

Computer-Mediated Communication and Organizational Innovation

by Ronald E. Rice

Computer-mediated communication systems not only process information about innovation but are also an innovation that organizations must process, a circumstance that provides organizations with opportunities and challenges for enhancing their resourcefulness and responsiveness.

A major tenet of communication theory is that content can be distinguished from the medium in which it appears. But in traditional organizational media such as memos, reports, meetings, and face-to-face conversation, the process of "communication" rarely distinguishes content from medium, and therefore the medium's constraints upon the type of organizational content possible may not be immediately obvious. Although research on topics such as the rise of modern offices (85) and group decision making (170) does consider such distinctions, the diffusion of computer-mediated communication systems has highlighted this issue.

Since many kinds of content can be digitized by the computer and exchanged through telecommunications networks, content is now physically, instead of only theoretically, separable from its particular medium of transmission. Both content and medium can thus differentially influence how organizational members use and evaluate organizational information. This simultaneous separability, blurring, and interaction of content and medium generates both obstacles to and opportunities for communication within organizations. In particular, this article focuses on one of the most important aspects of organizational communication in rapidly changing environments, that of innovation.

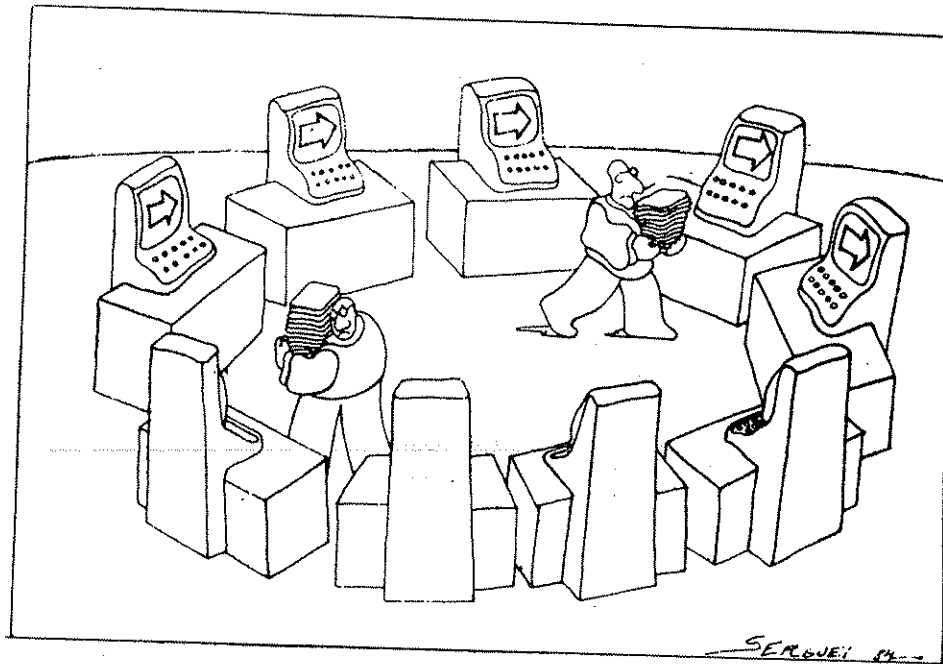
Computer-mediated communication systems (CMCS) have already been shown to be associated with persistent, although malleable and nonrevolutionary, differences in organizations (62, 94, 97, 119, 138, 139, 145). But these relationships have been described in many separate studies and scattered in many fields. In bringing together these studies in a framework that integrates an understanding of criteria for evaluating characteristics of both media and content with an input-conversion-output model of organizational information processing, I hope to illuminate the potential for CMCS to facilitate organizational

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The author would like to acknowledge the generous and helpful comments of Marsha Siefert, Lynne Markus, Charles Bantz, and two anonymous reviewers on previous versions of this article.

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innovation as well as to identify the processes by which CMCS themselves are adopted and reinvented.

Establishing a good fit between media and communication activities requires an understanding of the characteristics of different media, possible interactions among characteristics and activities, and the media usage patterns of information workers. There are many ways to characterize the differences among interpersonal communication (face-to-face, meetings, telephone), broadcast mass media (radio, television, audioconferencing), textual mass media (magazines, journals, newspapers, memos), computer-based textual media (electronic mail, computer conferencing), and computer-based numeric media (transaction systems, on-line financial data bases). Table 1 lists some of the more salient characteristics for the present discussion and indicates the extent to which each category of medium exhibits—either objectively or as perceived by users—that characteristic. The extent to which a user evaluates any particular medium as having any particular characteristic naturally depends on the context. For example, a CMCS can be programmed to have high interactivity, while interpersonal communication between a drill sergeant and a private in boot camp is low in interactivity. As Table 1 emphasizes, it is perhaps more useful to conceive of media as having different degrees of various communication characteristics than to describe some media as more deficient than others (30). Four categories of characteristics seem particularly useful.

Constraints are inherent characteristics that limit, hinder, or obstruct the freedom of interaction between users. They include the extent to which a medium

allows/requires the user: to know the recipient (or, more generally, the address) in order to transmit a message, to be able to communicate with a specific recipient, to overcome selective processing by the intended recipient, to control the timing of composing, sending, and receiving activities, to be physically proximate in order to communicate, to store the information for later delivery or retrieval, to use multiple access points or indices in retrieving the information, and to be able to restructure or reprocess the information during transmission or retrieval. A final constraint is the extent to which the medium requires/allows the receiver to be able to identify the sender.

Bandwidth here refers to the range of communication modes that a medium can convey. Adapted from the technical concept for the range of frequencies in a given unit of time that a medium can transmit (38), bandwidth (communication mode) is the diversity of cues that a particular medium can transmit. They include physical distance between the participants; expressions and gestures; tone, volume, and rate; verbal meaning; and numeric data. Social presence or information richness is related to bandwidth but also includes more general aspects of perceived satisfaction and appropriateness of media. These concepts have been defined as the extent to which the receiver feels the sender is present, the capacity to learn more about a situation by using the particular medium, and the interpretive value of communication in situations of high uncertainty (12, 33, 34, 87, 137, 146, 170, 194). Media are more or less effective and appropriate insofar as they can transmit the kinds of communication content and type of nonverbal cues that are required by a given communication activity.

Interactivity is the degree to which participants in a communication process have control over, and can exchange roles in, their mutual discourse. Control includes quickness of response and the ability to end the process. Exchangeability of roles involves the extent to which discourse is mutual, that is, the level of higher-order interactions between initiator and responder (16, 40).

Network factors concern the effect that the pattern of communication has upon the input, conversion, and output of interactions. For example, studies of small group communication (169) indicate that group structure influences patterns of information flow, distortion (such as decision quality), and the effect of specific roles (such as lower satisfaction for isolates than leaders). Further, different media facilitate one-to-one, one-to-many, one-to-some, and many-to-many communication patterns.

Table 1 also classifies these characteristics into more generic communication processes first suggested by Wofford, Gerloff, and Cummins (199) and later developed by Huber (75). These include routing (distributing), summarizing (while retaining the meaning), delaying (prioritizing and storing), and modifying (editing and distorting) the original content.

From over twenty studies of how information workers allocate their time to various media (145), it is clear that managers spend most of their time communicating (75–80 percent), about 60 percent of which is oral (phone, face-to-face, or in meetings). Higher-level managers spend more time communicating with subordinates than do lower-level managers; senior managers initiate more

Table 4: Characteristics and processes of interpersonal, mass, and computer-mediated communication media

Characteristics	Process	Medium								
		Interpersonal		Mass media		Computer media				
		Face to face	Tele-phone	Broad-cast	Text	Elec-tronic mail	Nu-meric	Voice mail		
Constraints on users										
Able to identify sender	Routing	+	0	0	0	0	0	0	0	0
Have to know receiver	Routing	+	+	-	-	0	0	0	0	0
Have to know address	Routing	+	+	-	-	0	0	0	0	0
Able to overcome receiver's selectivity	Modifying	+	0	-	-	-	-	-	-	-
Need to be temporally proximate	Delaying	+	+	+	+	+	+	+	+	+
Need to be geographically proximate	Routing	+	-	-	-	-	-	-	-	-
Access to sending system	Routing	-	+	-	0	0	0	0	0	0
Able to store content	Delaying	-	-	-	0	0	0	0	0	0
Able to retrieve content	Summarizing	-	-	-	0	0	0	0	0	0
Able to reprocess content	Modifying/summarizing	-	-	-	-	-	-	-	-	-
Bandwidth										
Proxemic-distance	Modifying/summarizing	+	-	-	-	-	-	-	-	-
Kinetic-gestures	Modifying/summarizing	+	-	-	-	-	-	-	-	-
Paralinguistic-tone	Modifying/summarizing	+	+	+	0	0	0	0	0	0
Linguistic-meaning	Modifying/summarizing	+	+	+	+	+	+	+	+	+
Data-denotation	Modifying/summarizing	0	-	0	0	0	0	0	0	0
Ability to convey social presence	Modifying	+	+	0	0	0	0	0	0	0
Speed of input	Delaying	+	+	+	0	0	0	0	0	0
Interactivity										
Quickness of response	Delaying	+	+	-	-	-	-	-	-	-
Ability to terminate	Delaying	-	0	+	+	+	+	+	+	+
Mutual discourse	Modifying/delaying	+	+	-	-	-	-	-	-	-
Network factors										
Information flow	Routing	One to few	One to few	One to many	One to many	One to many	One to many	One to many	One to many	One to many
Distortion	Modifying	+	+	0	0	0	0	0	0	0
Effect of role	Modifying/summarizing	+	+	0	0	0	0	0	0	0

The symbols + (high) and - (low) are approximate and relative scale endpoints. That is, when a communication channel has the lowest relative amount, or none, of the characteristic, it receives a "-" value. "0" indicates where characteristics are especially contextual or adaptable. Also, characteristics such as access assume the system exists; e.g., electronic mail systems in general are highly inaccessible worldwide, but once a user has an account, access to sending messages is much less constrained than, say, having an article printed in a newspaper. See 33; 70, pp. 32-39; 75; 105; 144; 166; 198; 199.

downward communication than upward communication; those at lower levels engage in more peer communication; only a small amount of managerial time is actually spent making decisions; managers communicate more in situations of greater innovation and uncertainty; and written communication is less likely to capture the attention of managers because of their fragmented, interrupted schedules (115, 184).

Thus, organizations are increasingly adopting CMCS to take advantage of their unique media characteristics. Computer-mediated communication systems use computers to structure and process information and use telecommunications networks to facilitate its exchange. CMCS include electronic mail, computer conferencing, computer bulletin boards, videotex systems, voice messaging, and related media. The simplest use of computer conferencing is no different from that of electronic mail: a user types in a text-based message at a terminal in one location at a given time and sends it through a packet-switched common carrier telecommunication network to a central file, where the intended user can log on to the system and retrieve the message using a terminal in a different location at a later time of his or her choosing. A slightly more group-oriented use of computer conferencing is a computer bulletin board: the posting of a message for all or some subset of users on the system to read and respond to. The processing capabilities of CMCS may involve structuring access to shared files by one or more users, on-line polling and tabulation, partitioning computer memory for joint authoring of documents, electronic publishing, retrieving information by the use of keyword indices, altering the content or format of an entry, preprogrammed selecting of the time and location of transmission or reception, and prioritizing the sequence of individuals' contributions to real-time conferences.

CMCS have been in constant development since the early 1970s, due to the diffusion of value-added networks and desktop terminals and to the continuing reduction in computing costs (81). Scientific Time Sharing Corporation developed the first electronic mailbox system in 1972. Electronic messaging became more widely available on the network known as Arpanet to facilitate government-supported computer research (155), and computer conferencing systems such as Notepad were first used for supporting research and development scientists (82) or for managing the wage price freeze (70). There were over a dozen commercial conferencing services in the United States by the end of 1983 (67). Estimates of the electronic messaging market indicate a growth from \$178 million in 1984 to \$636 million in 1986 and \$1 billion by 1990 (77, 200).

Industry interest in electronic mail services is exemplified by A.T.&T.'s year-long testing of A.T.&T. Mail, which involved 200 companies and 15,000 employees (44). A 1984 survey found that half of the sampled organizations expected CMCS would be a significant portion of their 1987 telecommunications budget, up from 5 percent in 1984 (100). A 1985 survey reported that 71 percent of Fortune 1000 companies planned to have CMCS by 1986 (99). By the end of 1985, there were over 1 million commercial "electronic mailboxes" sending 13.5 million messages per month, prompted by the installation of

nearly 6 million personal computers with communications capabilities (200, 201). Easylink, the network component of an information vendor, reports that over 65,000 messages per day flow through its system. The top 15 most active messaging centers in France's Minitel videotex system relayed 6.6 million messages in April 1986 (113). Private, in-house use may be much greater: Hewlett-Packard exchanges 25 million messages per year, Texas Instruments exchanges 4 million, one of IBM's two networks transmits 6,800 messages per minute in peak periods, and Olin Corporation of Stamford, Connecticut exchanged 750,000 messages in 1985 (45, 49, 51, 94, 145).

Nonprofit university and research networks are growing as well. The top five uses of the computer system at Carnegie-Mellon University in 1986 were devoted to finding other users on the system, printing, sending private messages, using a word processor, and sending public bulletin board messages (95). There are approximately one million users in five continents on the "UNIX to UNIX Copy" (UUCP) electronic mail network. In April 1987, there were nearly 1,000 messages per day on one subset (USENET) of the UUCP network (41).

In 1984, electronic messages were estimated to comprise only 250 million of the 974 billion messages sent in the United States (the other sources, in billions, were telephone, 600; interoffice memos, 250; first-class letters, 125; and telegram-telex-priority mail, 1). But although 40 percent of all those 974 billion messages are keyboarded, only about .25 percent are currently machine readable (78). Thus, a tremendous potential exists for the use of CMCS in processing messages.

The major technical components of CMCS—computers, electronic nationwide networks, digital transmission and storage, shared files, and desktop terminals—create a combination of characteristics and functions unavailable in interpersonal and mass media. Users are free from temporal and geographical constraints, for they do not have to be on the system simultaneously in order to send or receive messages. Although many social cues cannot be communicated, participants may use the computer to help structure, edit, and index their messages in ways not possible through traditional media. The lower social presence of CMCS may be desirable in certain communication situations, as will be discussed later. Depending on the extent to which the system was designed to provide it, users may request or provide interactivity when they wish to clarify points, request further information, or prepare an adequate response. Users can typically contact other users through a CMCS network without having to have met them in advance or, by using distribution lists or interest area keywords, without necessarily even knowing that those persons exist.

A variety of evaluative criteria embody different assumptions and place different emphases on organizational communication content and media and thus on the potential role of CMCS in organizational innovation. These criteria are economic, technical, satisfaction, political, cultural, and cognitive (see 11).

Economic criteria. Information has characteristics that make it unlike other products and thereby generates anomalous outcomes when evaluated by classical economic criteria of cost and revenue. For example, the same information may be shared simultaneously by multiple users; it is difficult to exclude additional users; assessing the value of information often requires some of that information itself; it is difficult to identify the original creator and subsequent enhancers of information; and it is subsequently difficult to allocate all the consequences of information to the costs of its production. Studies of office automation show that most organizations continue to apply narrow measures of classic economic productivity instead of taking into account these and other unique aspects of information (39, 85, 179).

There are at least three significant problems that can arise when economic value is the exclusive criterion for evaluating information work (63). First, the value of the material medium is an approximate or arbitrary, and probably distorting, indicator of the value of the information contained or transmitted by the medium. For example, Strassman (179) estimates that less than 20 percent of the total first-year cost for an end-user work station is attributable to equipment depreciation. Other costs include training, supplies, overhead, telecommunications, software, support staff, and furniture. "Organizational learning" about uses, implementation, and behavior related to information systems is the single most expensive, and long-term, cost.

Second, the ratio of benefits to the cost of information is often ambiguous, so information is often underinvested and undervalued. Indeed, econometric studies have shown, based upon analyses of inputs and outputs of 50 industries in 1967 and 51 in 1972, that organizations underinvest in information (66). And third, increased efficiency may be sending a misleading signal to the organization about the effectiveness or relevance of the information work itself, leading to "rigidity and unresponsiveness to change" (5).

The most severe set of consequences of the inappropriate application of classic economic criteria to organizational communication is that information work can become deskilled, fragmented, and routinized while workers receive inadequate training, are monitored on narrow performance measures, and experience occupation-specific unemployment (15, 72).

Technical criteria. Conceiving of the communication process as the transmitting of information by a sender through a channel to a receiver was crucial for establishing a framework for improving the technical aspects of communication systems (168). These technical advances are evaluated according to criteria such as the rate of transmission, signal/noise ratio, and cost per unit of transmission. An overemphasis on such technical criteria, however, leads to three biases in the evaluation of organizational communication processes. First, these criteria tend to assume that obtaining more, and more accurate, information is always desirable. More relevant information *can* increase decision-making performance. However, more but inappropriate information decreases the signal/noise ratio, competes with useful information, diverts organizational members from more important activities, and can reduce performance (122, 171, 178). Second, such criteria also assume that information is an object that is separable

from the participants in a communication process. Thus, such criteria not only ignore the actual process of interpreting the meaning of the information but also prevent designers and implementers from considering the importance of the relationships among organizational members (136). Third, these criteria assume that the organization is a rational system with common goals that require only the efficient distribution of information (97).

Satisfaction criteria. Subjective attitudes that users report about information or an information system have included relevance, accuracy, factualness, amount, timeliness, precision, readability, and reasonableness (58, 102, 162, 202). Other aspects include routineness, uncertainty, equivocality, permanence, process, programmability, knowledge work predictability, and personalness (21, 33, 35, 46, 50, 90, 111, 125, 127, 129, 130, 133, 142, 170, 171, 179, 196). Two difficulties immediately arise in attempting to understand how such evaluative criteria influence the use of information through and about CMCS. First, many of these studies tend to assume that such characteristics inhere in the information or the system, rather than constitute attitudes of the respondents. Second, many analyses of satisfaction do not specify the communication activities or the stage of adoption of the medium in which the respondent is engaged.¹

Political criteria. Information and information systems serve, and are affected by, political aspects of organizational communication (97, 98, 108). These aspects may include the symbolic use of information, intentional ambiguity, control over evaluation criteria, and the ability to set the agenda for adoption choices (43, 50, 131, 132). For example, some individuals may have an account on a CMCS primarily to symbolize their innovativeness rather than to communicate about organizational matters. Designers tend to assume that systems that are highly evaluated on economic and technical criteria would be readily adopted were it not for political motivations (14). However, evaluations that seem political may in fact be based on satisfaction or technical criteria. For example, resistance from users may be a quite valid sign of flawed system design, inappropriate matching of technology to tasks, or unexpected demands on cognitive skills (90, 108, 203).

Cultural and normative criteria. At various levels of analysis, many cultural aspects influence organizational information processing. National cultures differ in their historic rationales for, and interpretation of, institutional information systems (93). Community cultures affect the selection and use of information sources (197). Organizational norms can lead to negative sanctions against seeking information (e.g., from a high-status supervisor or a competitive peer) that consequently reduce the willingness of individuals to seek out innovative information (37). Responsibilities for coordination of or communication through CMCS can become diffused and contentious (74, 173, 174). Cues and rewards within the work unit socialize members about whether to use CMCS to

¹ One exception is a study by Trevino, Lengel, and Daft (188), which applied a symbolic interaction perspective to analyze why organizational members choose different media in different situations. Respondents were more likely to be satisfied with face-to-face communication for reasons of content and symbolic value and with electronic mail for overcoming situational constraints.

communicate about innovative topics or about the level of appropriate use of a CMCS (56, 163).

Cognitive criteria. At the individual level, limits on information processing also affect the use, effect, and evaluation of different content and media (121, 124, 193). For example, decision makers generally prefer more rather than less information, even though this preference may lead to information overload. During such periods users report increased confidence and satisfaction with decisions, although performance rapidly declines (122). Also, even though individuals have different cognitive styles and prefer different types and formats of information (10, 13), designers, implementers, and users of CMCS rarely are trained in how to match CMCS with users' cognitive capabilities (69, 203).

A framework for identifying and analyzing possible roles of CMCS in facilitating innovation in organizations can be constructed by mapping them onto a two-dimensional typology based on organizational information-processing theory. The first dimension of this typology comprises the three stages of organizational information processing: input, conversion, and output. These processes are not just linear procedures for transmitting objective information but also processes through which organizational members interpret the meaning of resources and activities (36). The increasingly complex environments of modern organizations generate diverse and uncertain signals,² and organizations respond by altering their goals, organizational structures, and technology—in a word, by innovating (6, 57, 88, 103, 185). Communication from and about the environment is necessary for organizations to perform and innovate successfully (17, 29, 32, 107, 156, 157).

The second dimension includes the twofold purpose of each information-processing stage. Changes in organizational goals, structures, and technology not only affect what is processed at each stage but also help to buffer, smooth, allocate, and monitor how that content is processed (161). By mapping these purposes onto our prior discussion of characteristics of content and media, the second dimension considers CMCS as a *content* as well as a *medium* of organizational innovation processing. That is, a CMCS not only can be used to process information about innovations but also can be seen as an innovation that an organization must process.

Organizations can use CMCS to facilitate the input of innovative content and content about innovations. Table 2 indicates how these two dimensions interact to identify examples of some of those uses. The following sections discuss each of these cells.

² One measure of this increased environmental complexity is indicated by the growth of an information economy. A greater proportion of labor, occupations, gross national product (over 50 percent), and research and development in the United States and some other countries is devoted to the handling of information; the amount, diversity, and sources of scientific and technical information continue to grow exponentially; interorganizational and international information flows are increasing; services and information work have replaced industrial activities as the primary segment of the U.S. economy (as the industrial sector replaced the agricultural sector earlier); and there is greater conflict and contradiction in traditional as well as information economic sectors (9, 66, 76, 79, 101, 106, 134, 165).

Table 2: Examples of uses of computer-mediated communication systems as content and medium in facilitating organizational innovation, by input, conversion and output stages of information processing

In process	Role of CMCS in communication as	
	Medium (as conveyer of content)	Content (as content of adoption)
Input	Boundary spanning On-line data bases Recruitment of personnel Agenda setting in adoption process	Rationale for innovation Access to system Networks Social presence Task requirements User's position and level Social information processing
Conversion	Substitutability Complementarity Information processing Decision making Expansion of network	Adoption Implementation Reinvention Users as resource
Output	Invisible colleges Electronic journals Desktop publishing Individual, group, organizational performance	Distribution chains Telecommunications community Organizational interdependence

Media with low social presence (especially print mass media) are very influential during the early stages of awareness about an innovation (105, 112, 156), because awareness requires a change in knowledge, not attitudes, and because at that time the availability and use of such media are not completely constrained by cultural, cognitive, or political norms of the interpersonal network (60, 124). Other studies indicate that media with less social presence are actually more influential than interpersonal communications in fostering adoption, possibly because of their unambiguousness, formality, and permanence (73, 162). CMCS and on-line data bases could facilitate the awareness, adoption, and implementation of innovations.

Input processes involve exchanges across boundaries between organizations and their environments (1, 190, 191). "Organizational boundary-spanning individuals. . . may be the link in translating external, market and/or technical information into terms that are relevant and useful for the unique requirements of the organization" (192, pp. 12-23). Computer-based media such as on-line data bases provide the capability for scanning a wider and deeper sector of a particular environment, not only by reducing time and geographical constraints in exchanging information with individuals through CMCS but also by having access to environmental information that is available to an organization's competitors or suppliers. Such scanning increases the diversity of organizational networks, the likelihood of acquiring valuable but unknown information through weak and infrequent ties, and the awareness of interorganizational liaisons (3, 60, 157). For example, "in one firm where someone posted a new product idea on the network, the proposition was sent in one minute to 300

colleagues in branches across the country, and, within two days, sufficient replies were received to launch a new long-distance joint project" (96, p. 1127). Organizations using interorganizational CMCS have increased the number of research projects that used information from external sources (47).

Although a strict interpretation of the "information richness" theory of media use proposes that interpersonal channels are optimal for nonroutine tasks (33, 34), it seems likely that for boundary-spanning activities some categories of interpersonal sources are perhaps less diverse and accessible than CMCS and on-line data bases. From an economic and possibly political evaluation, CMCS could remove many of the costs associated with interdepartmental and vertical communication about innovations.

CMCS can also be used to increase the potential for "reinvention," the change in the form or use of an innovation by the adopter after it has been adopted (152). Reinvention may be intentional—that is, planning for reinvention or a vicarious seeking out of how others solved their mistakes—or unintentional—that is, a reactive solution to problems caused by an intended innovation or secondary responses to problems caused by others' reinventions (85). Because the costs and risks of innovating are so high, reinvention may be far more important and useful for successful performance than innovation (195). Thus, media and content that foster the identification and development of reinvention are a valuable, but underutilized, resource. For example, users of CMCS could describe new ways of solving problems on a bulletin board in the same CMCS that they might use in their work, if this facility is available and supported. Or, computer bulletin boards for industries and user groups can be scanned for innovative solutions to inadequacies in the design of popular software. Reinvention of CMCS itself will be discussed below as part of the conversion process.

However, because organizations are often biased toward economic and technical criteria in their evaluation of information, they may focus too narrowly on the kinds of information that reside in specific data bases, or they may unknowingly institutionalize the cultural and cognitive biases of their search analysts.

Alternatively, CMCS itself can be viewed as the content of the organizational input process of adoption, a process that is influenced by many factors. Organizations often initially adopt media on the basis of rationales biased toward technical, economic, and satisfaction criteria that constrain the quality of information communicated and the organization's subsequent uses of the system for innovation. Early or unequal establishment of economic-based chargeback policies can be an extreme constraint on organization-wide adoption of a CMCS, as users learn to avoid paying for benefits that accrue to others elsewhere in the organization or are difficult to evaluate locally (109). These early rationales may also generate later cultural and political conflict by establishing the subsequent criteria for evaluating performance and limiting the kinds of information that are valued in the work unit (132). In a study of 200 organizations, the rationales for adopting word-processing systems tended to focus on efficiency criteria such as reducing typing, avoiding costs, and reduc-

ing staff (84, 85). Supervisors in such organizations typically had to spend their limited resources on satisfying those narrow productivity criteria instead of managing the work unit's boundaries, scanning their environment, encouraging innovative solutions to their clients' problems, or training their operators to learn advanced functions.

Access may significantly determine the level of use of an organizational medium. Users' perceived accessibility to a system, its information, and other users typically has been a stronger predictor of whether or not they will use that information than its perceived quality (4, 64, 123, 159). Accessibility to a computer system requires not only physical access to a terminal but also the presence of the information in the data base, the reliability of the system, and ease of learning the control language (27). Those with access in this broad sense have been shown to exhibit greater expected, reported, and actual usage of CMCS and on-line data bases (28, 92, 128, 146, 153, 167, 177).

Accessibility plays such a strong role because, as noted previously, the meaning of communication content is typically difficult to determine in advance. Therefore, using the most accessible medium regardless of the differences in content from the alternative media is an efficient strategy, especially when economic and technical criteria emphasize quantity and cost over quality (4), when the situation is ambiguous (123), or when symbolic and cultural criteria favor action over deliberation (37).

Access to the network of users becomes a crucial factor influencing the use of the system. The value of the system—the number of relationships—grows exponentially as new individuals become accessible but is not sufficient for many potential users until a "critical mass" is reached (110, 140, 141). A larger number of other CMCS network members also increases the amount and rapidity of feedback, improving the social presence and richness of a CMCS (69). This is why the number of other users who are known before one adopts a CMCS is a significant predictor of how much a CMCS is used (92).

The potential user's interpersonal network can also influence if and how a CMCS is adopted, as peers provide social information about its use and meaning, maintain norms about its acceptability, and provide role models of adoptive behavior (56, 151, 156). The size of one's interpersonal network has been associated with a user's overall innovativeness and continued use of a CMCS (150).

According to political and cultural criteria, the use of CMCS may increase conflict between organizational units because of the difficulty of communicating subtle differences in interpretation and intention and because long-established authority and peer coalitions may be weakened (94, 186, 191). However, once users have access to CMCS and therefore to a network of other users, the amount of social presence required by their tasks may influence the appropriateness, and therefore the level of usage, of CMCS. Figure 1 shows average ratings, from seven studies of computer conferencing and five studies of electronic messaging, of the appropriateness of the media for a variety of generic communication activities (developed in 107, 170). The ratings show a clear progression from a greater to lesser appropriateness of CMCS as the communi-

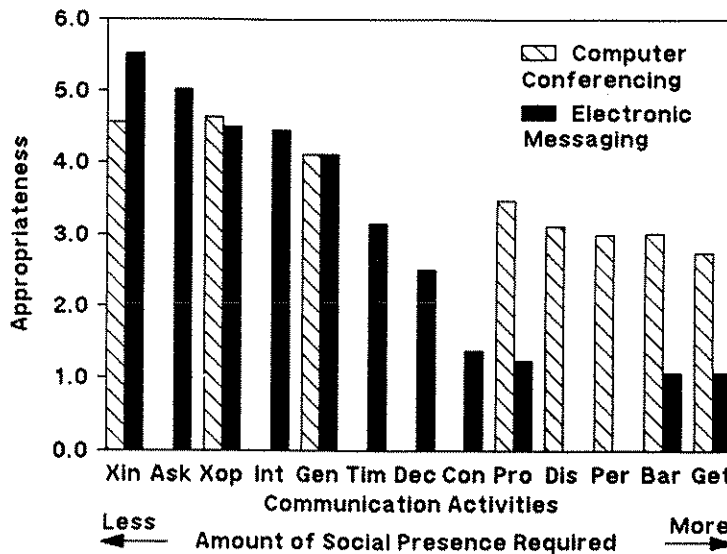


Figure 1: Ratings of electronic messaging and computer conferencing systems on appropriateness and satisfaction for communication activities with varying levels of required social presence

Xin = exchanging information; *Ask* = asking questions; *Xop* = exchanging opinions; *Int* = staying in touch; *Gen* = generating ideas; *Tim* = exchanging timely information; *Dec* = making decisions; *Con* = exchanging confidential information; *Pro* = solving problems; *Dis* = resolving disagreements; *Per* = persuading; *Bar* = bargaining; *Get* = getting to know someone.

Values plotted are averages of ratings from seven studies of computer conferencing (reviewed in 142, p. 132) and five studies of electronic mail (146—two samples; 147, 153, 154). The aggregate results are used to illustrate the general differences in users' subjective evaluations of CMCS for generic communication activities. Results across computer conferencing and electronic mail are not strictly comparable, as the computer conferencing studies used a 7-point scale measuring satisfaction, while the electronic mail studies used either a 5-point or binary scale measuring appropriateness. All scales were converted to a 7-point scale (from 0 to 6).

communication activities require more social presence. Further, computer conferencing seems slightly more appropriate than electronic messaging for activities that require more social presence, perhaps because of the increased capability for network structures and interaction among participants and the decreased constraints on processing content. Other studies have shown this difference in perceived appropriateness to be a significant discriminating factor between users and non-users and among dimensions of use (147, 177).

Given that users consistently make such distinctions about the appropriateness of CMCS for various communication activities, and given the characteristics of CMCS compared to those of traditional organizational media, two questions arise. First, can these new media convey social and emotional information? Studies of public and organizational CMCS transcripts

indicate that about 30 percent of their content comprises such information (149), and there are indeed many typographic ways to convey paralinguistic cues (7). Indeed, because of the filtering of nonverbal cues, CMCS may actually increase emotional content (96), and increase variance in that content (176), compared to interpersonal communication.

More important, as Table 1 shows, CMCS have characteristics that more "information-rich" media do not, and these functions may enhance certain kinds of interpersonal communication (30). The increased connectivity that users can experience through CMCS networks can lead to new interpersonal contacts. For example, the number and strength of close and personal ties in a group of 50 social scientists who used a CMCS increased significantly during a one-year period (55). Organizational members with low tenure are more likely than longer-term members to use a CMCS for social purposes in order to learn about the organization's culture more quickly than they would if they relied solely on traditional organizational media and opportunities (177). However, preliminary studies show that individuals' communicator styles are associated with the extent to which this lower social presence influences the use of CMCS for certain communication activities. For example, Rice and Torobin (154) found that the "dramatic" and "precise" dimensions of communicator style (118) were significant predictors, in opposite directions, of respondents' expectations about their use of electronic messaging.

Second, are there situations in which decreased transmission of social and emotional information is appropriate? Some media are more appropriate than face-to-face communication because they screen out some highly socioemotional cues, such as extremely embarrassing interactions, or because they prevent interference of some cues with others, such as personal charisma or style of dress, that can mask signals of deceit or lack of information (142, 170). This is one reason that computerized diagnoses and medical bulletin boards are generally preferred by individuals with asocial behavior or illnesses, who would otherwise be too embarrassed or shy to reveal such intimate information to another person directly (22, 48, 61). Further, this masking of political, cultural, and symbolic information may improve conversion processes in some contexts, as will be discussed.

The relationship between the choice of medium and communication task is influenced by the purpose of communication, the direction of communication, the leadership of the users' work units, and awareness of media characteristics (33, 34, 137, 146). Users increasingly prefer face-to-face and telephone channels over CMCS when they need more social and emotional communication and when tasks are complex or diverse (33, 34, 86, 162, 170).

However, two characteristics of tasks that are not routine, but are amenable to the unique attributes of CMCS, are cross-locational interdependency and innovation. Cross-locational interdependency—typically high for organizational members who supervise a large number of employees, occupy boundary-spanning roles, and coordinate relationships among several work units—has been associated with greater use of CMCS because of the greater freedom from temporal and geographical constraints (92, 177, 182). Organizational members

whose tasks involve generating or implementing new ideas are likely to have more positive attitudes toward innovations in general and thus to be more accepting of CMCS in their work (181).

As those at higher organizational levels spend more time communicating interpersonally and handling equivocal tasks, they are less likely to find CMCS appropriate according to satisfaction criteria; executive norms against using terminals may also hinder usage. Clerical workers may spend less total time communicating but a greater proportion in mediated communication or routine information processing; they therefore would use CMCS to a greater extent. Some studies have found just such positional differences in CMCS usage (150, 153, 175); others have not found significant differences (89, 117). Age tends to be negatively associated with acceptance and use of technological innovations in general and CMCS in particular (92, 156), while organizational level was the strongest predictor of the perceived overall appropriateness of a university CMCS (146). Thus, potential users' position, level, tenure, and current media habits tend to influence their adoption of CMCS, due to the nature of communication activities associated with certain positions and levels and to older employees' increasing reluctance to change.

These patterns often have been used as the basis for identifying potential opportunities for CMCS (39, 72, 164). This kind of analysis, however, tends to be based on the classical economic assumption that total dollar cost is the primary criterion for evaluating organizational productivity. However, the assumption that lower-level information workers have little to contribute to organizational performance—because they have relatively less opportunity for reducing communication costs by reducing the time they spend in using media—ignores the greater familiarity that information workers have with work unit information flows, tasks, and context. Organizations that focus only on technical and economic criteria will tend not to support the adoption of CMCS by lower-level employees or the use of CMCS by those employees for processing information about organizational innovation.

CMCS can substitute for, as well as complement or augment the use of, traditional media's facilitation of organizational conversion processes such as routing, modifying, delaying, and summarizing content. At the interorganizational level, CMCS can increase the capabilities and diversity of organizational conversion by, in essence, extending organization boundaries along their "value chains. . . transforming the nature of products, processes, companies, industries and competition itself" (135, p. 149). Telemarketing is an example of organizational use of communication systems to overcome physical, temporal, and market constraints on performance.

At the intraorganizational level, the adoption of CMCS may convert communication processes by substituting for the use of traditional media, although time and cost savings would be differentially allocated by position and level, as discussed previously. Studies have found decreases in written, telephone, travel, and some face-to-face communication after a CMCS was implemented (23, 26, 52, 53, 59, 83, 89, 114, 116, 126, 146, 180, 183).

At both the inter- and intraorganizational levels, studies of CMCS have shown subsequent increases in overall direction, amount, and diversity of communication linkages (18, 24, 26, 53, 55, 69, 70, 82, 83, 92, 104, 126, 139, 145, 146, 153, 180, 183). Such systems have complemented not only vertical and redundant communication among organization members but also horizontal communication and coordination in organizations with a matrixed structure.

Because of their combination of media characteristics, information systems in general, and CMCS in particular, have been shown to improve many aspects of organizational information processing (145, 179). Currently, conversion processes such as media transformation, timing, and shadow functions may take 20 percent or more of a professional information worker's time (8, 164). CMCS may help users improve their control over information. One example is the use of electronic mail to send "active messages" that are in essence programs that perform functions in the systems where they are received (189). CMCS users may reduce media transformations (the number of times particular content must be delayed or modified across different media), thus reducing time, energy, and errors in converting content. They may also reduce delays and modifications due to shadow functions, those unforeseen, unpredictable, time-consuming conversion activities that are associated with some organizational media but that do not contribute to achieving goals and outcomes (such as "telephone tag," business travel, or waiting for other group members to show up at a meeting).

Group decision making is another conversion process that can be affected by CMCS. Because CMCS do not convey as much information as face-to-face communication about socioeconomic status, physical attributes, gender, age, locational surroundings, speaker dominance, network structure, and communication regulator cues (such as turn taking), participants are freed from some of the constraints of dyadic and group exchanges. In addition, CMCS can lead to greater accuracy of the decision, greater equality of participation by the members, greater variance of opinion, and fewer total words during the decision process. However, groups tend to take longer to arrive at a decision (although this decreases as users gain experience with the keyboard), are slightly less likely to arrive at consensus, and are less likely to have a strong leader emerge (80, 142).

In light of CMCS's possible influences on this conversion process, it is important to note that some of the assumed advantages of face-to-face group decision making are not necessarily beneficial to group performance. For example, leaders of new groups tend to be chosen on the basis of their speaking frequency and duration, which has no strong relation to content expertise (70). Yet, early opinions and decisions by group leaders are significantly correlated with the group's final decision. Further, although consensus may be a valued symbolic and political outcome, in controlled experiments, consensus is not correlated with the quality or accuracy of the decision (142), and group norms such as avoidance of conflict or high costs for seeking information outside the group may actually result in a conservative, inappropriate decision.

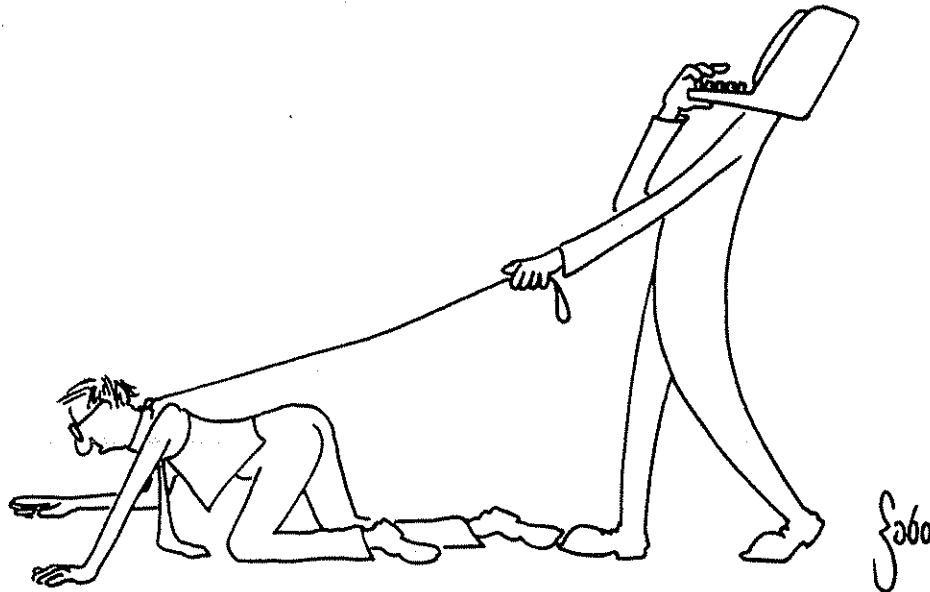
The opposite danger is that the differences in CMCS-based group decision

making may be evaluated solely on technical and economic criteria, which would overlook the real cognitive, satisfaction, and political needs for consensus and intuition satisfied by face-to-face decision making. CMCS allow a group to collaboratively create meaning out of diverse sources of information, commenting on and editing messages and documents, indicating ways in which individual opinions may diverge from common material, and possibly continually affecting the group's shared experiences and meaning. Transactional and interpretive analyses may be appropriate approaches to understanding how users create a "unique acquired literacy" (68, p. 2). Others have commented on how using CMCS can develop an altered state of consciousness, but in general this direction has not been pursued (20, 70, 83). Thus, both CMCS and traditional media may constrain or facilitate the possibility of an innovative decision, but in different ways.

CMCS has other potential for innovation by facilitating more open organizational networks. Because more open networks reduce uncertainty about tasks and other members, increase access to information, increase accuracy of information because trust is improved (121), and facilitate stronger linkages among multiple subjects, organizations with more open networks tend to be more innovative and successful in implementing innovations (2, 17, 42, 87, 158, 186, 191). Even at the individual level, innovativeness is associated with one's centrality in organizational networks, which has traditionally been heavily determined by the physical proximity of the members (91). CMCS have media characteristics that can facilitate the development of internal networks by overcoming political or cultural evaluations due to difference in communicators' status and overcoming technical or economic boundaries due to distance. By integrating members into social and work networks early on, CMCS can facilitate the development and frequency of associated innovation networks (2).

Development of networks through CMCS may, however, be problematic. For example, unless a CMCS contains relevant formal information, unfounded rumor could spread quickly. Also, the rise of electronic networks can diffuse responsibility, prevent the identification of the source of information, blur formalized communication boundaries, and increase transaction costs for nonmembers (94, 142, 172, 173, 174). Interorganizational CMCS networks can facilitate ephemeral and uncohesive groups or even redefine the concept of groups. Depending on how CMCS are implemented and managed, they may also increase organizational inequity and distinctions based upon access to information and power (143).

As an organizational innovation, computer-mediated communication systems, as well as their users, may be the content of conversion processes. CMCS may be reinvented in an ongoing process of converting the original form of the innovation into forms that are more customized or better adapted to the needs of users and the organization. For example, CMCS can be redesigned to structure communication processes to filter content and reduce information overload. However, solely technical solutions to such problems can preclude users' being exposed to unpredicted and innovative message content



(71). Political or cultural obstacles to users becoming involved in the ongoing design and application of CMCS, or a reliance on technical solutions to changing needs, may also significantly constrain the reinvention of CMCS and subsequent internal innovations.

Part of this adaptive capability is influenced by organizational policies about peer communication and training. Supervisory support for group communication about work and experimentation, feedback about the unit's performance, and ongoing learning are crucial for improving performance and developing innovations (31, 120, 160). The few studies that compare modes of training for office automation systems indicate that users prefer to learn a new system from their peers, especially for advanced functions and applications (54, 85). Although vendor manuals and introductory seminars are useful for learning the basics of a system, they do not provide insights into either a conceptual understanding of the system or its contextual and potential uses. For example, a study of the influences on innovative word processing in nearly 200 organizations showed that communicating and learning about word-processing hardware and operations were not associated with unit reinvention. However, regular meetings and unit communication about how the technology could be used in work and about advanced features were significantly associated with unit reinvention (85).

Organizational learning and reinvention occurs at the level of the users. Users can be considered the "content" of processes that "convert" them into skilled but local information sources. These system users can become interunit liaisons or even inputs to other functional areas: they become a medium for diffusing innovative content—about how to use a system or how to apply it—to the other users whose tasks they have come to understand and which they can

improve (85, 148). Unfortunately, this subsystem strategy is typically ignored by evaluations of information work that focus solely on technical and economic criteria and by job designs that effectively assume that workers are only input and conversion *media* and not conversion and output *content*.

This reconceptualization of the roles that users of CMCS may play has another important implication. Until expert systems become very commonplace, the expertise that users gain is difficult to make accessible to others in a permanent or widespread manner. Thus, a subtle problem can arise with the investment of so much contextual information in the users themselves: corporate memory disappears when unsatisfied workers leave or is unavailable when they are constrained to satisfy only local economic or technical criteria.

CMCS also have the potential to facilitate output processes, both as media and as content. The process of spanning organizational boundaries is conducted by individuals, typically through media, and includes the negotiating transactions required to distribute outputs, to represent the organization to its environment, and to buffer the organization from uncertainty about who will receive those outputs and what their requirements are (1). As an output medium, CMCS systems can facilitate the diffusion of information to an organization's environment, both directly through interorganizational electronic mail networks and indirectly through electronic journals posted on text data bases. Large-scale CMCS, especially those that cross organizational and industry boundaries, are already providing such structures, some in the form of invisible colleges (25, 69, 187). Research and development workers use these networks to keep informed, solicit evaluations, collaborate on research, and gossip about funding and job opportunities. Theoretically, some physical, temporal, and financial constraints can be removed from the creation, distribution, and utilization of scientific and technical information. Currently, however, there are considerable obstacles to such exchange, including economic criteria (unacceptable or difficult-to-justify economic costs, ambiguous ownership of on-line information), technical criteria (insufficient technical resources, disagreements about international standards), symbolic criteria (reward systems such as tenure based upon printed refereed articles), cognitive and satisfaction criteria (the difficulty of reading complex text from terminal screens), and political criteria (the inaccessibility of networked CMCS for most people even in the United States).

An organizational CMCS may also serve to develop feedback cycles into subsequent organizational inputs. For example, information about prior input, conversion, and output processes can be made available through an organization-wide suggestion data base or through distribution lists that send comments to a relevant subsample of the organization.

The increased complexity of organizational environments (see footnote 2) includes increased cross-organization and cross-industry linkages required to provide innovative information services (52). As computers and networks become a more fundamental basis for information services, information and media providers will not only experience greater environmental uncertainty in

the form of new inputs, outputs, and competitors but will also take part in increased joint activities with other economic sectors. Organizational output processes may thus include CMCS as innovative products or as innovative ways of managing environmental uncertainty. For example, electronic news, an on-line data base service, requires transmission, information, software, and hardware resources. General-service videotext services are not faring as well as localized teletext services partially due to the heavy dependency on interorganizational resources of videotext services (65). However, this increased interorganizational innovation may in turn generate economic conflicts, such as opportunities for oligopoly and price setting, decreasing ease of entry, and lowered organizational autonomy (19).

This review of the existing research and theory about CMCS has shown that such systems possess distinctive characteristics that can influence communication about, and the adoption of, organizational innovations.

Characteristics such as freedom from some communication constraints, lowered social bandwidth, increased bandwidth, and extended networks all differentiate CMCS from traditional organizational media and thereby can change how organizations input, convert, and output content about innovations in their attempt to resolve and reduce environmental uncertainty. Additionally, the medium of CMCS is for most organizations an innovation itself and thus can be analyzed as content that is interpreted, evaluated, adopted, and possibly reinvented at each stage of organizational information processing.

However, unless content of CMCS is adequately understood and evaluated, the adoption and use of the medium of CMCS may be constrained by narrow and insufficient evaluation criteria. Management practices that concentrate too heavily on technical and economic evaluations of CMCS will miss the important role that cultural, satisfaction, political, and cognitive evaluations play in organizational innovation processes. Some of these pitfalls include evaluating communication on classical economic criteria of increased output per cost of input, evaluating the appropriateness of organizational media solely on the basis of requirements of routine tasks instead of including requirements of social and emotional communication activities, or designing CMCS in ways that prevent access to external and innovative communication sources. The criteria used to evaluate content and media can significantly influence the extent to which organizations communicate about as well as adopt innovations. Indeed, there is no necessary assumption or assurance that the use of CMCS either as content or medium *will* be associated with organizational innovation. I have tried to show that CMCS may have both advantages and disadvantages for organizational communication, and that, depending on different criteria, they may or may not be adopted and reinvented.

Finally, research on organizational innovation must continue to analyze the counter-intuitive and elusive characteristics of both communication content and organizational media. This approach requires a more detailed identification of the processing stage being analyzed, the criteria used to evaluate the content and the media, and the communication-related needs of organizational mem-

bers and their activities. In particular, theories of organizational innovation can benefit by taking into consideration and further specifying interactions among media, content, processing stage, and organizational structure (34). For example, CMCS may well be differentially appropriate for communicating about innovations in different information-processing stages depending on specific attributes of the innovations and characteristics of the adopting individual or organization. These relationships may well be contingent on, and lead to, different organizational structures. For instance, a decentralized organization may be more likely than a centralized one to adopt CMCS and use it for diffusing content about reinventions. Although the fields of management science and organizational communication have in fact come a considerable distance from the initial studies of computer-mediated communication systems, complex opportunities and challenges in studying CMCS as both medium and content of organizational innovation still remain.

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