. Therefore, new information technologies eventually will change conditions in striking ways. Some democratization theorists have heralded new information technologies as powerful enabling instruments for "delayering" organizations, meaning that they allow significant increases in effective spans of managerial control, and thereby reduce the need for layers of middle management. Some have gone so far as to

forecast the era of the flat organization, consisting essentially of a single level of hierarchy beneath a very small leadership core.

There is an irony in this predicted change. On the one hand, a thorough delayering of organizations and great widening in span of control would effectively centralize organizations by decreasing the distance between loci of decision rights. Conceivably, this could enable total centralization of even very large organizations by placing all decision rights in the hands of a single manager who is able to supervise each and every subordinate directly through computer-assisted technologies for communication, surveillance, analysis, and so on. On the other hand, these new technologies are often promoted as powerfully decentralizing and empowering of subordinates, because the numbers of middle managers are reduced and the amount of effective decision autonomy granted to workers can be increased as long as ultimate corrective authority resides with the residual managerial core.

The irony has led to a shakeup of social scientists' concept of centralization. The concept traditionally has been tied to decision authority structure in circumstances where there was no practical ability to leave large amounts of discretion to local actors while retaining sufficient surveillance and interdiction capability to intervene in a "wrong" decision before organizationally negative consequences occurred. Local actors either had decision rights or they did not, making it easy to declare the prevailing organizational structure as centralized or decentralized. But with such surveillance and interdiction capability in place, we face a dilemma in labeling situations where, for example, the decisions of local actors are watched and could be interdicted by higher authority, but in fact, they never are interdicted because they are always "right." Does centralization reside in decision authority principle or in decision authority practice?

THE SOCIAL CONTEXT

Research on the social impact of information technologies sometimes supports general effects arguments, sometimes the benefits-to-the-core argument, and sometimes the democratization argument. The social context often determines the nature of these effects of informaton technology. Researchers such as Attewell, Westin, Barley, and others

have identified important contextual factors related to specific outcomes. These include: (1) the prior history of labor relations and managerial philosophy in a firm; (2) the size and clerical intensity of the firm; (3) the growth rate and competitive situation of the firm; (4) the scarcity of the labor pool; (5) the introduction of the system (e.g., top down versus bottom up); and (6) the intrinsic dullness of work.

A rule of thumb from research on social context is that for all to benefit (or for all to lose) from information technology, all must have access to the technology and control of the ways they want to use it. Utilization will be biased in the direction of those in control. Therefore, if the core maintains control over access to and utilization of the information technology resource, technology effects are more likely to fulfill the predictions of the benefits-to-the-core school. If the technology is equally in the hands of core and peripheral people, the needs of the periphery will be addressed and there will be more evidence for general effects or for democratization.

NEW SOCIAL ORGANIZATIONS

The discussion above focused on the impact of information technologies on existing organizations. New technologies also might create social organizations or new kinds of groups with characteristics and behaviors not seen before.

The appearance of nationally and internationally accessible computer-based communication networks has changed not only individuals, but groups. Paramount among these changes are the strengthening of existing distributed work groups and the creation of new such groups. In some cases, these groups have become sufficiently powerful and influential to exert significant and concentrated pressure on established organizations and institutions. In a few instances, these distributed groups have evolved features of size, hierarchy, and operating norms common to organizations. These are fundamentally new kinds of social organization, not anticipated or explained by existing social theory. Moreover, they show promise of being a major form of social organization in the coming years.

The central feature of these groups is that they exist completely within computer-based telecommunication networks, and their mem-

bers usually function as members of one or more formal organizations at the same time they are active participants in the electronic groups. A common situation is that of a university faculty member or a researcher in a corporation with access to one of the major national/international networks (e.g., Bitnet or Internet). While individuals have normal organizational duties and responsibilities in the organization of their employment, these duties can extend through the networks to individuals in other such organizations with whom they have work-related needs for discourse and discussion. Collaboratively authored documents flow back and forth through the networks, residing in different versions here or there in various host machines, eventually wending their way to dissemination or publication. Also, there can be extensive discussion via private person-to-person electronic mail, "broadcast" electronic mail from one person to many, or via "posting" to public bulletin boards or news groups.

The astonishing growth in use of computer networks, as measured by both numbers of users and message traffic, is crude but powerful testimony to their significance among their users. At minimum, they are a great convenience for communication among the professional actors with access to them. There are suggestions, however, that the import of these networks goes far beyond that of just another way of communicating. Among other things, these networks have been used several times as instruments for mobilization of major social actions by distributed and institutionally disconnected individuals.

> Hi, World,
>
> Could you please measure and send me the dimensions of your office? Our manager wants to move us into smaller office space. I don't think I can get any work done in a closet. If you e-mail your stats ASAP, I will have some ammunition to use with our boss's boss. . . .
>
> *E-mail broadcast to all members of a firm.*

Political mobilization is particularly effective in one electronic news collective called USENET, available through various networks such as Internet and Bitnet. No one knows exactly how many people read USENET news groups, or how often, but current estimates place the number of organizations with access to USENET at more than

50,000 and the number of people reading at least one newsgroup at nearly 2 million. Two instances of USENET activity for social organization are worth noting.

One instance was during the Tiannanmen Square confrontations in June 1989, in which the USENET newsgroup soc.culture.china became a highly interactive communications device among Chinese students in the United States and Europe for sharing information and plans for action in response to the crisis. This was not simply an electronic version of Tom Paine and the pamphleteers: it was a powerful organizing modality that permitted nearly real-time mobilization and coordination across vast distances. The fact that postings to this newsgroup could not be anonymous meant that participants identified themselves as protesters in a way not common to mass physical demonstrations. Records of the transactions were lasting and widely available.

Another incident occurred in 1991, with extensive discussion of the new Lotus Development Corporation's product Households—a "profile" advertising data base—on the USENET comp.risks newsgroup. This discussion began when an individual close to the development of the product but not working for Lotus "leaked" a detailed description of the product to his own company's bulletin board. This was read by another person, and "reposted" with a few keystrokes to the comp.risks bulletin board with its thousands of readers. The subsequent discussion on comp.risks precipitated an electronic protest message writing campaign directly to the e-mail address of Lotus CEO Joe Manni that produced thousands of e-mail messages decrying the new product. It is reported that this message campaign had a pronounced effect on the Lotus leadership, who subsequently scuttled the product.

In quite a different vein, these networks have been used to conduct professional work among widely distributed actors concerned with common issues. Some of these activities are discrete and one-time-only. For example, mathematical computer scientists at Bell Communications Research and Digital Equipment Corporation used the network as a coordinating mechanism for organizing a distributed work project to factor a very large prime number, Fermat's 9th Number. In this case, the distributed computing resources of many organizations were contributed to the project using the network as the analytical coordinator. In other cases, the collaborations are ongoing and have become embedded work routines of whole cadres of professionals. For example, physical

oceanographers have been using electronic network distribution lists to coordinate large projects, such as the World Ocean Current Experiment. The network is used to report results to colleagues, to solicit advice and help for doing the work of the experiment at various locations, and to obtain access to large data bases. These activities all occurred in oceanography before networks were available, but use of the network has significantly increased participation overall and by those scientists in remote locations.

These networks raise important intellectual and theoretical questions about how individuals join and leave groups, how groups establish and maintain group cohesion, and how individuals build their allegiances and connections to multiple, disparate groups through the network modalities. They also constitute an important and controversial crossing of the boundary between individuals' various group memberships and commitments, and between the worlds of work and leisure. Participation in these networks is often enabled by and supported through an individual's primary employment, but network activities often go far beyond employment responsibilities to include social discourse and entertainment uses that employers could hardly justify in strict economic terms. These modes of communication are creating a fertile ground of controversy over fundamental notions of free speech, privacy, proprietary rights to intellectual discourse, and liability that simply has not been seen before.

CONCLUSION

As we explore the nature of information, it is as important to study people as to study the technologies that create, change, store, transmit, or manipulate information. The nature of information rests on how people use, trade, and react to it. We are continually being faced by new information technologies—new means of dealing with information. Although extensive planning goes into the development of the technical features of these new technologies, their real impact will come from the ways that people use them, particularly the unexpected or unintended uses.

The research cited in this paper shows that general benefits or loss arguments, benefits-to-the-core arguments, and democratization arguments all can be valid in different contexts. A context-free technology

is just as rare as teacher-proof classroom learning. The design and implementation of a technology, and policies for its regulation, or avoidance of regulation, are critical in determining the nature of the social impact—and ultimately changes in the nature of information. Recently, the White House issued an announcement that it would help democratize politics by setting up computer network linkages between the public and White House staff and Congress. Much of the design planning for this network assumed that the most important activity in the network would be messages flowing from the public to public officials, and the most important function of the technology would be to speed up or increase such communications. Since public officials already receive thousands of communications from the public, it seems unlikely the network will have impact either on society or on the nature of information. Compare that with a network that over the last decade has vastly improved the qualitative ability of people (including children) to find people and create new groups, where members talk with one another on any subject they want to discuss (including politics). This network is the Internet, whose thousands of "newsgroups" talk about music, the environment, legal issues in art and child care, and hundreds of other topics. The emerging "network community" seems a truly interesting phenomenon which changes both people's relationships and the nature of information. The Internet was developed over two decades, sheltered from the public eye and with little interference by commerce or government, except for financial and technical support through the Department of Defense. Engineers and scientists, educators, and students, especially technical graduate students, built the Internet for themselves. The Internet is a wonderful reminder that the effects of technology are unpredictable and often surprising, and always involve people's behavior.

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AUTHORS

INTRODUCTORY ESSAY
Nicholas Johnson

Nicholas Johnson is a visiting professor in the College of Law of the University of Iowa, a national board member of Common Cause, and a fellow of the World Academy of Art and Science. He is a computer and communications technologies expert and the author of several books and monographs including *How to Talk Back to Your Television Set.* Johnson was formerly an FCC Commissioner, a network television host, and a syndicated columnist.

THE ROLE OF TECHNOLOGY IN AN INFORMATION AGE: TRANSFORMING SYMBOLS INTO ACTION
Stephen H. Haeckel and Richard L. Nolan

Stephen H. Haeckel is director of strategic studies at IBM's Advanced Business Institute. He also represents IBM on the Marketing Council of the American Management Association. A guest lecturer at the Harvard Business School and the Tuck School, Haeckel is chairman of the Research Policy Committee and vice chairman of the Executive Committee of the Marketing Science Institute. His current research focuses on the strategic use of information and technology to create and manage adaptive organizations.

Richard L. Nolan is a professor of business administration at the Harvard Business School. Formerly he was chairman of Nolan, Norton

and Company; a systems analyst for the Office of the Secretary of Defense; and financial systems manager of the Boeing Corporation. Nolan's most recent book is *Globalization, Technology and Competition.* His research and writing deal with organization and architecture, creating the 21st-century organization, and the design of network organizations.

THE ECONOMICS OF INFORMATION: A USER'S GUIDE

Roger G. Noll

Roger G. Noll is the Morris M. Doyle Centennial Professor in Public Policy and Director of the Public Policy Program in the Department of Economics at Stanford University. He is the author of *The Technology Pork Barrel* and *The Economics and Politics of Deregulation.* Microeconomics, social control of business, and political economics are among Noll's research interests. He also is a consultant to business and other organizations, including Nike, Delta Airlines, the Federal Trade Commission, Matsushita, Pepsico, the International Entertainment Group, and the Major League Baseball Players Association.

COMPETING WITH INFORMATION: EMPOWERING KNOWLEDGE NETWORKS WITH INFORMATION TECHNOLOGY

Blake Ives and Sirkka L. Jarvenpaa

Blake Ives is chairman of the Management Information Sciences Department at the Edwin L. Cox School of Business at Southern Methodist University. In addition to writing articles in numerous journals, he has provided consultative services to IBM, AT&T, TRW, GTE, CIGNA, Price Waterhouse, Procter & Gamble, and others. He is senior editor of *Management Information Systems Quarterly*, a member of the board of the Society for Information Management, and the chairman of the executive committee of the International Conference on Information.

Sirkka L. Jarvenpaa is an associate professor of Information Systems at the University of Texas at Austin. Her research projects focus on global information technology, strategic use of information systems, and IT-enabled radical business process innovation. In 1994 she will become the Marvin Bower Research Fellow at the Harvard Business School. Jarvenpaa is an associate editor of *Management Science*, *Information Systems Research*, *MIS Quarterly*, and *Database*.

THE PROMISE OF A NEW WORLD INFORMATION ORDER

Peter F. Cowhey and M. Margaret McKeown

Peter F. Cowhey is a professor in the Department of Political Science at the Graduate School of International Relations at the University of California–San Diego. His teaching fields include international relations, international political economy, foreign investment research, comparative public policy, and energy research. Among his many publications are *The Problems of Plenty: Energy Policy and International Politics; Profit and the Pursuit of Energy: Markets and Regulations*; *When Countries Talk: Global Telecommunications for the 1990s;* and *Changing Networks: Mexico's Telecommunications Options.*

M. Margaret McKeown is a partner in the law firm of Perkins Coie in Seattle, Washington. Her practice areas include intellectual property counseling and litigation with emphasis on software protection, trade secrets, unfair competition, securities, antitrust, and contracts. She is widely published on the topics of trade secrets, software protection, and computer litigation. Ms. McKeown was a White House Fellow and served as special assistant to the secretary of the interior and White House Office of Policy Development.

TECHNOLOGY, INFORMATION, AND SOCIAL BEHAVIOR

Sara B. Kiesler and Pamela Hinds

Sara B. Kiesler is a professor in the Department of Social and Decision Sciences and a faculty member of the Robotics Institute at Carnegie-

Mellon University. She is a member of the Office of Technology Assessment Advisory Panel on The Electronic Enterprise: New Opportunities for American Business and Industry; the Gallaudet University Advisory Committee on New Technology; and the National Research Council Panel on Linkages Between Individual and Organizational Productivity.

Pamela Hinds is researching the organizational impact of communications technology and the development of technical teams as part of her doctoral studies at Carnegie-Mellon University. She has worked for Pacific Bell as technical director for managed systems analysis, application development, quality assurance, and vendor management for the development of small business applications.

NETWORK LITERACY IN AN ELECTRONIC SOCIETY: AN EDUCATIONAL DISCONNECT?

Charles R. McClure

Charles R. McClure is a professor at the School of Information Studies at Syracuse University. He teaches courses in U.S. government information management and policies; information resources management; library/information center management; and planning/evaluation of information services. He is editor of *Internet Research*, a quarterly journal, and has written extensively on topics related to U.S. government information; information resources management; and information policy. His most recent book is *Libraries and the Internet/NREN: Issues, Perspectives, and Opportunities.*

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Maryam Alavi
Associate Professor
Information Systems
College of Business and Management
University of Maryland
College Park, Maryland

Judy Brown
Senior Fellow
The Aspen Institute
Queenstown, Maryland

Peter Cassidy
Senior Fellow
Institute for Information Studies
Northern Telecom Inc.
Nashville, Tennessee

Cathy Clark
Program Associate
The Markle Foundation
New York, New York

Ron Cross
Director
Regulatory Policy Analysis
Northern Telecom Inc.
Nashville, Tennessee

Diane DeSimone
Assistant Vice President
Multi-Media Communications Systems
Northern Telecom Inc.
Nashville, Tennessee

Herbert Dordick
Professor of Communications
Temple University
Carlsbad, California

Sandra Feagan
Director
Wye Center Programs
The Aspen Institute
Queenstown, Maryland

Charles Firestone
Director
Communications and Society Program
The Aspen Institute
Washington, D. C.

Lonn Henrichsen
Special Assistant for Applied Technology
Bureau of Transportation Statistics
U.S. Department of Transportation
Washington, D.C.

John Hewer
Manager
Media Relations
Bell Northern Research, Ltd.
Nepean, Ontario, Canada

Paul Kahn
Dynamic Diagrams
Providence, Rhode Island

Dennis Kastner
Assistant Vice President and Executive Director
Institute for Information Studies
Northern Telecom Inc.
Nashville, Tennessee

Richard Lowe
Director
Media and Consultant Relations
Northern Telecom Inc.
Nashville, Tennessee

Jeffrey Murray
Director
Cardiothoracic Anesthesiology
University of Michigan Medical Center
Ann Arbor, Michigan

Paul J. Myer
Vice President
Integrated Marketing Communications
Northern Telecom Inc.
Nashville, Tennessee

James Nelson
Senior Fellow
The Aspen Institute
Queenstown, Maryland

Donald O'Connor
Director
Global Networks
Fluor Daniels, Inc.
Irvine, California

Eric Vogt
President
Micro Mentor, Inc.
Cambridge, Massachusetts

Madeline Weiss
President
Weiss Associates, Inc.
Bethesda, Maryland

Frederick Williams
Professor
Center for Research on Communications Technology and Society
University of Texas at Austin
Austin, Texas